Beyond Defense Spending: An Empirical Analysis of Defense Investment and Collaboration in the European Union

Winden, Danique van

Beyond Defense Spending: An Empirical Analysis of Defense Investment and Collaboration in the European Union

Danique van Winden

Leiden University

MSc Public Administration: Economics & Governance

Advisor: Dr. Rik de Ruiter

Second Reader: Dr. Jaap Reijling

9 June 2023

Abstract

The central research question addressed in this study is: What are the key determinants of European defense spending, defense investment, and defense investment collaboration from 2005-2021? Using data from SIPRI and the European Defense Agency (EDA), this paper performs a series of analyses in the form of Ordinary Least Square (OLS) Regressions, Heckman Two-Step Analyses, and a Qualitative Comparative Analysis (QCA) to understand the determinants of the three dependent variables mentioned above. This is the first research to address defense investment and defense investment collaboration as separate dependent variables from defense spending. The findings support the fact that the determinants of defense investment and defense investment collaboration do not exactly mimic those of defense spending, and therefore these should be treated as separate dependent variables going forward. Specifically, this research finds that the type of external threats faced by a country, whether it is an EU15 member, and the risk of free riding all play different roles in defense spending, investment, and collaboration, respectively. A heightened understanding of the determinants of defense spending, defense investment, and defense investment collaboration as different entities will allow EU leadership to make more effective policy decisions in order to enhance investment levels among member states. This is especially important given the current tense geopolitical environment and the depletion of military equipment stockpiles following the 2022 invasion of Ukraine.

Keywords: defense spending, defense investment, defense investment collaboration, free-riding, external threats, fiscal capacity, EU15

Table of Contents

1. Introduction

In 2014, Russia invaded the Crimea and Donbas region of Ukraine, and within one month, annexed the region as its own. Though the world responded with a series of condemnations and refusals to accept Russia's claim of the territory, the hostile invasion failed to mobilize a global response. This was not the case in February of 2022 when Russia invaded Ukraine again. This time, the world responded with an outpouring of support, aid, and weapons transfers (Bergmann et al., 2018). As of February 2023, EU institutions have supplied over 35 billion euros in aid to Ukraine, and aid is expected to continue as Ukraine maintains a strong defense (Statista, 2023). With the increasing urgency of EU security given recent developments, it has become especially important to fully understand the supply and demand of defense expenditure in the EU.

Though the EU has been increasing its defense expenditures, an interesting phenomenon has come to light over the years: the EU is not collaborating sufficiently on defense initiatives (European Commission, 2022b). In 2021, only 11% of defense investment was spent on collaborative endeavors, less than one third of the EU target of 35% (European Commission, 2022a). This begs the question of whether an increase in EU defense spending is effective, or if it is simply a result of multiple member states making duplicate expenditures and investments due to lack of collaboration. The European Commission appears to fear the latter; it recently published a Joint Communication specifically highlighting the defense investment gap problem in the EU and how uncoordinated spending and a lack collaborative defense investment pose an urgent threat to security (European Commission, 2022b).

Defense investment is a subset of defense spending. According to the data from the EDA (European Defense Agency), defense investment consists of two major factors: defense equipment expenditure and defense R&D expenditure (which also includes R&T) (European Defence Agency, n.d.). This means that investment does not include other costs included in defense spending, such as operations costs, personnel, infrastructure, and outsourcing costs (European Defence Agency, n.d.). Collaborative spending similarly encompasses only collaborative defense procurement expenditure and collaborative defense R&T expenditure (European Defence Agency, n.d.).

Determinants and comparisons of defense spending have been researched in several contexts, often with a region- or country-specific focus, or with a lens focused on the relationship between defense spending and other key indicators, such as economic growth (Robertson, 2022; Kollias et al., 2004; Eichenberg & Stoll, 2003). Previous studies have investigated the determinants of defense spending, both in specific countries and in the EU in general (Christie, 2019; Nikolaidou, 2008; Kuokštytė et al., 2021; Odehnal & Neubauer, 2018). Defense investment, however, has surprisingly hardly been researched, even

though the EU explicitly distinguishes between the two indicators in its defense reports (European Commission, 2022a; European Commission, 2022b).

Existing research on defense investment and collaboration focuses on the relationship between private industries and public investments (Malizard, 2015; Oneal, 1990) and theoretical descriptions of collaboration patterns and problems (Eilstrup-Sangiovanni, 2014; Martill & Gebhard, 2023; Moretti et al., 2019; Fiott, 2017). Both lenses are important, however, surprisingly, it has not been investigated how these forces work simultaneously. Therefore, as opposed to further studying the determinants of defense spending, it is essential to analyze what determines defense investment and defense investment collaboration in the EU.

This research will argue that it is crucial to examine defense investment and defense investment collaboration as a measure of defense resilience. Defense spending typically focuses on fulfilling short-term defense needs. The EDA specifies that defense investment refers to long-term military solutions, such as procurement and research & development initiatives (European Defence Agency, 2022). This implies that defense investment is an investment in a long-term stronger, smarter, and more effective defense system. The EDA argues that investment is needed in order to keep the EU from falling short in its military capabilities compared to the rest of the world (European Defence Agency, 2022). Furthermore, core EU institutions such as the EDA and the European Commission argue that increased collaboration is essential for European defense resilience. Without collaborative investment in military endeavors, which would allow for knowledge and equipment sharing, economies of scale in production, and a decrease in fragmentation, the EU will continue to exist as a collection of small independent defense forces, instead of as a stronger united front (European Commission, 2022b; European Defence Agency, 2022). The European Commission further argues that more harmonized defense investment and collaboration will make the European defense industry more competitive, which could result in a stronger economy in the EU overall (European Commission, 2022b).

As of this reading, no empirical research has been done explicitly regarding the determinants of defense investment and defense investment collaboration among EU member states. Additionally, no study has yet used the EDA investment and investment collaboration data in a quantitative analysis. This might be because the EDA only started publicizing figures on defense collaboration in 2005. Some might argue that there is no need to investigate defense investment as a separate phenomenon from defense spending, and that these two dependent variables might have the same determinants. This argument is directly refuted by the empirical evidence presented in annual European defense reports; as spending increases, national defense investment continues to grow at a considerably slower rate together with collaborative investment (European Defense Agency, 2022). This is not to say that there is no overlap in the determinants of defense spending, defense investment, and defense investment collaboration. Since defense investment and defense

investment collaboration are a subset of total defense expenditure, it is expected that these three concepts do share some determinants, but this study will aim to demonstrate that these determinants are not identical.

Therefore, this study will consist of three main investigations. First, it will aim to combine the findings of previous studies on defense spending determinants to establish a more comprehensive and complete understanding of defense spending determinants. This will help set the foundation for the second and third analyses, which will use the findings from the first analysis to determine what the exact determinants of defense investment and defense investment collaboration are. To do so, this study will conduct a quantitative analysis of European defense spending, defense investment, and defense investment collaboration initiatives. To supplement the quantitative analysis of the EDA data, this paper will also dive deep into the current collaborative EU defense investment projects of Permanent Structured Cooperation (PESCO) to highlight the importance of strategic interactions and state power in actualized defense investment decisions.

In summary, the core scientific contributions of this research are as follows: it combines and improves upon existing defense expenditure determinants research (Christie, 2019; Nikolaidou, 2008; Kuokštytė et al., 2021; Odehnal & Neubauer, 2018) with newer data, it is the first research to investigate defense investment and defense investment collaboration in the EU as dependent variables, and it proves that defense spending, defense investment, and defense investment collaboration do not have identical determinants, and therefore should not be treated or perceived as the same dependent variables. Specifically, this research shows that key indicators, such as the type of external threats faced by a country, whether it is an EU15 member, and the risk of free-riding all play different roles in defense spending, investment, and collaboration, respectively. This is especially the case for EU countries, where states have competing overlapping international commitments and obligations.

The societal relevance of this research is that it helps provide a better understanding of what deters and encourages defense investment and defense investment collaboration in the EU. Priorities, politics, and the global stage have all changed drastically since the EU came to be, and it is important to understand how these changes have manifested themselves in the decisions of member states. A clearer understanding of defense spending, defense investment, and defense investment collaboration over time would allow the EU to implement more effective policy in an era of rising geopolitical aggression. This research proves that the existing research on defense spending is not sufficient or accurate as a basis for policy-making regarding defense investment and defense investment collaboration. Additionally, due to the additional strategic threat of China since early 2022, the EU cannot afford to fall behind in defense. For this reason, this research will answer the following main research question:

What are the key determinants of European defense spending, defense investment, and defense investment collaboration from 2005-2021?

Using data from the EDA, this research will show that the determinants of defense investment and defense investment collaboration differ from the determinants of defense spending, and therefore defense investment and its collaboration should be considered their own dependent variables in future research. This study finds that the positive defense spending determinants for this sample are: NATO membership, the change in US defense expenditure, and the threat of Russia. The negative determinant is the interaction between NATO membership and the defense spending levels of NATO countries, suggesting that NATO members are more likely to free-ride as defense spending among NATO allies increases.

The core positive determinants of defense investment include the change in US defense spending and the threat of Russia. The core negative determinants of defense investment include the average level of defense spending in NATO countries, suggesting free-riding behavior also extends to countries not in the NATO alliance. The other key negative determinants were the level of terrorism and involvement in international conflict, suggesting that different types of immediate external threats can cause a fall in defense investment.

Using both Ordinary Least Squares (OLS) and Heckman two-step models, with a supplemental Qualitative Comparative Analysis (QCA), to investigate the determinants of both the likelihood and the subsequence amount of defense investment collaboration, this research finds evidence that perceived trust among governments is an important determinant of defense spending collaboration in R&T. In addition, being an EU15 member is strongly associated with more involvement in collaborative investment projects. The models also find that external threats have a downward impact on defense investment collaboration, as opposed to the common belief that national security risks will spur defense initiatives.

The following section will explain in depth the history of EU defense cooperation initiatives, as well as provide a brief overview of existing research about defense spending, defense investment, and defense investment collaboration. The theoretical framework will address the underlying theory that is expected to play a role in defense investment and collaboration initiatives. The next sections explain the data, methodology, and results of the analysis. Finally, the discussion and conclusion will explain the interpretation of the results for policymaking and suggestions for further research.

2. Background

The first steps toward a European defense strategy were set in 1948 under the Treaty of Brussels (European Union External Action, 2021). A second review of European defense strategy came about in 1999, when the Treaty of Amsterdam was signed. It established a stronger operationalization of the role of the Common Foreign and Security Policy (CFSP) that had been established under the Treaty of Maastricht (European Council, n.d.). It was not until 2009, under the Treaty of Lisbon, that the need for a common European defense strategy was emphasized; it created the Common Security and Defense Policy (CSDP) and called for a more unified approach to crisis management within the EU (European Union External Action, 2021).

The decade following the Treaty of Lisbon gave rise to a host of acronyms surrounding defense, such as the European External Action Service (EEAS), the European Defense Agency (EDA), the European Defense Fund (EDF), the Permanent Structured Cooperation (PESCO), and the Coordinated Annual Review on Defense (CARD) (European Union External Action, 2021). These initiatives were launched throughout the years under the premise of further enhancing defense capabilities and defense cooperation in the EU, however, as stated by the EDA itself: “Despite the increase in total defence expenditure, defence investments and defence equipment procurement, spending for collaborative projects does not seem to be a priority for the majority of MS [member states]” (Monaghan, 2023).

The institutions that play a central role in EU defense spending, defense investment, and defense investment collaboration are the EDA, EDF, PESCO, and CARD. Each of these has contributed to a concerted effort to increase defense cooperation in the EU. The EDA was created in 2004, with the goal of encouraging a more collaborative defense strategy in the EU (European Defence Agency, n.d.). In 2017, the European Council launched PESCO to further spur collaborative projects; its founding is rooted in Article 42(6) of the Treaty of Lisbon (Permanent Structured Cooperation, n.d.). Currently, 25 member states voluntarily take part, however, once they enter investment commitments, the agreement is binding (Permanent Structured Cooperation, n.d.). PESCO is supported by the EDF - which was launched in early 2021 and allows member states to apply for funding for collaborative defense projects – and CARD, a tool used to review the current defense environment and identify opportunities for collaboration between member states (European Defence Agency, n.d.).

Defense in the EU remains a complicated issue because of the multiple international commitments. Of the 27 EU countries, 21 are members of the North Atlantic Trade Organization (NATO). Members of NATO are required to commit at least 2% of their GDP to defense spending – in 2014, only four of 18 member states met this quota (World Economic Forum, 2019). Literature attributes this shortcoming to several factors, including the tendency to rely on US defense supplies and manpower and the issue of collective action.

The US is a major military power. The US defense budget is almost three times the size of the second-highest defense spender, China (World Economic Forum, 2019). Because of the deep economic, political, and military ties between the EU and the US, it has become increasingly attractive for the EU to rely on US military assistance in times of need. This kept military pressure off the EU for several decades and caused a slowdown in defense initiatives and spending (Monaghan, 2023). In 2014, Europe faced a wake-up call when Russia invaded and promptly annexed Crimea; that year, EU nations pledged to reach their NATO spending commitments and the EU started to focus on collaborative defense strategies (Monaghan, 2023).

Defense investment specifically is important to investigate because it adds a layer of complexity to the defense spending puzzle. With investments, it is more difficult to observe direct, favorable outcomes. This is because investments take longer to show returns, investments are not always guaranteed to show returns, and investments require large amounts of upfront human, physical, and monetary resources at the onset, which can make it difficult to fit investments (for example, into R&D) into tight budgets (Müllner & Nečas, 2022). It is much more attractive to spend on defense expenditures that can immediately have their use and cost justified through immediate payoffs. This is especially true in a political atmosphere. Politicians must justify public spending choices to their constituents and investing in projects that do not offer an immediate gain (monetarily or militarily) to society can be viewed as unfavorable by the electorate (Williams, 2015). Additionally, studies have shown that in the event of budgetary tightening, expenditures and particularly investments in the defense sector are more subject to scrutiny than other public spending (Coulomb & Fontanel, 2005; Müllner & Nečas, 2022). The following section will elaborate on each of these complexities and factors and how they translate into theories and predictions about (collaborative) defense investment in the EU.

3. Theoretical Framework

As was stated in the introduction, the core target question that this research aims to answer is the following: What are the key determinants of European defense spending, defense investment, and defense investment collaboration from 2005-2021?

Investigating this question involves a series of steps. First, it will be important to understand the determinants of defense spending, as found by previous research. Instead of simply relying on the results from previous research, this study will try and apply the findings of previous studies to this specific sample. This is because there have been many papers with conflicting findings about the determinants of defense spending, and it has not yet been concluded what the exact determinants are. Once the determinants for this specific sample have been found, it is believed that this will help establish a strong foundation for the determinants of defense investment and defense investment collaboration. Second, the determinants of defense investment will be analyzed. Finally, a third analysis will be focused on the determinants of defense investment collaboration. Table 3.1 summarizes the dependent variables in this study, as well as their definitions.

Table 3.1.

Dependent variables and their definitions

Dependent Variable	Definition	Analysis
Defense Spending (as % of GDP)	Total military expenditures, including, inter alia, operations costs, equipment, R&D, personnel, infrastructure costs	Analysis 1
Defense Investment (as % of defense spending)	Defense equipment expenditure and defense R&D expenditure, spent by each member state	Analysis 2
Defense Investment Collaboration (as % of defense spending)	Defense equipment expenditure and defense R&D expenditure, spent on joint initiatives between two or more member states	Analysis 3 & 4

Note. Definitions sourced from European Defense Agency (n.d.)

3.1 The determinants of defense spending

This research will first look at defense spending determinants before turning to defense investment and defense investment collaboration, because it is believed that these various dependent variables share many of the same determining factors. This has not yet been proven, because the determinants of defense investment and defense investment collaboration as separate entities from defense spending have never been analyzed before. However, this research supposes that this is the case because defense investment and

defense investment collaboration are subsets of defense spending. If this turns out not to be the case, this research will help prove that more thorough research is needed about defense investment and defense investment collaboration, and that these should no longer be considered comparable to defense spending.

To understand investment and collaborative investment, which is a part of total military expenditure, it is important to have a complete picture of what determines defense expenditure for this sample. Therefore, the purpose of the defense spending analysis that will be conducted here is simply to combine the findings of previous research to establish a solid understanding of the actual determinants of defense for this sample specifically, to work as a steppingstone of understanding for the subsequent analyses about defense investment and defense investment collaboration. Because this research does not aim to further expand on research about determinants of defense spending in general, no hypotheses will be developed here.

The determinants of defense spending have been thoroughly investigated in previous studies. Nikolaidou (2008), for example, was one of the first studies that looked at the demand for defense expenditure in the EU as a whole instead of just in individual countries. The study found that the determinants differed widely across member states or acted as stronger factors in the demand for military expenditure. For some member states, commitments to NATO were strong determinants of expenditure, while for others it was factors such as US defense expenditure, population size, or domestic income (Nikolaidou, 2008).

In a larger sample of all NATO countries, Odehnal & Neubauer (2018) investigated the determinants of military expenditure according to three categories: economic, security, and political factors. Though their main conclusion was that determinants differ significantly between countries, their analysis confirmed the findings of Nikolaidou (2008) and showed that defense expenditure is heavily dependent on expenditure levels in the previous period and on economic factors, such as the risk of inflation and debt, and security factors, such as international conflict.

Several years later, Christie (2019) extended this research by looking at a more contemporary time period and introducing the importance of fiscal capacity into the analysis. He argued that it is important to consider the fact that member states have agreed to certain fiscal limitations as part of their EU membership, and therefore this plays an important role in defense spending decisions. Because of his findings, this will also be further elaborated on as a hypothesized important determinant of defense investment and defense investment collaboration in the next sections. The second contribution of this paper was to consider the impact of Russia's annexation of Crimea in 2014; it found that this played a significant role in increasing defense expenditure (Christie, 2019). Because PESCO and its supporting agencies were created in 2017, partially due to the conflict in Crimea, this external threat factor will also be incorporated into the defense investment and defense investment collaboration analyses. This will be further elaborated on below, as

well. Alozious (2022) confirmed Christie's (2019) findings about fiscal capacity constraints, showing that debt-to-GDP ratios, and not just change in GDP growth or public debt, are significant indicators of demand for military expenditure.

Kuokštytė et al. (2021) extended the findings of Nikolaidou (2008) to a more contemporary time period. Additionally, they included domestic political factors in their analysis, such as political party strength and upcoming elections, which were found to be significant as determinants of defense expenditure. Kuokštytė et al. (2021) did not find any evidence of an association between EU member state military expenditure and US military expenditure, like Nikolaidou (2008) had found. This could be because these studies examined different time periods, or because they used very different control variables in their analyses. This study will therefore aim to confirm whether US defense spending serves as a determinant for EU spending. Kuokštytė et al. (2021) also further confirmed that the defense spending levels of other NATO allies is an important determinant of defense spending levels for a country, namely that as the spending levels of other NATO allies increase, countries tend to spend less due to free-riding behavior. This phenomenon was also investigated by Müllner & Nečas (2022); they found that defense capabilities have been receding in certain countries since the onset of the 2008 financial crisis, as these countries have tended to rely on their NATO allies for defense resources and strength.

A summary of the findings from previous literature is presented in Table 3.2 below. These explanatory and control variables will be tested in this specific sample in order to determine if they will be important to include in the defense investment and defense investment collaboration analyses.

Table 3.2.

Previous Research: Determinants of Defense Spending

Determinant	Previous Research
NATO, US & Russian Defense Spending	Nikolaidou (2008); Odehnal & Neubauer (2018); Kuokštytė et al. (2021); Christie (2019)
Fiscal Capacity, Domestic Economic Health, External Threats	Christie (2019); Odehnal & Neubauer (2018); Alozious (2022)
Political Party Strength, Impending National Elections, Defense Spending Levels of NATO Allies	Kuokštytė et al. (2021)

3.2 The determinants of defense investment and defense investment collaboration

3.2.1 The importance of the domestic defense industry

A domestic factor that is important to consider is the strength of a domestic defense industry (Moretti et al., 2019; Monaghan, 2023). A study by García-Estévez & Trujillo-Baute (2014) about the determinants of

industry defense investment in Spain show firm investment is dependent on the firm's level of collaboration with the Spanish Ministry of Defense. They attribute this to the demand-pull hypothesis, which postulates that increased demand for a certain good or service will spur further research and productivity to enhance the development of that product (García-Estévez & Trujillo-Baute, 2014). Examples are technological advancements outside the industry that demand innovation in the industry, or public policies that spur demand for such changes.

The opposite of the demand-pull effect is the technology-push effect, which takes the form of public R&D subsidies and investment projects (Aflaki et al., 2021). The technology-push effect requires the government to assume an important role in spurring investment activity to help overcome various market failures involved with private industry investment, such as knowledge externalities and information asymmetry. This technology-push effect of public R&D funding on firm investment was investigated by Moretti et al. (2019). Their study found that a 10% increase in public investment in R&D was associated with a more than 5% increase in R&D investment among private firms. Interestingly, they also found that public investment in one country was associated with an increase in private R&D investment in other countries. Not only do these results suggest that private industries are positively associated with public investment initiatives, but also that investments in one country can have positive impacts (spillover effects) on investments in others (Moretti et al., 2019). Because both the demand-pull and technology-push effect impact firm investment in the defense industry, it is expected that the existence and strength of a domestic defense industry will have a considerable impact on the defense investment decisions undertaken by a member state's government.

It is important to then understand why it is in the government's best interest for the defense industry to undertake investments. There are several factors that help answer the question. The first is that more investment into defense technology will allow for the development of more cutting-edge technology, which is essential for strategic reasons when it comes to national defense. The second mechanism is that a more advanced domestic defense industry will increase international demand for the technology of these companies. If a company in Germany, for example, is producing the most effective, precise, and advanced missile technology, it is likely that other nations will want to purchase this technology from Germany. This helps increase the share of one's exports, contributing to a lower import share, better terms of trade, and a stronger GDP (since GDP is a function of domestic investment, trade balance, government spending, and consumption) (Kollias & Paleologou, 2019). The larger the defense industry is in a certain country, the higher its contribution to GDP will be, and therefore the higher its potential is to help spur economic prosperity. Therefore, it is believed that the size of the domestic defense industry will have a strong impact on public defense investment, leading to the following hypothesis:

Hypothesis 1a: Member states with strong defense industries are more likely to have higher defense investment.

Building on Hypothesis 1a above, it is expected that countries that have undertaken investment in defense to support their private industries are also more likely to participate in defense investment collaboration. With strong private defense industries, these countries have stronger bargaining power, face less risk when undertaking projects and can influence the future direction of EU defense research, development, and strategy. It is beneficial for countries with strong defense industries to be involved in more collaborative projects, because this means that their technology and expertise will be used in more multinational defense systems (which can be reinforced by guaranteeing IPR). This helps maintain the relevance of their defense industries and keeps their technologies from becoming obsolete.

This effect is further strengthened by the Coordinated Annual Review on Defense (CARD) conducted by the EU. This was launched in tandem with the 2017 PESCO relaunch in an effort to better harmonize EU defense initiatives. CARD essentially takes stock of the defense needs and capabilities of participating countries on an annual basis and helps them identify potential partners for collaboration (European Defence Agency, n.d.). CARD focuses on four pillars for enhancing collaboration: military capabilities, research, innovation, and industry strength and capabilities (European Defence Agency, n.d.). By maintaining a strong focus on industrial capabilities, it is logical that CARD analyses will tend to highlight countries that have strong industries as strong contenders for collaborative projects. For this reason, the following hypothesis can be developed:

Hypothesis 1b: Member states with strong domestic private defense sectors are likely to have higher levels of defense investment collaboration.

3.2.2 The complexity of overlapping international obligations

There are many reasons why it is important to investigate phenomena in the EU specifically. One of the reasons is because the EU is a unique multinational institution. This means that theories and their expected effects that are typically observed outside the EU might not be directly applicable to EU member states themselves (for example, as Genschel et al. (2011) argue in their paper about tax competition theory inside versus outside the EU).

This holds true in the field of security and foreign policy because membership of the EU creates a complicated hierarchy of international commitments on top of national obligations (Hofmann, 2011). Membership of the EU means agreeing to adhere to the common security and foreign policy set forward by the Commission. Member states are also participants in other international institutions and coalitions, such

as the United Nations (UN), the Organization for Security and Cooperation in Europe (OSCE) and even various NGOs to which they have made commitments (Hofmann, 2011). On top of this, 21 member states are also members of NATO, an institution to which they have also made agreements on defense and security policy.

The dual obligation to the EU and to NATO in particular can create complications and competing interests in EU member state defense strategies (Fiott, 2017). The institutions that guide EU defense strategy can either work in harmony or (accidentally) work against one another. Under a theory coined "interaction through commitment", Fiott (2017, p. 401) argues that the EU could work as a complement to NATO defense expectations; while NATO pushes for higher defense expenditure, EU institutions have called for a more efficient EU defense industry based on enhanced collaboration and economies of scale. However, with the EU having since announced its own defense targets and expectations, it is possible that this has given member states an excuse to abandon the 2% NATO target and hide behind supposed EU defense efficiency obligations. Fiott (2017) describes this as "behavior interaction" (p. 401), a concept in which the behavior of one governing institution has an impact on the goals and outcomes of the other institution.

This does not only strain the effectiveness of the NATO alliance and defense expenditure guidelines, but it might also inadvertently further contribute to the collective action problem. Member states feel further removed from their national spending obligations (outlined by NATO) and are instead counting on a collective defense spending effort on the EU level (Fiott, 2017). This is further explained by the phenomenon of "institutional overlap" discussed by Hofmann (2011, p. 103), which can involve overlap over three dimensions: mandate, members, and resources. Once there is overlap, the issue is that various points of political jurisdiction emerge, such that it becomes difficult to govern, or determine who is responsible for governing, the shared mandate, members, and/or resources (Hofmann, 2011).

It is also argued that an increase in required investment commitments at the EU and NATO levels can have adverse effects on national investment levels (Fiott, 2017; European Commission, 2016). Binding EU member states to multiple international agreements can hinder incentives to maintain a robust level of investment nationally, which risks slowing down innovation in the entire industry (Fiott, 2017). Therefore, it is believed that multiple institutional commitments and obligations will further the free-riding issue, and that free-riding issues from NATO (Nikolaidou, 2008; Kuokštytė et al., 2021) will even extend beyond NATO members and spill into the EU investment and investment collaboration problem, including non-NATO members. Building on the findings of Kuokštytė et al. (2021) that increased NATO spending led to defense spending free-riding by non-NATO members, it is believed that this will present a similar problem in defense investment and defense investment collaboration. This leads to the following hypotheses:

Hypothesis 2a: Member states are likely to exhibit lower defense investment levels as average NATO spending levels increase.

Hypothesis 2b: Member states are likely to exhibit lower defense investment collaboration levels as average NATO spending levels increase.

Beyond defense spending requirements, being a member of the EU also puts limitations on the spending of member states in general. According to the Stability and Growth Pact (SGP), there are several fiscal and budgetary constraints that member states must follow in order to help maintain a healthy economy in the EU. One of these requirements is that member states must maintain a debt-to-GDP ratio below 60% (Eurostat, 2022b). Upon failure to comply, the member states will undergo an excessive deficit procedure (EDP) which can inflict a host of consequences on member states, including sanctions, in order to get them to comply with the SGP stipulations again (Eurostat, 2022b). Because of this tight budgetary control, it is expected that member states will avoid having to undergo the EDP procedure at all costs, which will impact their level of defense investment and defense investment collaboration, similar to findings from previous research about defense spending determinants (Christie, 2019; Alozious, 2022). This leads to the third hypothesis:

Hypothesis 3a: Member states with lower fiscal capacity will likely exhibit lower defense investment.

Hypothesis 3b: Member states with lower fiscal capacity will likely exhibit less defense investment collaboration.

3.2.3 The complications of facilitating multinational cooperation

There is abundant theory about the difficulties surrounding facilitating cooperation amongst international actors. Three main concepts that will be discussed are collective action, the Prisoner's dilemma, and competition. However, defense investment cooperation faces another hurdle. Namely, as a public good that is non-rival, investment in defense faces a problem of knowledge diffusion. These concepts will be described further below.

Collective action and its role in public defense have been extensively researched. Oneal (1990) examined the problem of collective action in NATO specifically, where he stipulates that NATO is a "uniquely privileged group" because it has one actor, the United States, that can technically provide the good for the whole alliance by itself (p. 431). In a more recent paper, Eilstrup-Sangiovanni (2014) empirically studies the European defense issue. It is argued that European defense (specifically, the CSDP)

is like any other alliance, where members seek the benefits of cooperation (such as economies of scale) but fear the risk of reneging by the other members of the alliance (Eilstrup-Sangiovanni, 2014; De Vore & Stai, 2019). Because defense is a public good, and since the EU does not have a disproportionately strong state that can hold other states accountable, as the United States has done in NATO, European defense has been plagued by collective action problems since its inception (Oneal, 1990; Eilstrup-Sangiovanni, 2014).

This reasoning leads to a Prisoner's Dilemma situation in the EU. It is only beneficial for a member state to undertake monumental increases in defense spending in investment if this is done by other member states, as well. This behavior is further exacerbated by the SGP constraint explained above. A result that follows from the Prisoner's Dilemma but could have the opposite effect on defense investment is the fact that member states are technically competitors in the field of defense. What is meant by this is that member states have private defense industries that provide a multitude of benefits to the state: employment, economic growth, foreign investment, and export opportunities (Kollias & Paleologou, 2019). If embarking on collaborative investment projects means knowledge sharing and profit sharing that could put the domestic defense industry at risk, it will become unattractive for member states to work together if they fear the other player (another member state) will renege on the agreement. This will likely lead to more independent public investment initiatives to prop up domestic defense industries and serve as a hurdle for collaborative defense initiatives between member states.

The fourth issue that the EU defense environment faces has to do with investment specifically. In the case of investment, an actor decides to spend capital upfront in the hopes that, in the long run, the investment will pay off (De Vore & Stai, 2019). It was already mentioned above that the first hurdle in this scenario is explained by the Prisoner's Dilemma. However, with investment, another deterrent is the risk of knowledge spillover (Sempere, 2018). For example, if State A invests in a technology that significantly improves efficiency and reduces costs, States B and C will also benefit from this technology, even though they did not have to sacrifice the capital investment that State A did. For this reason, it becomes even less attractive to undertake investment initiatives (Sempere, 2018).

These issues can be overcome through several factors. The first is repeated interactions (Bone et al., 2016); by increasing the number of times that member states interact on defense, which is done through PESCO, member states are held accountable for their commitments. Member states can enter agreements on a strictly voluntary basis and are then held to binding commitments (Permanent Structured Cooperation, n.d.). This helps ensure cooperation. To overcome the issue of knowledge spillovers and other market failures associated with investment, it is important for there to be intervention. Examples of this are subsidizing research (for example, through the EDF) and guaranteeing intellectual property rights (IPR) after technological advancements (Moretti et al., 2019). This makes it increasingly attractive for firms to undertake costly investments.

Though the EU has tried to account for the risk of free-riding and the Prisoner's Dilemma by creating institutions that support collaborative investment such as PESCO and EDF, the risks involved with participating in an alliance to provide a public good are still not completely removed. For example, Cieslik & Goczek (2017) found that high levels of corruption in a country lower the likelihood of investments in that country. This study believes that similar logic can be applied to engaging in collaborative investment projects between governments. It is therefore expected that trust in another member state's government and evidence of sticking to agreements in repeated interactions will be essential in determining who decides to collaborate on defense investment, and with whom. It is therefore expected that trust in a government and whether a member state is an EU15 state (and thus has had more time to develop a credible reputation, compared to newer states) will be pivotal in determining cooperation efforts. This leads to the following two hypotheses:

Hypothesis 4: Member states that have lower corruption levels are likely to have higher levels of defense investment collaboration.

Hypothesis 5: EU15 states are more likely to have higher levels of defense investment collaboration than accession countries.

3.2.4 The impact of external threats on defense investment

The main reason for having a strong, effective, and extensive defense system is of course to protect a state from external threats. It is therefore important to consider and include in the analysis the impact of external threats on investment and investment collaboration decisions in member states.

Previous literature has found that an increase in exposure to and perception of external threats will increase the level of defense spending (Christie, 2019; Kuokštytė, 2021). There is also a political aspect to external threats that reinforces why it is believed threats will lead to more investment spending. If a state is facing an imminent security threat, enough so that it is on the minds of voters, it will be politically favorable for a government to demonstrate efforts to expand defense capabilities (Williams, 2015). When the threat perception is low, defense expenditures (and thus investments) might be perceived as wasteful by voters. It is therefore expected that member states facing higher external threats, in the form of being involved in international conflicts, global threat perceptions, or proximity to dangerous actors, will have higher levels of defense investment, as well:

Hypothesis 6a: Member states facing more imminent external threats are likely to have higher levels of defense investment.

The potential link between external threats and defense investment collaboration requires more consideration. Because defense in the EU is multilevel (individual state, EU, and NATO), threats to security can exist at certain points for some member states while not being felt by others. For example, a member state such as Poland that shares a border with Russia in 2021 will be feeling a much more imminent security threat than, for example, Belgium, however, both countries are bound to NATO Article 5.

In general, the balance of power theory posits that there is a higher likelihood of collaboration when states face an external threat (Eilstrup-Sangiovanni, 2014). In the case of the EU, this would be the presence of an exogenous threat that threatens the security of the EU as a whole. For an individual member state, as mentioned above, this threat can exist at a much more individual level, depending on proximity to the threat, for example. Previous research has found various types of external threats to have significant effects on defense spending. External threats to Europe present themselves in several ways: proximity to Russia in kilometers (Kuokštytė et al., 2021), whether the country shares a border with Russia (Christie, 2019), whether the country is engaged in an international conflict (Kuokštytė et al., 2021), and the domestic threat of terrorism (Kuokštytė et al., 2021).

Therefore, in times of threats to national security, it is expected that governments will be more willing to embark on defense investment collaborative initiatives in order to satisfy their electorate. This leads to the next hypothesis:

Hypothesis 6b: Member states facing more imminent external threats are likely to have higher levels of defense investment collaboration.

3.2.5 The Structure of PESCO and its Contribution to EU Defense

PESCO initially came about through the Lisbon Treaty, but only really gained attention, popularity, and active involvement around 2014 and 2016, after the invasion of Crimea, the Brexit referendum, and the election of Donald Trump as President of the United States, respectively (Houdé & Wessels, 2022). To support PESCO, the EU launched a series of complementary initiatives, namely CARD, the EDF, and the European Defense Industrial Development Program (EDIDP), all aimed at identifying weaknesses in defense and providing funding for research initiatives (Martill & Gebhard, 2023). The latter can be viewed as the EU's solution to the investment problem discussed extensively above. By providing funding to member states in exchange for them taking on ambitious research projects, the EU is helping minimize the direct costs to individual Member States which helps target the market failure at play.

PESCO projects cannot be started at any time. Every two years, blueprints for projects as well as their participants can be submitted. These projects must meet the requirements put in place by the PESCO

governing body (Permanent Structured Cooperation, n.d.). Once the projects are adopted by the Council, they can be commenced. Only 25 member states have signed up to join PESCO. Denmark and Malta have bowed out due to neutrality, and the UK never joined because it had already decided to leave the EU by the time PESCO was relaunched in 2017 (Permanent Structured Cooperation, n.d.). Not all 25 member states were equally enthusiastic about strengthening PESCO, however, mostly due to fears it would conflict with obligations to NATO and that it would present a danger to defense industries in smaller member states that would now have to compete with defense industries in larger member states (Martill & Gebhard, 2023). To get all member states on board, it was necessary to introduce differentiation (Martill & Gebhard, 2023). In the domain of international relations and multinational cooperation, differentiation refers to introducing different forms of selectivity into cooperation initiatives to help mitigate political barriers (Martill & Gebhard, 2023). This is especially important in the EU, where various governments, answering to the needs of even more constituents, often need to find consensus in decision-making.

PESCO utilizes differentiation in several ways. First, by working on a voluntary basis and then transitioning into binding commitments, PESCO avoids forcing member states into agreements and projects in which they do not want to take part. PESCO also uses project-based clustering (Martill & Gebhard, 2023). This means that member states sign up to participate in a specific project, in coordination with other willing member states. This helps streamline responsibility and accountability, reduces the number of actors involved, and allows for partnerships to be formed intentionally in ways that benefit all parties involved. For example, if one member state is strong in one aspect, it can partner with a member state who is able to compensate for one of its weaknesses. Third, PESCO also allows for the involvement of non-EU members. This helps strengthen the effectiveness of PESCO because it allows member states to draw on the expertise and resources of the rest of the world and keeps the PESCO initiative from drawing away from NATO by keeping projects integrated with non-EU allies (Martill & Gebhard, 2023).

The PESCO environment is an excellent case to further empirically analyze the theories explained above. Because of the required investments, perceived external threats, fiscal capacity, private industry interests, and other factors mentioned above, member states will either be very active in PESCO projects or be less active in PESCO projects, depending on the hypotheses outlined above.

3.3. Summary of theories and variables

The theories and their respective hypotheses explained above, as well as the relevant indicators for each, regarding the determinants of defense investment have been consolidated into Table 3.2. This has been done for the determinants of defense collaboration in Table 3.3, as well. The indicators listed below will be

further elaborated on in the data and methodology section; they are listed here for convenience of reference while following the analyses.

Table 3.2

Overview of Theories and Variables: Determinants of Dependent Variable Defense Investment

Theory	Hyp. #	Hypothesis	Indicator	Source
Private Defense Industry	1a	Member states with strong defense industries are more likely to have higher defense investment.	Share of total arms sales of companies in SIPRI top 100	Moretti et al. (2019); Monaghan (2023)
NATO Free-Riding	2a	Member states are likely to exhibit lower defense investment levels as average NATO spending levels increase.	Defense Spending of NATO Countries (t-1)	Kuokštytė et al. (2021); Nikolaidou (2008)
Fiscal Capacity	3a	Member states with lower fiscal capacity will likely exhibit lower defense investment.	Fiscal Capacity Indicator, Debt-to-GDP Ratio (t-1)	Christie (2019); Alozious (2022)
External Threats	6a	Member states facing more imminent external threats are likely to have higher levels of defense investment.	Russian Threat Index, Terrorism, International Conflict	Christie (2019); Kuokštytė et al. (2021)

Table 3.3

Overview of Theories and Variables: Determinants of Defense Investment Collaboration

Theory	Hyp. #	Hypothesis	Indicator	Source
Private Defense Industry	1b	Member states with strong domestic private defense sectors are likely to have higher levels of defense investment collaboration.	Arms Exports (% of GDP); Share of SIPRI Top 100 Arms Companies	Moretti et al. (2019); Monaghan (2023)
NATO Free-Riding	2b	Member states are likely to exhibit lower defense investment collaboration levels as average NATO spending levels increase.	Defense Spending of NATO Countries (t-1)	Kuokštytė et al. (2021); Nikolaidou (2008)
Fiscal Capacity	3b	Member states with lower fiscal capacity will likely exhibit less defense investment collaboration.	Debt-to-GDP Ratio (t-1); Fiscal Capacity Indicator	Christie (2019); Alozious (2022)
Trust in Government	4	Member states that have lower corruption are likely to have higher levels of defense investment collaboration.	Corruption Perception Index	Cieslik & Goczek (2017)

EU15	5	EU15 states are more likely to have higher levels of defense investment collaboration than accession countries.	EU15 dummy	Bone et al. (2016)
External Threats	6b	Member states facing more imminent external threats are likely to have higher levels of defense investment collaboration.	Russian Threat Index, Terrorism, International Conflict	Christie (2019); Kuokštytė et al. (2021)

4. Data & Methodology

4.1. Data

The dataset for this study has been assembled from a variety of sources based on previous research about defense spending determinants and based on the hypotheses derived above (an overview of the data and its sources can be found in the Appendix, Table A.1.). The sample involves 27 EU countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, and the United Kingdom. The United Kingdom is included in this analysis because this study examines panel data from 2005-2021, a period in which the UK was still a member of the EU.

Ideally, a longer time period would have been used, however, the EDA data on defense investment and defense investment collaboration is limited to these years. Therefore, the variables for all three quantitative analyses will span this time period. The sample sizes, sources, and limitations of this data will be further discussed in each of the respective subsections below.

This study will complete four analyses in total. The first is a multivariate regression analysis of the determinants of EU defense spending to combine the findings of Kuokštytė et al. (2021), Nikolaidou (2008), Alozious (2022), and Christie (2019) with newer data in order to get a more complete picture of the determinants of EU defense spending. Then, since EU institutions themselves have argued that increased defense does not particularly mean effective collaborative defense investment is taking place, a multivariate regression analyses will be used to examine the factors of defense investment and collaborative defense investment. Finally, to further understand these empirical findings, a qualitative comparative analysis (QCA) will be done using the 60 existing PESCO collaborative defense projects.

4.2. Controls

There are some other factors that will be considered in this research based on findings from previous studies about the domestic determinants of defense spending. It is believed that these factors will have a similar effect on defense investment levels since defense investment is a subset of defense spending.

The first is whether a member state is facing an election in the next year. Kuokštytė et al. (2021) found this to be a significant determinant of defense spending since an impending election reduces the attractiveness of large public expenditure. This data was extracted from the International Foundation for Electoral Systems (2023), and refers to legislative elections. Additionally, Nikolaidou (2008), Christie (2019), and Kuokštytė et al. (2021) found the change in US and change in Russian defense spending in the previous period to be a significant indicator of defense spending among EU countries, and therefore these

will also be included as controls, lagged by one year to allow for reaction time. This data is sourced from SIPRI (2022c). Finally, the relative power of right-wing parties in a government will also be included, which is found to be associated with higher levels of defense spending (Kuokštytė, 2021). This data comes from the Comparative Political Data Set (Armingeon et al., 2022). This variable will also be lagged by one year based on previous research.

In all iterations of the models, another control for lags of the dependent variable will be included. This will allow for the analysis of the current level of defense spending, defense investment, and defense investment expenditure based on past levels. Based on findings from previous research, it is believed that excluding these would lead to omitted variable bias. The following sections will explain the data sources, models, and methodology for analyses one through four.

4.3. Analysis 1: Determinants of Defense Spending

This study will attempt to streamline and improve upon the findings of previous literature for a newer time period, namely 2005-2021 (Christie, 2019; Kuokštytė et al, 2021; Nikolaidou, 2008). This will be done with a multivariate regression analysis for several models, introducing various explanatory variables from previous research. Because there is no missing data for the period of 2005-2001 for these 27 sample countries, the sample size in this analysis is 459 observations. As was mentioned in the introduction, this analysis will combine the important contribution of Christie (2019) regarding fiscal capabilities and threat perception with the findings of Kuokštytė (2021) about the importance of domestic political factors, such as upcoming elections and cabinet partisanship, in a more contemporary time period. Establishing a better understanding of how these previous studies fit together will allow for better predictions regarding the determinants of defense investment and defense investment collaboration, as well.

The dependent variable, defense spending, was assembled from the Stockholm International Peace Research Institute (SIPRI) database, instead of the data available in the EDA database (SIPRI, 2022c). This is done for several reasons. First, the SIPRI database has more complete data, which allows for more observations in the regression analysis. Second, previous studies, such as Christie (2019) and Kuokštytė et al. (2021) also retrieved their defense spending data from SIPRI. Finally, the US and Russian defense spending variables are also obtained from the SIPRI database, and therefore using this same database for retrieving the dependent variable allows for more consistency. All defense spending variables in this analysis are expressed as a percentage of the Gross Domestic Product (GDP) for each country. Because this is a panel data set, the lag of the dependent variable is included in the regression analysis. The core econometric model is as follows, where *s* denotes a member state and *t* denotes the year:

$$Defense\ Spending_{st} = \alpha_{st} + \beta_1(Defense\ Spending_{s(t-1)}) + \beta_2(External\ Threats_{st}) + \beta_3(Fiscal\ Capacity_{st}) + \beta_4(NATO\ Spending_{s(t-1)}) + \beta_5(Change\ in\ US\ \&\ Russian\ Defense\ Expenditure_{st}) + \beta_6(Domestic\ Politics_{s(t-1)}) + \beta_7(NATO\ Membership) + \pi_{st}$$

Previous studies have operationalized the threat of Russian resurgence in several different ways: whether the country shares a border with Russia, distance to Moscow, among others. It is believed that the metric proposed by Christie (2019) is the most encompassing, as it combines the increased perceived threat of Russia following the invasion of Crimea by providing weights of 0, 1, and 3 from around the period of 2013-2014 depending on the level of perceived Russian aggression. This number is lagged by one year, and divided by the squared distance of the member state to the nearest stationed Russian troops. It is believed that this offers a more composite measure of the perceived threat of Russian aggression and allows for the use of just one variable.

Numerous studies also found that whether a country is involved in an international conflict to be a significant determinant of defense spending (Kuokštytė et al., 2021; Odehnal & Neubauer, 2018); for this reason, this will also be included as a measure of external threats. The data comes from the Uppsala Conflict Database Program/Peace Research Institute Oslo (Davies et al., 2022; Gleditsch et al., 2022). The third measure of external threats is the level of domestic terrorism from two years before, which Kuokštytė et al. (2021) also found to be a significant determinant. This is expressed as the number of terrorist attacks faced by a country in a given year, and the data comes from the Global Terrorism Database (2020) from the University of Maryland. These three variables will together measure the level of external threat faced by a country (Christie, 2019; Kuokštytė et al., 2021).

Fiscal capacity will be measured in several ways, based on findings from previous literature, to see which is the most significant contributor to defense spending, defense investment, and defense investment collaboration for this sample specifically. The first measure is the fiscal capacity indicator calculated by Christie (2019), however this is only available for the years 2007-2016 and therefore causes significant sample shrinkage. The second will be the debt-to-GDP ratio (Alozious, 2022).

This analysis will be done following a multivariate Ordinary Least Squares (OLS) regression. The benefit of this analysis is that various iterations of the model can be run to test which variables are the most important contributors to defense expenditure. A limitation, however, is that endogeneity can never be definitively ruled out, though this study aims to do so by including the lag of the dependent variable in the analysis. Additionally, one can never be certain that all possible controls have been included in the analysis. By combining various previously conducted studies, however, it is believed that this analysis is able to achieve a substantive idea of what the most crucial contributors to defense spending are to determine which

variables are most appropriate to include in the analysis. Table 4.3.1. summarizes the relevant variables, expectations from previous literature, data, and methodology for the defense spending variable.

Table 4.3.1.

Determinants of Defense Spending: Analysis Overview

Variable	Type	Expectation	Indicator	Source
Defense Spending	Dependent	-	Defense Spending, as a % of GDP	SIPRI (2022c)
External Threats	Explanatory	Positive association with defense spending	Conflict, Russian Threat Index, Terrorism	Uppsala Conflict Database Program / Peace Research Institute Oslo (2022); Davies et al. (2022); Gledistsch et al. (2002); Global Terrorism Database (2020); Rondeli Foundation (2023); DistanceFromTo (n.d.)
Fiscal Capacity	Explanatory	Positive association with defense spending	Fiscal Capacity Indicator; Debt-to-GDP Ratio	Christie (2019); Eurostat (2022a)
Elections	Control	Negative association with defense spending	Election Year in next year	International Foundation for Electoral Systems (2023)
Right Wing Party Strength	Control	Positive association with defense spending	Share of parliament that is controlled by right-wing	Armingeon et al. (2022)
Change in Russian and US defense spending levels	Control	Positive association with defense spending	Change in Russian/US spending as a percent of GDP	SIPRI (2022c)
NATO Membership	Explanatory	Positive association with defense spending	Dummy for NATO membership	NATO (2022)
NATO Free-Riding	Explanatory	Negative association with defense spending	Defense spending levels of NATO countries; interaction	NATO (2022)

	NATO dummy and NATO spending
Methodology: OLS	

4.4. Analysis 2: Determinants of Defense Investment

Many of the same explanatory variables used in Analysis 1 will be used in this analysis, as well. These include: external threat factors, domestic political factors, NATO expenditure, fiscal capacity constraints, and US and Russian defense expenditure. This analysis will, however, include a new key explanatory variable: private defense industry strength.

Limited availability of data means that it cannot be explicitly determined how much private military companies contribute to the national GDP for each of the countries in the sample. Therefore, using SIPRI (2022a), private defense industry strength will be calculated as follows. For each year, it will be calculated what the arms sales were for companies in this dataset in each of the member states as a percentage of total arms sales made by all companies in the dataset. For example, if Italy has 3 companies in the dataset in 2017 that produced three, one, and one and a half percent of total arms sales out of all companies in the 2017 dataset, Italy will have a value of 5.5 for 2017. As an additional check, another proxy that can be used for the relative strength of the private defense industry is the value of arms exports as a percentage of GDP (SIPRI, 2022b). Models will also be tested using this variable.

Similar to the previous analysis, defense investment will be included as a lag to serve as a control. Due to some missing data in the EDA's defense investment database, either due to unreported or confidential data, the sample size for this analysis will be slightly smaller than in the first analysis. Defense investment is expressed as a percentage of defense spending. The equation of interest is as follows:

$$Defense\ Investment_{st} = \alpha_{st} + \beta_1(Defense\ Investment_{s(t-1)}) + \beta_2(Defense\ Spending\ NATO_{s(t-1)}) + \beta_3(Fiscal\ Capacity_{s(t-1)}) + \beta_4(Private\ Defense\ Industry_{s(t-1)}) + \beta_5(Change\ in\ US\ \&\ Russian\ Defense\ Spending_{st}) + \beta_6(Domestic\ Political\ Factors_{st}) + \beta_7(External\ Threat\ Factors_{st}) + \beta_8(NATO_{st}) + \pi_{st}$$

The determinants of defense investment will be tested using a multivariate regression, as has been done in previous studies. There are some limitations to Ordinary Least Squares (OLS) regressions. For example, one can never be sure that all factors are included in the model, or definitively exclude the possibility of endogeneity. However, as mentioned above, by running various iterations of the model and using lagged versions of variables, it is believed that the methodology will appropriately aim to target these shortcomings. A summary of this analysis and the variables that will be included can be found in Table 4.4.1.

Table 4.4.1.

Determinants of Defense Investment: Analysis Overview

Variable	Type	Hypothesis	Indicator	Source
Defense Investment	Dependent	-	Defense Investment, % of Defense Spending	EDA (2023)
External Threats	Explanatory	6a: positive association	Conflict, Russian Threat Index, Terrorism	Uppsala Conflict Database Program / Peace Research Institute Oslo (2022); Davies et al. (2022); Gledistsch et al. (2002); Global Terrorism Database (2020); Rondeli Foundation (2023); DistanceFromTo (n.d.)
Fiscal Capacity	Explanatory	3a: negative association (increase in debt yields lower investment)	Fiscal Capacity Indicator; Debt-to-GDP Ratio	Christie (2019); Eurostat (2022a)
Private Defense Industry	Explanatory	1a: positive association	Share of SIPRI top 100 military firms; arms exports as a % of GDP	SIPRI (2022a); World Bank (2022a)
Elections	Control	Negative association	Election Year in next year	International Foundation for Electoral Systems (2023)
Right Wing Party Strength	Control	Positive association	Share of parliament that is controlled by right-wing	Armingeon et al. (2022)
Change in Russian and US defense spending levels	Control	Positive association	Change in Russian/US spending as a percent of GDP	SIPRI (2022c)
NATO Free-Riding	Explanatory	2a: negative association	Defense spending levels of NATO countries; interaction NATO dummy and NATO spending	NATO (2022)
Methodology: OLS				

4.5. Analysis 3: Determinants of Defense Investment Collaboration

The sample size for this analysis is 382 observations due to missing data, either due to data being unreported or confidential. Total defense collaboration is made up of procurement and R&T (research and technology). Defense investment collaboration is the sum of these two components, as reported by the EDA. Since the EDA provides this data at a disaggregated level, the determinants of both procurement, R&T, and total collaboration investment will be investigated separately. Each of these is expressed as a percentage of total defense spending in a given year. It should be emphasized that this analysis focuses only on collaboration on the European level; the EDA also provides data for collaboration outside the EU, but that is not within the scope of this study.

This analysis will also introduce a new concept, namely that the level of trust in a government will impact the level of collaboration in which it partakes. Trust will be measured through the Corruption Perception Index (CPI) (Transparency International, 2022). The corruption perception index is measured on a scale from 1 to 100, where 100 indicates a fully clean government, while 1 represents a highly corrupt government.

Multiple variations of the regression equation below will be carried out in order to see how the inclusion of various controls contributes to the main hypotheses of interest. This is the predicted model based on how the analyses above will proceed; it is possible some factors will fall away if they are deemed insignificant factors for this sample in previous analyses, and if so, this will be confirmed using robustness checks later on.

$$\textit{Defense Investment Collaboration}_{st} = \alpha_{st} + \beta_1(\textit{Defense Investment Collaboration}_{s(t-1)}) + \beta_2(\textit{Corruption}_{st}) + \beta_3(\textit{Fiscal Capacity}_{s(t-1)}) + \beta_4(\textit{Private Defense Industry}_{s(t-1)}) + \beta_5(\textit{EU15}_{st}) + \beta_6(\textit{Domestic Political Factors}_{st}) + \beta_7(\textit{External Threat Factors}_{st}) + \beta_8(\textit{NATO}_{st}) + \beta_9(\textit{Change in US \& Russian Defense Expenditure}_{st}) + \beta_{10}(\textit{Defense Spending NATO}_{s(t-1)}) + \pi_{st}$$

This analysis will take the form of a multivariate regression and Heckman two-step model. The Heckman two-step model works as a selection model, in which the first round is a probit selection model and the second is an Ordinary Least Squares (OLS) regression. The Heckman model allows for a maximum likelihood estimation (MLE), which accounts for sample selection that occurs non-randomly (Marchenko & Genton, 2012). A drawback of this method is that it is sensitive to collinearity between variants. Because we cannot control for fixed effects, as will be done for the OLS regressions, the risk is that this collinearity is not accounted for in the Heckman models. A suggested solution is to include multiple selection variables,

a method that this analysis will also utilize; this is further elaborated on below (Marchenko & Genton, 2012).

The Heckman two-step model is often used in research about, for example, the determinants of arms transfers or military aid. This is because the determinants that play a role in deciding which country will receive arms or aid in the first place will likely slightly differ from the factors that determine how much that country will receive. The same logic is being applied to this research; whether a country even decides to participate in defense collaboration is predicted to have different determinants than its decision in how much to invest in collaboration after having made the initial choice to collaborate in the first place.
This specification is appropriate for this analysis because the first round will remove any observations in which investment collaboration is equal to zero. The second round will include only observations for which investment is nonzero, which allows for a more effective analysis of which determinants impact how much a country invests in defense collaboration.

The first stage selection variables that will be used are EU15, the corruption index, and NATO membership. It is believed that each of these variables plays a role in the selection round of whether a country will decide to participate in collaboration, but is unlikely to have a subsequent significant role in the *amount* of collaboration. Since it is difficult to isolate whether a variable is only important for the selection round and not the following regression round (Marchenko & Genton, 2012), several iterations of the Heckman models with different combinations of the selection variables are run to see if this has any significant impact on the results.

The variable EU15 is considered important because it is likely that EU15 countries are seen as more attractive collaboration partners because of their extended history of building trust and a solid reputation with other EU15 members. Similar reasoning applies to the corruption index; if a country has a higher corruption index, this is likely to deter other countries from wanting to collaborate with them in the first place, and is unlikely to have a later impact on how much collaboration follows once it is decided whether to collaborate. Finally, NATO is an important indicator because it is believed that NATO countries are more prone to collaborative efforts due to a shared military alliance, and due to the theory of repeated interactions outlined in the theoretical framework. However, once a country decides to participate in collaboration, NATO membership is unlikely to significantly impact how much.

However, because an empirical analysis of defense investment collaboration has not been done before, this is the first time this methodology will be tested on this data. It is possible that the Heckman model is not the appropriate model for this dataset, which can be determined after the Heckman model is utilized by looking at the Inverse Mills Ratio (IMR). The IMR essentially measures the fraction of the covariance between the decision to participate in collaboration and by how much, and the decision to just collaborate in the first place. Therefore, in the cases where the IMR is insignificant, the Heckman selection

model is not applicable, as that would fail to reject the null hypothesis that there is no selection bias. In these cases where the IMR is insignificant and the Heckman model thus insufficient, a multivariate OLS regression will be used to examine the determinants of defense investment collaboration, as was done for the defense spending and defense investment analyses. Table 4.4.1. summarizes the variables, related hypotheses, indicators, and their sources.

Table 4.4.1.

Determinants of Defense Investment Collaboration: Analysis Overview

Variable	Type	Hypothesis	Indicator	Source
Defense Investment Collaboration (Procurement, R&T, and Total)	Dependent	-	Defense Collaboration (R&T, Procurement, Total), % of Defense Spending	EDA (2023)
External Threats	Explanatory	6b: positive association	Conflict, Russian Threat Index, Terrorism	Uppsala Conflict Database Program / Peace Research Institute Oslo (2022); Davies et al. (2022); Gledistsch et al. (2002); Global Terrorism Database (2020); Rondeli Foundation (2023); DistanceFromTo (n.d.)
Fiscal Capacity	Explanatory	3b: negative association (increase in debt yields less collaborative investment)	Fiscal Capacity Indicator; Debt-to-GDP Ratio	Christie (2019); Eurostat (2022a)
Private Defense Industry	Explanatory	1b: positive association	Share of total arms sales of companies in SIPRI top 100; Arms exports as a % of GDP	SIPRI (2022a); World Bank (2022a)
EU15	Explanatory	5: positive association	Dummy for EU15 membership	Statistics Netherlands (n.d.)
Trust in Government	Explanatory	4: positive association	Corruption Perception Index (CPI), 100 means completely clean government	Transparency International (2022)

Elections	Control	Negative association	Election Year in next year	International Foundation for Electoral Systems (2023)
Right Wing Party Strength	Control	Positive association	Share of parliament that is controlled by right-wing	Armingeon et al. (2022)
Change in Russian and US defense spending levels	Control	Positive association	Change in Russian/US spending as a percent of GDP	SIPRI (2022c)
NATO Free-Riding	Explanatory	2b: negative association	Defense spending of NATO countries; interaction NATO dummy and NATO spending	NATO (2022)
Methodology: OLS, Heckman Two-Step Analyses				

4.6. Analysis 4: PESCO Projects

It will be investigated which countries are most likely to collaborate on defense initiatives. This will be done by investigating which member states have collaborated on the 60 PESCO projects launched since its inception in 2017. To test this, first a PESCO dummy will be added to the above analysis to see if collaboration increased after 2017. This will be followed by a Qualitative Comparative Analysis (QCA) in which the dependent variable of defense collaboration will be analyzed. This will be examined based on the same variables investigated in Analysis 3 above. The sample size for this analysis is 25 since there are only 25 countries that are members of the PESCO project.

The research specifically will employ a fuzzy set QCA, since fuzzy sets can be applied to crisp (binary) data sets, as well as to datasets with variables that take on values in a range from 0 to 1 (Pappas & Woodside, 2021). This is the case for the dependent variable, frequency of participation in PESCO projects, which is represented as a percentage, calculated by dividing the total number of projects participated in by a country by the total number of projects, 61. These frequencies were then assigned various values on a scale from 0 to 1 using the fsQCA software in RStudio.

It will be investigated under which conditions collaboration occurs, and which of the variables outlined in the hypotheses are or are not present based on the collaborations that occur (Toshkov, 2016). This will allow for a more in-depth, practical application of the quantitative outcomes. It can even be argued that the QCA analysis allows for a more accurate analysis of the data. With strictly quantitative regression

models used above, only strictly linear effects are considered (Toshkov, 2016). The QCA allows for more flexibility in examining the conditions and context in which outcomes occur.

The QCA methodology relies on necessary and sufficient conditions (Toshkov, 2016; Krook, 2010). Necessary conditions need to be present for an outcome to occur. Sufficient conditions entail that the outcome must always occur when the condition does (Toshkov, 2016). To carry out this analysis, the conditions (or determinants, in the case of this research) will be coded into dummy variables for "high" or "low" values for continuous determinants that are not yet in dummy variable format (Krook, 2010). Only data from 2021 will be used since the PESCO data is current, and the 2021 data is the closest data available at the time of this research. Once all variables are coded, Boolean algebra will be applied to the sample to determine which variables were present for which outcomes (Krook, 2010). Given the complexity of this research and the many factors that determine defense collaboration, strict necessary and sufficient conditions will not be used. Instead, it will be considered if conditions hold for most cases in order to be considered sufficient in determining the outcome, namely collaboration on PESCO defense projects (Toshkov, 2016).

A limitation of this methodology is that it does not account for unintended consequences or feedback loops (Hanckel et al., 2021). For example, this analysis cannot take into account if a project between two member states that started early on encountered issues that impacted their likelihood of collaboration at a later moment in time. However, due to the high level of regulation in the EU and the binding natures of PESCO itself, it is assumed that member states have similar commitments to its success and therefore such a case is unlikely.

In this sample, the benchmark debt-to-GDP ratio for the EU is set at 60%. Any values exceeding 60% are considered high debt, and therefore any debt-to-GDP ratios above this will be coded as 1, while any below will be coded as 0. Similarly, the defense spending variable (expressed as a portion of GDP) will be coded as 1 if it is above 2%, and 0 if it is below. This is based on the 2006 NATO agreement to commit 2% of GDP to defense spending. For the Corruption Perception Index (CPI), the 2021 average for Western Europe and the European Union was 66 (Transparency International, 2022). Therefore, any values of 66 and above will be coded as 1, while any values below are coded as 0.

For the Russian Threat Index, a value of 1 is given if a country has a threat index above the sample average (0.000179), and 0 otherwise. Lastly, for private defense industry strength, a 1 is coded if the country has a presence in the SIPRI top 100 database, and a 0 is coded if it does not. An overview of the bivariate table that will be used for the QCA analysis can be found below in Table 4.6.1. The next section will delve into the results for each of the four analyses, which will be further elaborated on in the discussion section.

Table 4.6.1.

PESCO QCA Analysis Coded Variables

Country	CPI	Debt to GDP Ratio	EU15	Russian Threat Index	Private Def Industry (% SIPRI top 100)	Shares Border w/ Russia	Int'l Conflict
AUT	1	1	1	0	0	0	1
BEL	1	1	1	0	0	0	1
BLG	0	0	0	0	0	0	0
CRO	0	1	0	0	0	0	0
CYP	0	1	0	1	0	0	0
CZR	0	0	0	0	0	0	1
EST	1	0	0	1	0	1	1
FIN	1	1	0	1	0	1	1
FRA	1	1	1	0	1	0	1
GER	1	1	1	0	1	0	1
GRC	0	1	1	0	0	0	0
HUN	0	1	0	0	0	0	0
IRE	1	0	1	0	0	0	0
ITA	0	1	1	0	1	0	1
LAT	0	0	0	1	0	1	1
LIT	0	0	0	0	0	1	1
LUX	1	0	1	0	0	0	1
NLD	1	0	1	0	0	0	1
POL	0	0	0	1	1	1	0
PRT	0	1	1	0	0	0	1
ROM	0	0	0	1	0	0	1
SVK	0	1	0	0	0	0	0
SLV	0	1	0	0	0	0	0
ESP	0	1	1	0	1	0	1
SWE	1	0	1	0	1	0	1

5. Results & Analysis

The central research question of this paper is: What are the key determinants of European defense spending, defense investment, and defense investment collaboration from 2005-2021? The previous section outlined that each of these three dependent variables will be investigated individually. For this reason, the results section will also be split into each individual analysis; to start off, some brief descriptive statistics and summaries of the data set will be provided.

This panel data set is strongly balanced, however, it is unclear whether fixed or random effects models should be used. This can be tested using the Hausman test, however this should not be done until the final model is determined, at which point it can be determined if fixed or random effects are more appropriate. Therefore, following the methodology of Christie (2019), this research will first examine models with random effects until concrete final models are stipulated for each analysis. Then, Hausman tests will be used to confirm fixed or random effects. Robustness checks for each of the analyses will be included in the Appendix. The specific tables in which the robustness checks can be found will be mentioned in each of the subsections.

Tables 5.1. and 5.2. contain the descriptive statistics for the main variables of the analyses that will be done in this research.

Table 5.1.

Descriptive Statistics of Main Dependent Variables

Variable	Observations	Mean	Standard Deviation
Defense Spending as a % of GDP	459	0.0142173	0.0053461
Defense Investment (% of total defense spending)	441	0.1699	0.0955
Defense Investment Collaboration: Total (% of total defense spending)	306	0.0194	0.0438
Defense Investment Collaboration: Procurement (% of total defense spending)	331	0.0220	0.0484
Defense Investment Collaboration: R&T (% of total defense spending)	357	0.0006	0.0012

Table 5.2.

Descriptive Statistics of Main Explanatory Variables

Variable	Observations	Mean	Standard Deviation

Private Defense Industry (share of SIPRI top 100)	459	0.0067423	0.019010
Private Defense Industry (Arms Exports as % of GDP)	243	4.98e+08	6.88e+08
Right Wing Government Share	459	41.8617	37.5013
Corruption Index	459	62.8214	15.7528
Debt-to-GDP Ratio	459	64.82498	37.78909
Fiscal Capacity Indicator	230	11.89957	13.56236
International Conflict	459	0.7712418	0.42049
US Defense Spending (% of GDP)	459	0.03981	0.005501
Russian Defense Spending (% of GDP)	459	0.03874	0.005912
Defense Spending NATO Countries (% of GDP)	459	0.2739	0.002639
Russian Threat Index [Threat Index / (Proximity to Nearest Stationed Russian Troops)^2]	459	7.70e-06	0.0000212
Terrorism	459	6.590414	17.6078

Note. Some variables, such as the Fiscal Capacity Indicator and Private Defense Industry (Arms Exports as % of GDP) have smaller numbers of observations than others, which can present a risk to the analysis. Therefore, as was previously mentioned, alternatives for each of these will also be tested in the analyses to make sure this risk is accounted for.

5.1. Defense Spending

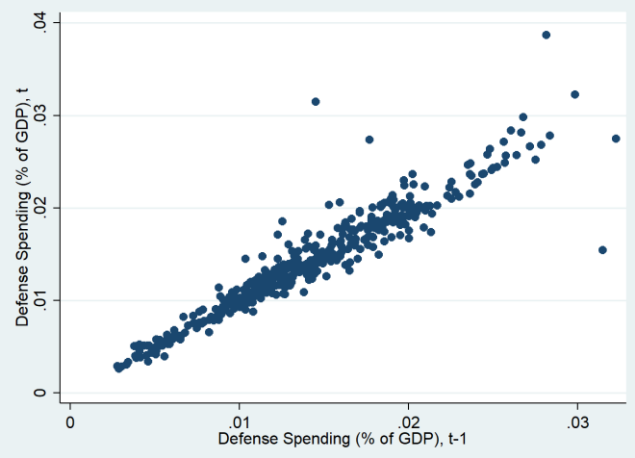
Like the findings in previous research, defense spending in the current period is strongly associated with the spending levels in the prior period (Figure 5.1.1.). This confirms that it is important to include the lag of the dependent variable of defense spending as an explanatory variable in the regression models. Various iterations of the regression will be run in order to be able to see how introducing various controls, or the operationalization of different concepts, influence the relationship in question. This research follows the methodology of Christie (2019) in assuming random effects until the final model is developed. Then a Hausman test will be carried out to determine if fixed effects is more appropriate for that specific model.

The first model (Model 1) is a basic regression model with the main dependent variable as well as one explanatory variable: defense spending from the year prior. This is in line with the graphical representation in Figure 5.1.1. Model 2 introduces the findings of Kuokštytė et al. (2021), Nikolaidou (2008), and Christie (2019). It utilizes Christie's (2019) fiscal capacity indicator, which cuts the sample to less than half of Model 1. Under Model 2, NATO membership is a weakly positive yet significant

determinant of defense spending, while the interaction between NATO and defense spending levels of NATO countries is slightly negative, suggesting the spending of NATO members falls as the total NATO expenditure rises. This is in line with the free-riding theory. The Russian threat index proposed by Christie (2019) is strongly positive, suggesting that this is a major indicator of defense spending levels.

Figure 5.1.1.

Defense Spending (% of GDP) (t, t-1)



Model 3 repeats Model 2 but includes the debt-to-GDP ratio instead of the change in fiscal capacity, as suggested by Alozious (2022). This has little impact on the coefficients of the variables from Model 2, however debt-to-GDP ratio from the previous period is significant. For this reason, Model 3 will be adopted as the most comprehensive model of defense spending determinants for this sample. A Hausman test is run for Model 3 to confirm whether fixed or random effects are the most appropriate estimation for this sample.

Table 5.1.1.

Determinants of Defense Spending (Random Effects)

Variables	Model 1	Model 2	Model 3	Model 4 (Fixed Effects)
Defense Spending, t-1	0.9758***	0.9692***	0.9458***	0.6637***
	(0.1501)	(0.0182)	(0.0350)	(0.0389)
NATO Member		0.0048***	0.0034***	0.0048**
		(0.0016)	(0.0013)	(0.0022)
Change in US Defense Spending		0.0195	0.0791***	0.1173***
		(0.0330)	(0.0257)	(0.0375)

Change in Russian Defense Spending		0.0160 (0.0175)	0.0101 (0.0139)	0.0028 (0.0170)
Defense Spending NATO countries (t-1)		0.0712 (0.0439)	-0.0016 (0.0297)	0.0791 (0.0645)
NATO*Defense Spending NATO countries (t-1)		-0.1625*** (0.0556)	-0.1097** (0.0459)	-0.1522** (0.0703)
Terrorism (t-2)		-5.37e-06 (3.57e-06)	-3.29e-06 (3.71e-06)	-0.00002** (7.15e-06)
Conflict (t-1)		-0.0002 (0.0003)	-0.0001 (0.0002)	-0.0002 (0.0003)
Election (t+1)		0.0001 (0.0002)	-0.0001 (0.0002)	-0.0002 (0.0003)
Right Wing Cabinet Share (t-1)		-1.11e-06 (1.67e-06)	2.53e-06 (2.35e-06)	1.93e-07 (2.63e-06)
Russian Threat Index		17.6707*** (3.7109)	15.1357*** (2.9997)	28.1949*** (5.2850)
Change in Fiscal Capacity (t-1)		0.00001 (0.00002)		
Debt to GDP Ratio (t-1)			6.32e-06* (3.55e-06)	-9.79e-07 (5.77e-06)
Constant	0.0004*** (0.0002)	-0.0021* (0.0013)	0.0002 (0.0007)	0.0024 (0.0020)
Observations	459	207	458	458
R Squared (Within)	0.4964	0.6347	0.5468	0.5668
R Squared (Between)	0.9979	0.9966	0.9974	0.9810
R Squared (Overall)	0.9025	0.9592	0.9118	0.8898

* p < 0.10. ** p < 0.05. *** p < 0.01.

The null hypothesis of the Hausman test, which stipulates that variation is not systematic, is rejected by the significant Chi squared statistic (Table 5.1.2). A fixed effects model implies that the variations between the units in this analysis (countries) are systematic. The fixed effects model helps to control for these systematic differences, and the outcomes of the fixed effects model can be found under Model 4.

Table 5.1.2.

Hausman Test for Model 6 (Dependent Variable: Defense Spending)

Chi-Squared Statistic	Probability > Chi Squared
60.88	0.000

Note. Hausman Test for Random or Fixed effects.

According to Model 4, the most important indicators of defense spending for this sample are: defense expenditure levels from the previous period, the change in US defense spending, NATO membership, NATO membership interacted with defense expenditure levels of NATO allies in the previous period, terrorism, and the Russian Threat Index. The fixed effects estimation causes the debt-to-GDP ratio variable to become insignificant, while the terrorism variable becomes significant with a weak negative coefficient. This suggests that there is a slightly negative relationship between the level of terrorism from two years prior and the current level of defense spending, which is not in line with the findings of Kuokštytė et al. (2021).

This model does confirm the findings from previous research that US defense expenditure is a major determinant of EU defense expenditure. As a major military ally, the EU has grown dependent on US defense capabilities, and vice versa. Additionally, the defense expenditure levels of NATO members is an important determinant for NATO member countries, as suggested by the free-riding hypothesis proposed in and supported by previous research. For this variable, the coefficient is negative, suggesting that a one unit increase in defense expenditure as a percentage of GDP by other NATO members decreases defense expenditure in a NATO member country by 0.1522 percentage points.

Surprisingly, the domestic political variables were not found to be significant for this sample. This is an unexpected result, however it could be because the threat index from Christie (2019) captures such a strong effect in the model. Therefore, it may be the case that, when external threats play such a large role in determining defense spending, the political factors become less significant as national security takes priority.

5.2 Defense Investment

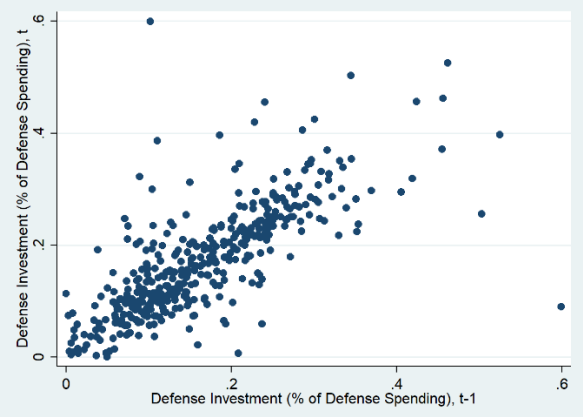
Similar to the process for determining the defense spending determinants above, and like what Christie (2019) did in his analysis, this section will first assume random effects and test for fixed effects using the Hausman test once the final model is decided upon. In line with previous research, this analysis will express the dependent variable (defense investment) as a percentage. In this case, it is expressed as a percentage of total defense spending. The previous analysis already touched upon fiscal capacity, NATO, and the impacts

of external threats on defense spending. It was found that fiscal capacity is not a significant determinant of military expenditure for this sample. NATO and external threats, in particular the threat of Russian aggression and proximity to Russian armed forces, were found to be significant. These will be important considerations to take into account for the defense investment analysis.

Figure 5.2.1. represents the relationship between defense investment in the current period versus defense investment from the period before. There is a strong, positive association between the two time periods. This confirms that it is important to once again include the lag of the dependent variable in the regression analyses.

Figure 5.2.1.

Defense Investment (% of Defense Spending), (t, t-1)



The hypotheses for the determinants of defense investment formulated in the theoretical framework are restated below for convenience.

Hypothesis 1: Member states with strong defense industries are more likely to have higher defense investment.

Hypothesis 2a: Member states are likely to exhibit lower defense investment levels as average NATO spending levels increase.

Hypothesis 3a: Member states with lower fiscal capacity will likely exhibit lower defense investment.

Hypothesis 6a: Member states facing more imminent external threats are likely to have higher levels of defense investment.

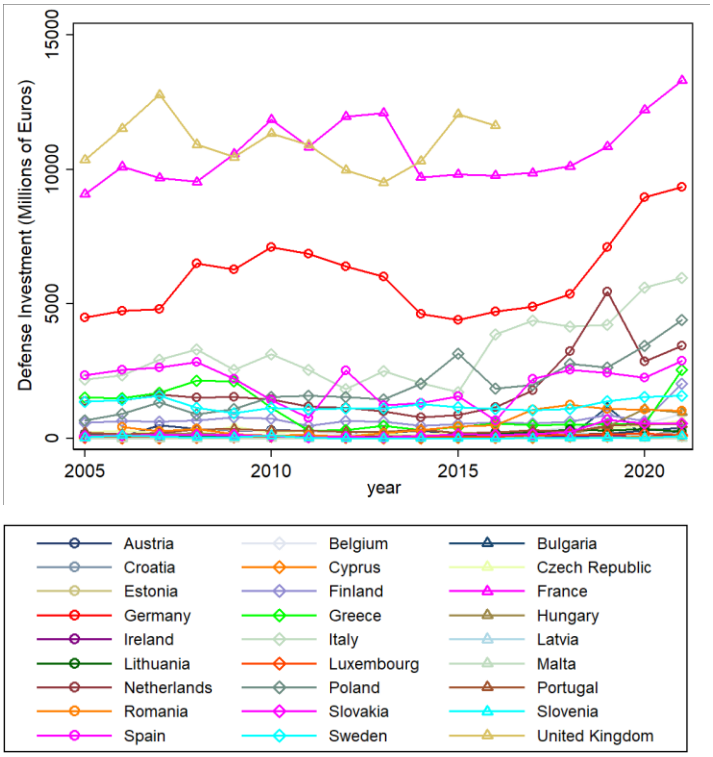
Figure 5.2.2. provides a brief graphical overview of the defense investment data for the sample. For some countries, such as Germany, Italy, and Poland, there is a clear upward trend in defense investment levels.

For other countries, however, the level of defense investment has remained relatively stable and close to zero; this includes, inter alia, Slovakia, Slovenia, Lithuania, and Bulgaria.

First, a basic model is run to see how the lag of the dependent variable of defense investment performs on its own (Table 5.2.1., Model 1). The defense investment as a percentage of total defense spending from the previous year is a strongly significant determinant of defense investment in the current year, which is expected based on the graphical representation in Figure 5.2.1.

Figure 5.2.2.

Defense Investment (Millions of Euros)



Because this research makes predictions about how a new variable, defense industry strength, might act as a determinant of defense investment and collaboration (Hypothesis 1), this variable is first tested on its own, using both proxies for defense industry strength (Models 2 and 3, Table 5.2.1.). As was explained in the data section, the first indicator is the percentage of sales of a country's top military companies in the SIPRI top 100 list (SIPRI, n.d.). The second indicator that is tested to check the effectiveness of the first indicator is the share of arms exports as a percentage of GDP for a given country. As can be seen, both models yield similar results: positive and significant coefficients, with little impact on the other variables included in the model. Their coefficients have different magnitudes due to the nature of the data. Because

the SIPRI top 100 data has more data points, the rest of the models will proceed with this indicator as the measure of private defense industry strength.

The second and third models do suggest that strong industries in the previous year tend to result in higher defense investment in the current year, however the coefficients are not significant. Though it still needs to be examined how the private industry variable performs when other controls and explanatory variables are introduced, these models demonstrate that there is some correlation between private industry strength and the level of defense investment. However, conclusions about Hypothesis 1 cannot be drawn until this variable is tested with other explanatory and control variables present.

Table 5.2.1.

Determinants of Defense Investment (Random Effects)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5 (Fixed Effects)	Model 6 (Fixed Effects)
Defense Investment (t-1)	0.7728*** (0.000)	0.7695*** (0.0341)	0.5010*** (0.0602)	0.7615*** (0.0336)	0.4870*** (0.0456)	0.4921*** (0.0455)
Defense Industry Strength (t-1) (Share of SIPRI Top 100)		0.0940 (0.1675)			-0.0450 (0.2956)	-0.0629 (0.2956)
Defense Industry Strength (t-1), Arms Exports (% of GDP)			17.3273 (15.5009)			
NATO Member				0.0890 (0.0758)	Omitted, collinearity	Omitted, collinearity
Change in US Defense Spending					3.1327** (1.4350)	3.1439** (1.4364)
Change in Russian Defense Spending					-1.3834** (0.6405)	-1.3506** (0.6407)
Right Wing Government (t-1)					0.0002 (0.0001)	0.0002 (0.0001)
Elections (t+1)					-0.0019 (0.0063)	-0.0020 (0.0063)
Defense Spending NATO Countries						
Defense Spending NATO Countries (t-1)				-1.8585 (2.4062)	-0.3682 (2.3783)	-3.0152** (1.3237)

NATO* Defense Spending NATO countries				-2.7408 (2.7441)		
NATO* Defense Spending NATO Countries (t-1)					-3.5396 (2.6580)	
Terrorism (t-2)					-0.0069** (0.0003)	-0.0007** (0.0003)
Conflict					-0.0179 (0.0109)	-0.0201* (0.0108)
Russian Threat Index					448.1153** (195.2417)	428.5292** (194.8876)
Debt-to-GDP Ratio (t-1)					-0.00001 (0.0002)	5.66e-06 (0.0002)
Constant	0.0432*** (0.0064)	0.0430*** (0.0064)	0.0841*** (0.0143)	0.0855 (0.0664)	0.1859*** (0.0429)	0.1841*** (0.0429)
Observations	414	413	233	414	413	413
R Squared (Within)	0.2925	0.2928	0.1370	0.3195	0.3706	0.3676
R Squared (Between)	0.9894	0.9871	0.6004	0.9890	0.1682	0.8073
R Squared (Overall)	0.5592	0.5594	0.4686	0.5760	0.2495	0.5220

* p < 0.10. ** p < 0.05. *** p < 0.01.

Hypothesis 2 stipulates that member states will invest less as defense expenditure of NATO allies increases, due to the risk of free-riding behavior. This variable is introduced in isolation in Model 4 to achieve an understanding of how the interaction effect and the two variables that make it are potentially related to defense investment. Neither NATO membership, defense expenditure levels of NATO countries, nor the interaction are significant in Model 4. The NATO coefficient is positive, suggesting that being a member of NATO tends to be correlated with higher levels of defense investment, while the other two coefficients are negative, suggesting higher spending among NATO member countries tends to push down investment levels, with an enhanced negative effect in countries that are NATO members themselves. Though insignificant, this does lend some evidence to the free-riding hypothesis.

Model 5 introduces all relevant control and explanatory variables, initially as a random effects model and then as a fixed effects model based on the Hausman Test (Table 5.2.2.). With a highly significant Chi squared statistic, the null hypothesis that random effects is the most effective estimation is rejected, and therefore fixed effects is adopted. This is also the case for Model 6. Though Models 5 and 6 show largely the same variables as being significant determinants of defense investment, the R squared in Model 6 is much larger than that in Model 5. Because the R squared in Model 5 was so low, we experimented with removing the interaction between NATO countries and the defense spending of NATO members.

Fascinatingly, this creates a drastically more significant model for almost all variables involved in Model 6, and therefore this is deemed the most appropriate model for this sample.

NATO membership was omitted in the fixed effects models due to collinearity. This is because, from the data that is available for defense investment, there is no time variation in the NATO variable for any of the countries. This means that NATO membership is already controlled for by using a fixed effects estimation, and therefore this variable is excluded from the model. This is not necessarily a problem because NATO membership is not a primary variable of interest, nor is it part of any interactions of interest after dropping the NATO interaction with NATO defense spending in Model 6.

The third hypothesis touches upon the importance of fiscal capacity in determining defense investment levels. In no models is Christie's (2019) fiscal capacity indicator, measured as used in his paper as the change in the fiscal capacity lagged by one year, significant. The indicator also does not become significant when fiscal capacity is lagged by one year, without considering the annual change. Therefore, the second proxy for fiscal health, the debt-to-GDP ratio, is considered in these models. To reiterate, this indicator is beneficial because there is more data available for this indicator of fiscal health than there is for Christie's (2019) fiscal capacity indicator. The debt-to-GDP ratio remains insignificant in Models 5 and 6, suggesting it is not an important indicator of defense investment.

Model 6 shows that the change in US defense spending and the Russian Threat Index are strong, positive determinants of defense investment. A one unit increase in the change in US defense spending, for example, is associated with a 3.14 percentage point increase in defense investment as a portion of defense spending. This makes sense considering the close allyship between the EU and the US, and it is likely that they collaborate on investment projects. It is perhaps possible that the EU is trying to decrease its dependency on US defense capabilities, and therefore has begun ramping up its investments. Alternatively, it is possible that in recent years, the EU has been experiencing more imminent security threats based on its geography, compared to the US, which is largely isolated. This could explain why the EU is ramping up its defense at a faster pace. This theory is supported by the fact that the Russian threat index remains strongly positive and significant in the fixed effects iterations, suggesting that the threat of Russian aggression is a strong determinant of defense investment (and its growth). Curiously, the coefficient on Russian spending is strong and negative, which might suggest that as Russian defense spending increases, EU countries forgo defense investment for regular defense spending for which they receive direct returns, instead of choosing to invest in long-term projects.

It was confirmed under the defense spending analysis above that internal political factors, such as percentage of right-wing government and upcoming elections, were insignificant determinants for this sample in this time period. This is confirmed in Models 5 and 6. In each of these models, the variables have very small, insignificant coefficients, suggesting they are not primary determinants of defense investment.

It is interesting that the Russian Threat index is positive while the coefficients for terrorism and involvement in international conflict in Model 6 are negative (albeit weak). It suggests that the Russian threat specifically increases defense investment, while terrorism and conflict have the opposite effect. This is in line with the determinants of defense spending found for this sample, however it is not in line with the findings and expectations suggested by previous literature and research. The slightly negative values for terrorism and conflict could be due to the fact that other national security threats, such as Russian aggression, become more pertinent as determinants of defense investment during the period of analysis. Alternatively, it is possible that being involved in international conflict and a higher threat of terrorism decreases the demand for defense investment because it increases the demand for immediate military expenditure. If a military budget is viewed as a fixed quantity, if a country is facing imminent, unexpected threats, or if their troops and allies are in need of immediate military equipment, it is likely that they will substitute defense investment with regular defense expenditure. This could explain why the coefficients on these two variables are consistently significant.

The strong, negative coefficient on the defense spending levels of NATO countries without the presence of the interaction in Model 6 suggests that there is free-riding on the NATO alliance for both countries who are and who are not NATO members. Note this is not identical to the findings in the defense spending analysis. The defense industry variable remains largely insignificant in all models, suggesting it is not an important determinant of defense investment for this sample.

Table 5.2.2.

Hausman Test for Models 5 and 6 (Dependent Variable: Defense Investment)

Model	Chi-Squared Statistic	Probability > Chi Squared
5	58.54	0.000
6	58.09	0.000

Note. Hausman Test for random or fixed effects.

The much higher R squared in Model 6 does beg the question of why the interaction between NATO and NATO countries' defense expenditure levels created such a distortion in Model 5, especially since previous studies and the above defense spending analysis found it to be a significant determinant. It could be that the data set is simply too small to provide evidence of the importance of this interaction, especially given the limitation of collinearity above. However, the fact that the defense spending of NATO countries variable, without being interacted with the NATO variable itself, has a significant and strong negative coefficient provides evidence that, in general, increased NATO defense expenditure decreases defense investment, including for non-NATO members. This is in line with the findings of Kuokštytė et al. (2021) that free-

riding extends beyond NATO members for defense spending and gives evidence that the NATO alliance has become so strong that even non-members have begun to free-ride on its strength. This supports Hypothesis 2a. To summarize the findings and conclusions from the above analysis and relate them to the stated hypotheses, Table 5.2.4. lists each hypothesis and whether it was supported, and additional robustness checks can be found in the Appendix, Table A.2. The robustness checks show that largely the same results uphold with various versions and combinations of explanatory and control variables included.

Table 5.2.4.

Defense Investment: Summary of Hypotheses and Evidence

Indicator	Hyp. #	Hypothesis	Evidence
Private Defense Industry	1a	Member states with strong defense industries are more likely to have higher defense investment.	Not supported; insignificant in all model variations
NATO Free-Riding	2a	Member states are likely to exhibit lower defense investment levels relative to total defense spending as average NATO spending levels increase.	Supported; increased NATO expenditure led to decrease in investment for all countries, not just NATO countries
Fiscal Capacity	3a	Member states with lower fiscal capacity will likely exhibit lower defense investment.	Not supported; not significant in any models
External Threats	6a	Member states facing more imminent external threats are likely to have higher levels of defense investment.	Partially supported; Russian Threat Index proved to be strong positive determinant, however Terrorism and Conflict had weak negative coefficients

5.3 Defense Investment Collaboration

Defense investment collaboration consists of procurement and research and development (R&D) or research and technology (R&T). Since the EDA provides data on total collaboration, as well as data on the individual components of R&D/R&T and procurement, this research will investigate each of these as separate entities to see if their determinants differ, and to offer a more segmented analysis of determinants of defense investment collaboration. It should be reiterated that there is significantly less data for defense investment collaboration than for the previous two analyses, and therefore the sample sizes in the following analyses will be somewhat smaller. To summarize, the hypotheses regarding investment collaboration were as follows:

Hypothesis 1b: Member states with strong domestic private defense sectors are likely to have higher levels of defense investment collaboration.
Hypothesis 2b: Member states are likely to exhibit lower defense investment collaboration levels as average NATO spending levels increase.
Hypothesis 3b: Member states with lower fiscal capacity will likely exhibit less defense investment collaboration.
Hypothesis 4: Member states that have lower corruption are likely to have higher levels of defense investment collaboration.
Hypothesis 5: EU15 states are more likely to have higher levels of defense investment collaboration than accession countries.
Hypothesis 6b: Member states facing more imminent external threats are likely to have higher levels of defense investment collaboration.

Recall that the defense investment collaboration model will be tested using OLS and Heckman two-step models. To investigate the assumptions about the selection variables of EU15, corruption, and defense spending as a percentage of GDP from the previous period, some descriptive statistics are pulled from the data. A dummy variable was created for whether a country had participated in defense collaboration (0 if no collaboration in both R&T and procurement, 1 if collaboration exists for either or both procurement and/or R&T). As can be seen from Figure 5.3.1., EU15 countries (represented by the number one on the horizontal axis) are more likely to participate in collaboration.

When graphing corruption indices against the likelihood of collaboration, we can see that this relationship is slightly less clear. Though the corruption index is slightly higher (and thus lower levels of corruption) in countries that do participate in collaboration (indicated by a 1 on the horizontal axis), the difference between the two groups is only slight. For this reason, some additional models will be tested without corruption as a Heckman selector to see if this makes the models more representative.

Finally, Figure 5.3.3. shows that NATO member countries are more likely to have participated in defense investment collaboration. Although this graphical representation is helpful for visualizing the data, the Heckman model will allow us to test whether these three variables, or variations thereof, are in fact significant selection variables for defense investment collaboration.

Figure 5.3.1.

Likelihood of Defense Investment Collaboration versus EU15 Membership

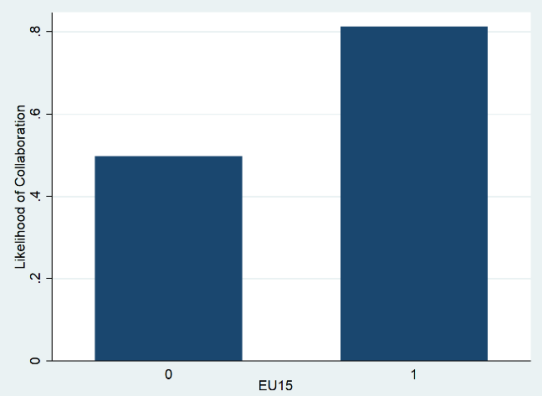
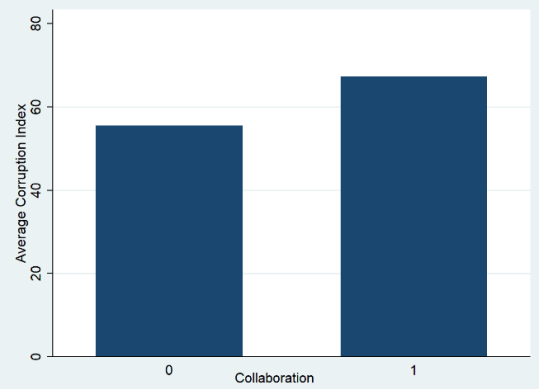


Figure 5.3.2.

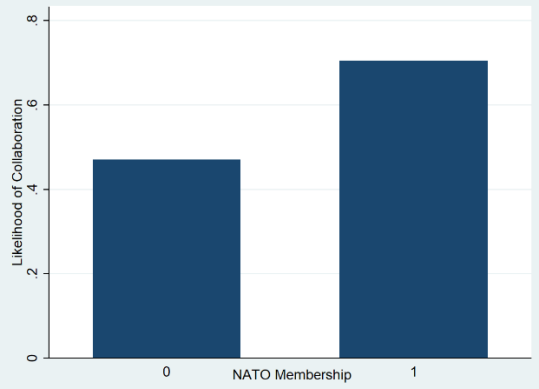
Average Corruption Index versus Collaboration



Note. The Corruption Perception Index (CPI) is measured on a scale from 1 to 100, where 100 refers to the lowest level of corruption.

Figure 5.3.3.

Likelihood of Defense Investment Collaboration versus NATO Membership



5.3.1. Defense Investment Collaboration: Procurement

Defense investment collaboration on procurement (equipment expenditure) is expressed as a percentage of total defense spending each year for each member state. This data will first be analyzed with an OLS regression based on the defense investment analysis, starting with the model that was found to be most significant in the overall defense investment model (Model 6). Each of the new variables of interest are individually introduced into the models, starting with EU15, then corruption levels, and finally private defense industry strength. Model 4 is put through a Hausman test, which confirms fixed effects to be the most appropriate model (Table 5.3.2.). It should be noted that elections and right-wing government share are not included as controls; this is because adding these did not yield any higher R-squared, and also they never exhibited any significant coefficients in any of the models. Because of the rather small sample size of this study, it was decided to exclude these to allow for a more accurate investigation of the variables that are expected to have actual significant impacts on the dependent variable (Appendix, Table A.3.).

Table 5.3.1.

Determinants of Defense Investment Collaboration (Procurement): Random Effects

Variable	Model 1	Model 2	Model 3	Model 4	Model 4 (Fixed Effects)
Defense Investment Collaboration (Procurement), t-1	0.8034*** (0.0425)	0.6852*** (0.0476)	0.6830*** (0.0477)	0.6818*** (0.0479)	0.5514*** (0.0560)
Change US Defense Spending	-0.1756 (0.7172)	-0.7458 (0.7007)	-0.6431 (0.7087)	-0.6957 (0.7208)	-0.2363 (0.8105)
Change Russian Defense Spending	-0.7702* (0.4364)	-0.5756 (0.4222)	-0.5616 (0.4225)	-0.5776 (0.4249)	-0.6962 (0.4349)
Debt-to-GDP (t-1)	0.0001 (0.0001)	-0.0002*** (0.0001)	-0.0002*** (0.0001)	-0.0002*** (0.0001)	-0.0001 (0.0001)
Corruption			0.0002 (0.0002)	0.0002 (0.0002)	-0.0003 (0.0005)
EU15		0.0259*** (0.0054)	0.0225*** (0.0064)	0.0224*** (0.0064)	Omitted, collinearity
Conflict (t-1)	-0.0106* (0.0057)	-0.0206*** (0.0058)	-0.0215*** (0.0059)	-0.0217*** (0.0059)	-0.0209*** (0.0076)
Terrorism (t-2)	-0.00003 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00005 (0.0002)

Russian Threat Index	-71.1256 (92.0853)	109.3211 (96.2026)	99.5844 (96.7351)	100.1427 (97.0377)	187.0051 (118.2637)
NATO	0.0102* (0.0053)	0.0156*** (0.0052)	0.0188*** (0.0062)	0.0183*** (0.0063)	Omitted, collinearity
Defense Spending NATO Countries (t-1)	-1.266 (0.7740)	-1.0145 (0.7471)	-0.8766 (0.7606)	-0.9292 (0.7708)	-1.0114 (0.8370)
Private Defense Industry (SIPRI top 100)				0.0652 (0.1293)	0.0394 (0.2909)
Constant	0.0466** (0.0232)	0.0426* (0.0224)	-0.0259 (0.0282)	0.0292 (0.0290)	0.0820* (0.0472)
Observations	296	296	296	295	295
R Squared (Within)	0.3805	0.3911	0.3907	0.3907	0.3973
R Squared (Between)	0.9665	0.9617	0.9662	0.9671	0.7106
R Squared (Overall)	0.6225	0.6511	0.6523	0.6524	0.5295

* p < 0.10. ** p < 0.05. *** p < 0.01.

The final model shows that the significant determinants of this fixed effects model are defense investment collaboration in procurement from the previous year and involvement in international conflict. The coefficient on conflict is negative, as it was for defense investment, suggesting that collaboration investment in R&T falls when a country is involved in an international conflict. The reasoning for this may be that a country in conflict may forgo investments in R&T for military expenditure with immediate returns when balancing a military budget. This is preliminary evidence against Hypothesis 6b.

Under fixed effects, the significance of the corruption, EU15, and NATO variables turn insignificant, suggesting these are not core determinants in this data set for defense investment collaboration in procurement under fixed effects estimations. Once again, EU15 and NATO are omitted due to collinearity, and therefore the importance of EU15 membership will be focused on during the QCA or any following significant Heckman modes. This model was also run with the NATO and NATO defense spending interaction, but this drastically reduced the R squared, suggesting the model is a weak indication of the relationship between the explanatory and dependent variables. The results can be seen in the Appendix in Table A.3.

Table 5.3.2.

Hausman Test Model 4 (Dependent Variable: Defense Investment Collaboration – Procurement)

Chi Squared Statistic	Probability > Chi Squared
20.88	0.004

Note. Hausman test for fixed or random effects.

A Heckman analysis was carried out next (Table 5.3.3.), to investigate if selection plays an important role in this analysis. Because the interaction between NATO and spending of other NATO countries was found to be such a distortional factor in previous analyses, both versions of the Heckman model including and excluding this variable are presented below. It is important to note that the IMR is not significant for either model, suggesting that selection bias did not play a role in the regression analysis and an OLS analysis was sufficient. In various iterations of the Heckman Model, the IMR remained insignificant, further solidifying this conclusion. The results for a model with corruption as both a selection and regression variable can be seen in Appendix Table A.5. Adding elections and right-wing government share also did not have any notable impact on the results.

Similar to the defense investment analysis, conflict has a weak, negative coefficient in the second round, suggesting that being involved in conflict decreases the demand for investment and investment collaboration. The strong negative coefficient for the Russian threat index in Round 1 suggests that facing strong Russian threats decreases the likelihood of participating in defense investment collaboration in procurement. This turns insignificant in the second round, suggesting it is less of an indicator of the amount actually invested in collaborative procurement. Once again, this lends evidence against Hypothesis 6b and suggests that, as a country perceives itself as facing higher threat levels, it is less likely to invest. This is not the case for the change in Russian defense spending in the first round, however. With a strongly significant positive coefficient of 94.2774 and then 89.5746, it appears that a positive change in Russian defense spending is associated with an increased likelihood of investment collaboration in procurement. Finally, the coefficient for the NATO variable is negative and significant, indicating that NATO membership decreases the likelihood of participation in procurement collaboration. This supports the belief that institutional overlap might be at play here, where member states are tied to various international institutions and agreements which keep them from committing to collaborative efforts at the EU level.

Table 5.3.3.

Heckman Model Defense Investment Collaboration (Procurement): With and Without NATO Interaction

Variable	Without Interaction		With Interaction	
	Round 1	Round 2	Round 1	Round 2

Defense Investment Collaboration (Procurement), t-1	20.1667**	0.8136***	19.6465*	0.7739***
	(9.7978)	(0.0490)	(10.2894)	(0.0510)
Change US Defense Spending	46.3408	-0.3270	54.2442	-0.3969
	(69.8278)	(0.7224)	(73.5543)	(0.7227)
Change Russian Defense Spending	94.2774***	-0.8098	89.5746***	-1.0333*
	(23.2145)	(0.6360)	(23.5219)	(0.6109)
Debt-to-GDP Ratio (t-1)	0.0029	-0.0001	0.0020	-0.0001
	(0.0050)	(0.0001)	(0.0053)	(0.0001)
Corruption	-0.0045		-0.0075	
	(0.0152)		(0.0160)	
EU15	-0.2793		-0.1591	
	(0.5222)		(0.5707)	
Conflict (t-1)	0.4549	-0.0067	0.5466	-0.0128**
	(0.3694)	(0.0051)	(0.3844)	(0.0059)
Terrorism (t-2)	-0.0054	-0.00004	-0.0049	-0.00003
	(0.0080)	(0.0001)	(0.0080)	(0.0001)
Russian Threat Index	-8975.014	-82.7992	-7462.107	-44.7344
	(6220.222)	(92.0810)	(6508.462)	(93.6145)
NATO	-0.6480		13.2151	0.0333
	(0.4344)		(13.7102)	(0.0480)
Defense Spending NATO Countries (t-1)	123.4875**	-1.4818	645.2801	-1.0339
	(61.0855)	(0.9866)	(549.0983)	(1.7539)
NATO*Defense Spending NATO Countries (t-1)			-549.6101	-0.7950
			(533.5708)	(1.7061)
Private Defense Industry (SIPRI top 100)	-9.9014	0.2010	-9.4556	0.2078
	(11.6341)	(0.1289)	(11.7870)	(0.1283)
Constant	-1.3825	0.0569*	-14.3957	0.0429
	(2.1322)	(0.0312)	(13.5994)	(0.0515)
Observations	316	295	316	295
Inverse Mills Ratio	0.0018		-0.0138	
	(0.0224)		(0.0208)	

Note. Heckman Two-step model with selection variables: EU15, Corruption Index, and NATO vs selection variables: EU15, Corruption Index.

* p < 0.10. ** p < 0.05. *** p < 0.01.

5.3.2. Defense Investment Collaboration: Research and Development/Technology

Like the approach adopted for defense investment collaboration in procurement, various iterations of the model were carried out by introducing new explanatory variables at different stages. In all variations, the change in US defense spending remains a strong, significant indicator of the level of defense investment collaboration in R&T. Additional models run for robustness can be seen in the Appendix in Table A.3.

Table 5.3.4.

Determinants of Defense Investment Collaboration (R&T): Random Effects

Variable	Model 1	Model 2	Model 3	Model 4	Model 4 (Fixed Effects)
Defense Investment Collaboration (R&T), t-1	0.8697*** (0.0227)	0.8622*** (0.0246)	0.8604*** (0.0248)	0.8606*** (0.0256)	0.6067*** (0.0469)
Change US Defense Spending	0.0235** (0.0105)	0.0226** (0.0106)	0.0235** (0.0107)	0.0233** (0.0108)	0.0324*** (0.0117)
Change Russian Defense Spending	-0.0081 (0.0060)	-0.0079 (0.0060)	-0.0076 (0.0060)	-0.0076 (0.0060)	-0.0005 (0.0060)
Debt-to-GDP (t-1)	-7.36e-07 (7.75e-07)	-1.12e-06 (9.11e-07)	-8.05e-07 (1.04e-06)	-7.92e-07 (2.63e-06)	-2.00e-06 (1.96e-06)
Corruption			1.64e-06 (2.62e-06)	1.67e-06 (2.63e-06)	0.00002*** (7.14e-06)
EU15		0.00006 (0.00008)	0.00003 (0.00009)	-0.00003 (0.00009)	Omitted, collinearity
Conflict (t-1)	0.00003 (0.00008)	0.00002 (0.00008)	9.32e-06 (0.00008)	0.00001 (0.00008)	0.00005 (0.0001)
Terrorism (t-2)	3.43e-06* (1.92e-06)	3.28e-06 (1.93e-06)	3.30e-06* (1.94e-06)	3.29e-06 (2.03e-06)	3.84e-06 (2.91e-06)
Russian Threat Index	-0.8073 (1.7141)	-0.3498 (1.8087)	-0.6071 (1.8566)	-0.6052 (1.8622)	-0.3686 (1.9938)
NATO	0.00004 (0.00007)	0.00004 (0.00007)	0.00007 (0.00008)	0.00007 (0.00008)	Omitted, collinearity
Defense Spending NATO Countries (t-1)	-0.0177 (0.0111)	-0.0167 (0.0112)	-0.0154 (0.0114)	-0.0156 (0.0114)	0.0090 (0.0122)
Private Defense Industry (SIPRI top 100)				-4.87e-06 (0.0023)	0.0005 (0.0044)

Constant	0.0006 (0.0003)	0.0005 (0.0003)	0.0004 (0.0004)	0.0004 (0.0004)	-0.0012* (0.0007)
Observations	315	315	315	314	314
R Squared (Within)	0.4766	0.4777	0.4792	0.4794	0.5055
R Squared (Between)	0.9702	0.9686	0.9666	0.9665	0.8169
R Squared (Overall)	0.8479	0.8482	0.8484	0.8484	0.7634

* p < 0.10. ** p < 0.05. *** p < 0.01.

The results of the Hausman test for Model 4 can be found in Table 5.3.5. The significant Chi Squared statistic indicates that a fixed effects estimation is most appropriate for this model. From the Model 4 (Fixed Effects) iteration, it is apparent that defense investment collaboration in R&T in the previous period is a strong, significant determinant of R&T collaboration levels in the current period. Additionally, the change in US defense expenditure is a strong, positive determinant across all iterations of the model, suggesting that a one unit increase in the change in US defense expenditure increases the level of R&T collaboration investment as a percent of defense spending by 2.33 percentage points.

Table 5.3.5.

Hausman Test Model 4 (Dependent Variable: Defense Investment Collaboration R&T)

Chi Squared Statistic	Probability > Chi Squared
36.47	0.000

Note. Hausman test for Random or Fixed Effects.

It is possible that this is such a strong relationship because the United States and Europe are such close military allies, and therefore an increase in US defense expenditure allows the EU to feel comfortable forgoing defense spending on operational activities for increased investment and collaboration. Alternatively, it could be that an increase in US defense expenditure signifies a similar increase in US R&T, and that research initiatives in the two entities coincide due to their close international ties. Nevertheless, the association between US defense investment and EU defense investment is an interesting phenomenon which warrants further research. Unfortunately, there was no public data regarding this available at the time of this research, so this could not be further investigated.

Another significant coefficient in Model 4 (Fixed Effects) is the level of corruption. Recall that corruption is measured on a scale from 1 to 100, where 100 represents the cleanest government, while 1 represents the most corrupt government. Therefore, a positive coefficient suggests that “cleaner” countries are more likely to participate in defense investment collaboration in R&T, lending evidence to Hypothesis 4. The dummy variables for NATO and EU15 were excluded from the fixed effects model, since neither of

these were time-variant with the available data for defense investment collaboration in R&T. This is not necessarily problematic, other than the fact that no conclusions can be drawn about the impact of NATO membership and EU15 status for the OLS regression.

A Heckman two-step model was also run for this analysis, and as shown in Table 5.3.6., the IMR for the second model with the interaction variable included is significant at exactly a ten percent level. Its slightly negative coefficient suggests that there would have been downward bias in the regular regression model, without the presence of the initial selection round. In the selection round (Round 1), defense investment collaboration in R&T, the change in Russian defense spending, and the private defense industry strength were all significant selection variables.

That the change in Russian defense spending is such a strong positive, significant determinant of the likelihood of R&T collaboration is an important finding that partially supports Hypothesis 6b. This suggests that, as Russia develops into a stronger threat and expands its military capabilities, the EU countries recognize the importance of building up long-term resilience to it through the betterment of military innovations and technologies with one another. Thus, their likelihood of collaboration on R&T is positively associated with increases in Russian military spending.

The strong negative coefficient on private defense industry strength (-20.85) is an unexpected result. It suggests that having a strong private defense industry reduces the likelihood of collaboration in R&T. The finding directly refutes the prediction set forth in Hypothesis 1b, where it was reasoned that having a strong defense industry would motivate a member state to be more involved in collaboration initiatives, since this would help keep their private industry from becoming obsolete. This evidence might support a more protectionist view, instead. For example, having a strong private defense industry might instead make a country turn inward and refrain from international cooperation, as keeping all research, development, and product domestically will support economic growth. This is concerning, as it means that those with the strongest defense industries are less likely to contribute to defense R&T projects, even when these countries are likely to have some of the best and most efficient technologies. This should therefore be further considered by EU regulating bodies, such as CARD and PESCO. It is important to continue to guarantee IPR protection and incentivize these countries and their industries to participate in R&T collaborative initiatives.

Round 2 of the Heckman model with the interaction included shows significant coefficients for defense investment collaboration in R&T in the previous period, change in US defense spending, and the change in Russian defense spending. This suggests that an increase in US defense spending is associated with an increase in the amount of defense investment collaboration in R&T in the EU. The negative coefficient on the change in Russian defense spending suggests the opposite effect, indicating that although Russian spending has a positive impact on the likelihood of collaboration in R&T, it has a negative effect

on collaboration on R&T once collaboration is occurring. This offers support for the previously theorized reasoning, namely that defense investment may be forgone for defense spending, instead, when the spending of an international aggressor increases.

Fiscal capacity (measured by the debt-to-GDP ratio) does not appear to be significant in any iterations of the models, suggesting that this is not an important determinant of defense investment collaboration in R&T. EU15 membership is also not a significant determinant in either of the selection rounds, suggesting this is not an important indicator of defense investment collaboration in R&T, either.

Table 5.3.6.

Heckman Model Defense Investment Collaboration (R&T)

Variable	Without Interaction		With Interaction	
	Round 1	Round 2	Round 1	Round 2
Defense Investment Collaboration (R&T), t-1	1099.079** (432.6718)	0.8445*** (0.0328)	1021.926** (426.004)	0.8394*** (0.0392)
Change US Defense Spending	-16.2067 (62.5949)	0.0259* (0.0136)	-25.5682 (64.3166)	0.0265* (0.0158)
Change Russian Defense Spending	84.3324*** (21.3846)	-0.0189* (0.0102)	86.8988*** (21.6765)	-0.0207* (0.0119)
Debt-to-GDP Ratio (t-1)	0.0062 (0.0046)	-9.94e-07 (9.96e-07)	0.0049 (0.0050)	-1.03e-06 (1.17e-06)
Corruption	0.0016 (0.0133)		0.0028 (0.0136)	
EU15	-0.5279 (0.4403)		-0.4367 (0.4565)	
Conflict (t-1)	0.2346 (0.3062)	0.00003 (0.00009)	0.2046 (0.3105)	0.00003 (0.0001)
Terrorism (t-2)	0.0023 (0.0089)	3.55e-06 (2.49e-06)	0.0003 (0.0093)	3.64e-06 (2.91e-06)
Russian Threat Index	-4544.017 (5915.201)	-0.5834 (2.0431)	-6284.596 (6228.196)	-0.2276 (2.4704)
NATO	-0.0136 (0.3377)		-1.5457 (2.9620)	0.0007 (0.0010)
NATO*Defense Spending NATO Countries (t-1)			53.312 (111.5487)	-0.0256 (0.0348)

Defense Spending NATO Countries (t-1)	159.1189** (69.4405)	-0.0331 (0.0029)	110.3787 (92.4769)	-0.0153 (0.0324)
Private Defense Industry (SIPRI top 100)	-20.0106* (11.0917)	0.0013 (0.0029)	-20.8458* (11.1965)	0.0015 (0.0034)
Constant	3.3729 (2.0568)	0.0011** (0.0005)	-2.2936 (2.7402)	0.0006 (0.0010)
Observations	339	314	339	314
Inverse Mills Ratio	-0.0006 (0.0004)		-0.0007† (0.0004)	

Note. Heckman Two-step model with selection variables: EU15, Corruption Index, and NATO vs selection variables: EU15, Corruption Index. The IMR for the model with the interaction is significant at exactly 10% level.
† p = 0.10.
* p < 0.10. ** p < 0.05. *** p < 0.01.

5.3.3. Defense Investment Collaboration: Total

Finally, it will be investigated what the determinants are of total defense investment collaboration by totaling the collaboration amounts for procurement and R&T. The results from basic OLS regressions can be seen in Table 5.3.7. Model 3 is adopted as the most comprehensive explanatory model for this OLS analysis, since adding defense industry strength causes almost no change in the explanatory strength of this model (as seen by the nearly identical R squared statistics). Unlike previous models, the Hausman test (Table 5.3.8) shows less strong evidence that a fixed effects model is the most appropriate estimator for this data. Additional OLS models were also run in Appendix Table A.4.

Table 5.3.7.

Determinants of Defense Investment Collaboration (Total): Random Effects

Variables	Model 1	Model 2	Model 3	Model 4	Model 3 (Fixed Effects)
Defense Investment Collaboration (Total) (t-1)	0.9205*** (0.0313)	0.8654*** (0.0359)	0.8631*** (0.0360)	0.8625*** (0.0362)	0.7913*** (0.0446)
Defense Industry Strength (t-1) (Share of SIPRI Top 100)				0.0202 (0.0964)	
NATO Member	0.0036 (0.0034)	0.0063 (0.0035)	0.0083* (0.0042)	0.0081* (0.0043)	Omitted, collinearity

EU15		0.0111***	0.0093**	0.0093**	Omitted,
		(0.0037)	(0.0043)	(0.0043)	collinearity
Change in US Defense Spending	-0.0310	-0.2596	-0.2011	-0.2129	0.0251
	(0.4722)	(0.4712)	(0.4770)	(0.4873)	(0.5607)
Change in Russian Defense Spending	-0.2650	-0.1946	-0.1872	-0.1915	-0.2227
	(0.2917)	(0.2882)	(0.2886)	(0.2902)	(0.3041)
Defense Spending of NATO Countries (t-1)	-0.7263	-0.6152	-0.5338	-0.5355	-0.5601
	(0.5240)	(0.5173)	(0.5272)	(0.5297)	(0.5861)
Terrorism (t-2)	-0.00001	-0.00005	-0.00006	-0.00006	-7.97e-06
	(0.00008)	(0.00008)	(0.00008)	(0.00009)	(0.0001)
Conflict (t-1)	-0.0038	-0.0086**	-0.0093**	-0.0094**	-0.0095*
	(0.0038)	(0.0041)	(0.0042)	(0.0042)	(0.0056)
Russian Threat Index	-89.1604	-16.5347	-26.8310	-27.0469	-32.6604
	(86.3394)	(88.3871)	(89.3465)	(89.6917)	(102.2922)
Debt-to-GDP Ratio (t-1)	-0.00002	-0.00008**	-0.00006	-0.00006	-2.29e-06
	(0.00003)	(0.00004)	(0.00005)	(0.00008)	(0.00009)
Corruption			0.0001	0.00009	-0.00004
			(0.0001)	(0.0001)	(0.0004)
Constant	0.02467	0.0233	0.0138	0.0144	0.0314
	(0.0159)	(0.0157)	(0.0195)	(0.0197)	(0.0326)
Observations	268	268	268	267	268
R Squared (Within)	0.6113	0.6120	0.6121	0.6122	0.6138
R Squared (Between)	0.9907	0.9893	0.9890	0.9883	0.9785
R Squared (Overall)	0.7939	0.8009	0.8014	0.8014	0.7838

* p < 0.10. ** p < 0.05. *** p < 0.01

For this reason, both the random and fixed effects versions of Model 3 will be considered. The random effects model includes NATO and EU15 because they are not removed from the analysis for collinearity when fixed effects are not applied. In the random effects version of Model 3, both NATO membership and EU15 have significant, positive coefficients, suggesting that NATO and EU15 membership lead to an increase in total defense investment collaboration. Once again, the coefficient on conflict is negative, suggesting that when a country is involved in international conflict, they will exhibit lower levels of total defense investment collaboration. In the fixed effects version of Model 3, where EU15 and NATO are

removed due to collinearity, conflict remains a slightly negative, although significant, indicator of defense investment collaboration.

Table 5.3.8.

Hausman Test Model 3

Chi Squared Statistic	Probability > Chi
9.28	0.098

Note. Hausman Test for confirmation of fixed or random effects modelling.

The Heckman analysis provides some additional insights (Table 5.3.9.). Once again, the models are run both with and without interactions. The IMR in both models are significant at a ten percent level with weakly positive coefficients, suggesting the OLS results in a slightly upward bias on the results. Therefore, the Heckman models can be considered a more appropriate model for this data, since the OLS suffers from selection bias. In both versions of the Heckman models below, the second round yields almost no significant results, besides the lagged version of the dependent variable. This does not mean, however, that the Heckman analysis did not yield helpful results. This analysis has in fact provided valuable insights.

Table 5.3.9.

Heckman Model Defense Investment Collaboration (Total)

Variable	Without Interaction		With Interaction	
	Round 1	Round 2	Round 1	Round 2
Defense Investment Collaboration (Total), t-1	16.053** (7.3971)	0.9697*** (0.0775)	15.1481** (7.5195)	0.9700*** (0.0775)
Change US Defense Spending	2.5358 (5.5049)	-0.1093 (1.1250)	7.8069 (67.9328)	-0.1052 (1.0511)
Change Russian Defense Spending	81.8412*** (22.0033)	0.8994 (0.9501)	77.5765*** (22.2606)	0.7981 (0.00008)
Debt-to-GDP Ratio (t-1)	0.0016 (0.0048)	-2.18e-06 (0.00008)	0.0009 (0.0050)	-4.84e-06 (0.00008)
Corruption	-0.0157 (0.0142)		0.0186 (0.0150)	
EU15	-0.3345 (0.4939)		-0.2226 (0.5357)	

Conflict (t-1)	0.5863	-0.0015	0.6446*	-0.0004
	(0.3719)	(0.0077)	(0.3831)	(0.0086)
Terrorism (t-2)	-0.0058	-0.00009	-0.0053	-0.00009
	(0.0078)	(0.0002)	(0.0078)	(0.0002)
Russian Threat Index	-12831.9**	-199.1977	-11350.48*	-206.3776
	(6351.647)	(195.897)	(6549.899)	(195.7903)
NATO	-1.1232**		10.9754	0.0072
	(0.4357)		(12.7042)	(0.0673)
NATO*Defense Spending NATO Countries (t-1)			-479.2854	-0.3413
			(512.1014)	(2.3737)
Defense Spending NATO Countries (t-1)	129.524	0.9437	586.158	1.0467
	(56.7651)	(1.5423)	(507.387)	(2.3892)
Private Defense Industry (SIPRI top 100)	-0.4897	0.0435	-0.1738	0.0501
	(11.2693)	(0.2212)	(11.3219)	(0.2065)
Constant	-0.6708	-0.0296	-12.038	-0.0308
	(1.9943)	(0.0485)	(12.5661)	(0.0702)
Observations	292	267	292	267
Inverse Mills Ratio	0.0464*		0.0433*	
	(0.0256)		(0.0261)	

Note. Heckman Two-step model with selection variables: EU15, Corruption Index, and NATO vs selection variables: EU15, Corruption Index.
* p < 0.10. ** p < 0.05. *** p < 0.01.

Though the second analysis does not offer significant coefficients, the selection rounds do. This has the following implications. For Russian defense spending, an increase in Russian defense spending as a percentage of GDP significantly increases the likelihood that member states will participate in collaborative defense investment. The strong negative coefficient on the Russian Threat Index shows that countries with a closer proximity to Russian armed forces, increasing as the perceived threat of Russia increased following Crimea, are less likely to participate in defense investment collaboration. This provides evidence against Hypothesis 6b, which predicted that facing a higher level of external threats would lead to higher levels of defense investment collaboration. This is an important finding, as it contradicts the findings about defense investment in section 5.2., where a higher Russian Threat Index led to more defense investment. The finding suggests that, as the Russian threat level increases for a country, it is less likely to turn outward for collaboration opportunities and will likely instead turn inward to focus on its own defense capabilities. Given the tumultuous geopolitical climate at the time of writing this research, it is very important that the

EU take this into consideration, as this likely means that the recent Russian aggression in Ukraine will cause a dip in defense collaboration. The EU should therefore further increase its efforts to spur collaboration between member states.

On the other hand, the coefficient on conflict in the second model with the interaction, round 1, is positive, suggesting that being involved in an international conflict increases the likelihood of having defense investment collaboration by 0.6446 percent. The coefficient is positive, though insignificant, in the first model without the interaction, as well. This suggests that being involved in an international armed conflict, which is one of the indicators measuring the external threats faced by a member state, is positively associated with the probability of collaboration. Since this is not in line with the findings for defense investment and spending in the previous two analyses, this will be further investigated in the QCA analysis in the next section.

Interestingly, in the model without the interaction, NATO membership is associated with a lower likelihood of participating in collaborative investment. This could be because NATO members are already tied to other investment obligations as part of their spending target, and becoming involved in other projects creates conflicts of interest or excessive financial burdens. An additional significant finding is that, overall, conflict leads to a higher likelihood of defense investment collaboration, as seen in the model with the interaction. This suggests that, when the interaction between NATO membership and NATO member defense spending is controlled for, conflict becomes a positive determinant of the chance of participating in collaboration, which lends support to Hypothesis 6b. Additional iterations of the Heckman model were run with different selection variables, such as just NATO and EU15 or just EU15 and Corruption Index. These were not found to have any significant impact on the results, and the results of these models can be found in the Appendix in Table A.6.

PESCO has also been included as a dummy in the total collaborative investment Heckman two-step analysis in Appendix Table A.7. The IMR does become even more significant once the PESCO dummy is included, suggesting the selection stage is especially important when analyzing the impact of the existence of PESCO on the likelihood of collaboration and, subsequently, the amount invested in collaboration. A multivariate OLS regression has also been run of Model 4 (Table 5.3.7.) with PESCO included as a dummy. These results can be found in the Appendix in Table A.8. The PESCO dummy is a dummy that is 0 for the years 2005 thru 2017 and adopts a value of 1 from 2018 onwards. Although PESCO was revamped in 2017, it was not officially launched until November 2017, and therefore the dummy only takes effect in 2018. In the Heckman analysis with the PESCO dummy, the coefficient is insignificant but negative for the selection and OLS round, suggesting that the likelihood of collaboration has fallen since the initiation of PESCO in 2017. However, since the dataset only goes to 2021, it is possible that this result

is because not enough time has passed since PESCO's initiation to sufficiently investigate the impact of PESCO on collaboration between member states.

5.4. PESCO Analysis

At the time this research was conducted, there were 61 ongoing or closed PESCO projects. Table A.9. in the Appendix lists data regarding the coordinators and participants of each PESCO project. PESCO projects cover a wide range of defense needs and capabilities, such as surveillance, maritime resilience, cyber response, intelligence development, space surveillance, and many others (Permanent Structured Cooperation, n.d.).

This analysis will begin my closely analyzing each of the individual factors in hypotheses one through six as individual entities. It is of course important to consider that the factors determining coordination and participation of PESCO projects do not work independently of one another, and therefore should be considered simultaneously. This will be done after the individual analysis. Recall that the variables were converted into dummies in Table 4.6.1. This table is copied below as Table 5.4.1.

Table 5.4.1.

PESCO QCA Analysis Coded Variables

	PESCO Partici-pant	Frequency of Participation	PESCO Coor-dinator	CPI	Debt to GDP Ratio	EU15	Russian Threat Index	Private Def Industry (% SIPRI top 100)	Shares Border w/ Russia	Int'l Conflict
AUT	9	0.14754	1	1	1	1	0	0	0	1
BEL	12	0.19672	1	1	1	1	0	0	0	1
BLG	6	0.09836	1	0	0	0	0	0	0	0
CRO	7	0.11475	0	0	1	0	0	0	0	0
CYP	9	0.14754	0	0	1	0	1	0	0	0
CZR	9	0.14754	1	0	0	0	0	0	0	1
EST	7	0.11475	3	1	0	0	1	0	1	1
FIN	5	0.08197	0	1	1	0	1	0	1	1
FRA	45	0.73770	14	1	1	1	0	1	0	1
GER	24	0.39344	9	1	1	1	0	1	0	1
GRC	18	0.29508	6	0	1	1	0	0	0	0
HUN	8	0.13115	1	0	1	0	0	0	0	0
IRE	5	0.08197	0	1	0	1	0	0	0	0
ITA	32	0.52459	11	0	1	1	0	1	0	1
LAT	5	0.08197	0	0	0	0	1	0	1	1
LIT	4	0.06557	1	0	0	0	0	0	1	1

LUX	8	0.13115	0	1	0	1	0	0	0	1
NLD	15	0.24590	1	1	0	1	0	0	0	1
POL	13	0.21311	1	0	0	0	1	1	1	0
PRT	14	0.22951	3	0	1	1	0	0	0	1
ROM	18	0.29508	2	0	0	0	1	0	0	1
SVK	6	0.09836	1	0	1	0	0	0	0	0
SLV	7	0.11475	0	0	1	0	0	0	0	0
ESP	28	0.45902	4	0	1	1	0	1	0	1
SWE	10	0.16393	1	1	0	1	0	1	0	1

Note. Projects and their participants and coordinators were sourced from Permanent Structured Cooperation (n.d.).

Table 5.4.1. also shows the number of projects each country is affiliated with, both as a participant and as a project coordinator. As can be seen in the table, every member state of PESCO has participated in at least one collaborative project, but not all member states have held coordinating roles. Specifically, Cyprus, Croatia, Finland, Ireland, Latvia, Luxembourg, and Slovenia have not yet coordinated a PESCO project. France, Germany, Spain, and Italy are the largest participants in PESCO projects. Except for Greece, they are also the countries that most frequently lead PESCO projects. This is consistent with Hypothesis 5, which predicted that EU15 countries were more likely to collaborate given their longer shared history and ability to build trust through repeated interactions. These countries also have the strongest private defense industries in the sample, per the SIPRI top 100 list. Only Poland, which collaborates in and leads fewer PESCO projects, has a comparatively strong defense industry. Poland is an outlier, however; it consistently has one of the highest defense expenditures in NATO. In recent years, Poland has become a major defense spender, mostly due to concerns about Belarusian and Russian security threats (Karnitschnig & Kosc, 2022).

A limitation of the QCA method is that we cannot rule out endogeneity here; it is possible, for example, that countries have larger defense industries because of the PESCO collaborations, instead of countries being more likely to participate in PESCO collaborations because of their strong defense industries. The former is unlikely to be the case, however, since the first PESCO projects were launched in 2019. The private defense industry data below is from 2021, and it is improbable that such a strong defense industry could be borne from a PESCO project in just under two years. For this reason, this table shows support for Hypothesis 1b, namely that member states with strong domestic private defense sectors are likely to have higher levels of defense investment collaboration. Hypothesis 2b, which discusses the amount of investment collaboration based on the level of defense spending of NATO countries, is not tested in this analysis. It is believed that the previously completed OLS and Heckman models can provide a much more accurate estimation of the impact of spending levels on defense collaboration, instead of based on the necessary and sufficient condition logic of a QCA analysis.

Hypothesis 3b predicts that member states with lower fiscal capacity will exhibit lower defense investment collaborations, since it is hard to justify expenditures with long-term (often unobservable) returns in times of economic stagnation, marked by high levels of debt. This hypothesis is not supported by the data. Leading PESCO participants and coordinators, such as France, Spain, and Italy, have high debt-to-GDP ratios. Alternatively, countries with lower debt-to-GDP ratios (Estonia, the Netherlands, Bulgaria, Sweden) have lower collaboration levels. Hypothesis 4 postulates that member states with lower levels of corruption will be more likely to participate in collaboration projects, under the assumption that lower levels of corruption mean that a government is more likely to be trusted and seriously considered as an investment partner by others. In general, this hypothesis is not supported by the data. Countries with relatively low corruption levels (Sweden, the Netherlands, Finland) have lower levels of collaboration than countries with considerably higher levels of corruption (Romania, Italy, and Spain). Hypothesis 5 hypothesized that being an EU15 member increases the amount defense investment collaboration; the data appears to lend considerable initial support for this, as the EU15 members tend to have the highest level of involvement in PESCO projects.

Hypothesis 6, which predicts that member states facing higher levels of security threats are more likely to participate in collaboration, does receive some support from the data. Countries with a higher Russian Threat Index, such as Poland, Sweden, and Romania, have moderate levels of collaboration. The data shows, however, that it is not necessarily the countries with the largest threat index that are most likely to be participating in collaboration projects, since countries with relatively low threat indices (Germany, France, Italy) are the biggest participants. This also appears to be the case for whether a country shares a border with Russia. It should be noted, however, that the dummy in this analysis only considers land borders. Sweden, for example, has a relatively high threat index, but its dummy for sharing a border with Russia is zero. Technically, Sweden shares a maritime border with Russia. Though this was not accounted for in this analysis in order to be consistent with previous research, this is an important consideration to take into account as military equipment becomes more advanced and capable. It is no longer just land borders about which countries need to be concerned, but also maritime ones (as is clearly demonstrated by the South China Sea tensions building in early 2023). Additionally, the existence of an international conflict in which the country is involved does not appear to play a major role in determining the likelihood of collaboration participation.

After considering each of these factors individually, it is now possible to examine the data more holistically. This will be done by running a QCA analysis in R studio. The analysis generates a truth table that summarizes the conditions and outcomes based on shared characteristics, and also lists the cases for which these outcomes occur. These results are in Table 5.4.2. below. The truth table shows that for four cases, namely Portugal, Greece, Italy and Spain, having high corruption (CPI value of 0), high debt-to-GDP

ratios, and being an EU15 together act in combination as sufficient conditions for the outcome of above average defense investment collaboration in PESCO projects. Table 5.4.2. also shows that almost all EU15 countries have above average PESCO collaboration levels, suggesting that collaboration is more likely when a country is an EU15 member. The finding can be expressed using necessary and sufficient conditions: ~CPI * Debt-to-GDP * EU15. This implies that where, simultaneously, CPI is 0 (suggesting high levels of corruption), Debt-to-GDP is 1 (indicating a high debt-to-GDP ratio) and EU15 is 1 (state is an EU15 member), the outcome tends to occur. This lends evidence in support of Hypotheses 5, and refutes Hypotheses 3b and 4.

For a number of other cases, including Austria, Belgium, France, Germany, Luxembourg, The Netherlands, and several others, not sharing a border with Russia but instead being in an international conflict (~Shared Border with Russia * Involved in Conflict) is associated with an outcome value of 1, suggesting an above-average level of participation in PESCO projects under these conditions. This might imply, for example, that countries are more willing to participate in collaborative investment when involved in conflict only when they are not faced with the imminent threat of sharing a border with an increasingly hostile Russia. This further confirms the findings from the Heckman model in section 5.3.3. There is no consistent outcome for the Russian Threat Index, as can be seen from Table 5.4.2.

The QCA does lend evidence to the hypothesis that having a robust defense industry is associated with a high level of involvement in PESCO projects. Although most countries with high defense industry strength do tend to participate more in projects, countries with relatively weaker defense industries also can have high levels of involvement, such as Greece, Portugal, Belgium, and Austria. Therefore, although a strong defense industry is always associated with an outcome of high level of PESCO participation, it is not a necessarily a necessary condition for the outcome to occur. This further suggests that more research needs to be done into the impact of defense industry strength on defense investment collaboration; though this relationship could not be confirmed in the Heckman and OLS models above, this QCA clearly shows that private defense industry is a prominent determinant for PESCO projects. In summary, the above results confirm that EU15 status and involvement in international conflict are all key factors in determining PESCO collaboration (Hypotheses 5 and part of 6b, respectively). Furthermore, it lends some evidence to Hypothesis 1b that members with strong defense industries are likely to participate in collaboration.

Table 5.4.2.

Truth Table QCA Analysis

Cases	Outcome	CPI	Shares Border with Russia	Debt-to-GDP Ratio	EU15	Russian Threat Index	Private Defense Industry	Int'l Conflict

BLG	0	0	0	0	0	0	0	0
CZR	1	0	0	0	0	0	0	1
ROM	1	0	0	0	0	1	0	1
CRO, HUN, SVK, SLV	0	0	0	1	0	0	0	0
CYP	1	0	0	1	0	1	0	0
GRC	1	0	0	1	1	0	0	0
PRT	1	0	0	1	1	0	0	1
ITA, ESP	1	0	0	1	1	0	1	1
LIT	0	0	1	0	0	0	0	1
LAT	0	0	1	0	0	1	0	1
POL	1	0	1	0	0	1	1	0
IRE	0	1	0	0	1	0	0	0
LUX, NLD	1	1	0	0	1	0	0	1
SWE	1	1	0	0	1	0	1	1
AUT, BEL	1	1	0	1	1	0	0	1
FRA, GER	1	1	0	1	1	0	1	1
EST	0	1	1	0	0	1	0	1
FIN	0	1	1	1	0	1	0	1

Note. Outcomes are based on frequency of collaboration. The outcome was calibrated in R Studio under the pretense of a fuzzy QCA analysis. An outcome assumes the value '1' when the calibrated frequency variable is above the average value of 0.48851, and outcome assumes a value of '0' otherwise.

For completeness, the variables in the QCA table (not in dummy variable format, Appendix Table A.10.) were run through a simple multivariate regression model. The outcomes can be found in the Appendix in Table A.11. These results are not included in the main body of this research, since the very small sample size of 25 is too small for a strictly quantitative analysis of this dataset. The regression was simply done to obtain a strong visualization of patterns in the data. The results show that having a strong private defense industry, debt-to-GDP ratio, being an EU15 country, and being involved in international conflict have strong positive coefficients, suggesting that countries with these conditions are more often participants in

PESCO projects. Though these findings are largely in line with what was found in the QCA and other Heckman/OLS analyses above, since this sample size is so small, definitive conclusions cannot be drawn from this sample.

The Russian threat index coefficient is strongly negative, suggesting that countries with higher Russian threat indexes are not as often likely to be involved in PESCO projects. This is consistent with the findings from the Heckman model for defense investment collaboration (total). However, this coefficient is insignificant, and the sample size is very small, so this should not be viewed as conclusive evidence of this. Instead, the QCA analysis above should be considered the primary and most reliable evidence for this PESCO sample. To streamline the findings from all the analyses performed above, and to circle back on what these findings mean for the hypotheses that were drafted in the theoretical framework, a summary of the conclusions can be found in Table 5.2.4.

Table 5.2.4.

Defense Investment Collaboration: Summary of Hypotheses and Evidence

Indicator	Hyp. #	Hypothesis	Evidence
Private Defense Industry	1b	Member states with strong defense industries are more likely to have higher defense investment collaboration.	Supported in QCA; weakly refuted in R&T Heckman Models
NATO Free-Riding	2b	Member states are likely to exhibit lower defense investment collaboration levels relative to total defense spending as average NATO spending levels increase.	Not supported; not significant in any models
Fiscal Capacity	3b	Member states with lower fiscal capacity will likely exhibit lower defense investment collaboration.	Not supported; not significant in any models
Trust in Gov't	4	Member states that have lower corruption are likely to have higher levels of defense investment collaboration.	Weak support in R&T OLS Model
EU15	5	EU15 states are more likely to have higher levels of defense investment collaboration than accession countries.	Supported (QCA); supported in total collaboration OLS model
External Threats	6b	Member states facing more imminent external threats are likely to have higher levels of defense investment collaboration.	Not supported for Russian Threat Index and Terrorism; supported for Conflict

6. Discussion

6.1. Defense Spending

In general, this dataset confirmed findings from previous research under certain conditions. Consistent with Kuokštytė et al. (2021), Christie (2019), and Nikolaidou (2008), the lagged variable of defense spending, NATO membership, and changes in US defense spending were significant determinants of defense spending for EU countries. The results obtained here also confirm that NATO members are more likely to free ride as the defense expenditure of other NATO members increases, and that the Russian threat index is a strong positive determinant of defense spending, per Christie (2019). This study was not able to confirm the findings of Christie (2019) and Alozious (2022) that fiscal capacity is an important indicator of the defense spending decisions made by member states, even when trying with various lags and measures of fiscal capacity. Perhaps this was due to the small sample size, or because this study included a much more extensive list of control variables than was included in either of the two aforementioned papers.

It should be questioned why the domestic political variables suggested by Kuokštytė et al. (2021) were not significant in this analysis, considering that dataset is not particularly outdated compared to this one. One possible theory is that this is because this paper utilized Christie's (2019) Russian threat index which is consistently proven in each model to be a strong predictor of defense spending, and later defense investment and collaboration. Because Christie's (2019) Russian threat index performed so strongly across all defense spending models, it is possible that this variable captured most of the variation in spending for this sample, and that the importance of political factors fall away as important determinants once national security is at risk. If a nation is facing an imminent external threat, either party is likely to respond with increased levels of defense expenditure. We therefore suggest that future research takes a closer look at using both domestic political factors and external threats in models (and interactions thereof), and how adding or removing these in varying degrees would potentially change results. This is beyond the scope of this research.

Finally, the defense spending research performed here confirmed that different types of external threats exhibit different effects on defense spending behavior. Though the Russian threat index was consistently a positive determinant, the involvement in international armed conflict and terrorism proved to either by insignificant or weak negative indicators of defense spending. Therefore, when enacting policy and imposing defense spending requirements, either at the EU level or through NATO, it is important to examine what kind of external threat factors member states are facing. In summary, this first analysis regarding the determinants of defense spending show that the determinants of defense spending are always changing and largely dependent on one another. Research in this field should continue to stringently

investigate these determinants and their relationship, and it is especially important that this empirical question is frequently revisited in the coming years as the security landscape of Europe continues to change.

6.2. Defense Investment

The determinants of defense spending were studied in the first analysis to work as a foundation for the determinants of defense investment and defense investment collaboration in the subsequent analyses, since no previous empirical research exists with defense investment and defense investment collaboration as dependent variables. Consistent with expectations, the variables that were significant in the defense spending analysis were also more likely to be significant determinants in the defense investment analysis. Specifically, the change in US defense spending, the lag of the defense investment dependent variable, and external threats (including the Russian threat index, conflict, and terrorism) were all significant in the defense investment analysis.

An important takeaway from these results is that the determinants of defense investment do somewhat mirror defense expenditure determinants, however, that they are not identical. A key difference between the investment and spending analysis was the finding that the interaction between NATO and defense spending of NATO allies was a largely distortional variable, and once it was removed from the analysis, a strong negative coefficient appeared on the variable representing defense spending of NATO countries. This implies that defense investment suffers from a free-riding problem across all member states, even those that are not NATO members, unlike the defense spending analysis where this applied mostly to strictly NATO members.

Secondly, there is once again an interesting finding regarding external threats and their impact on investment levels. In line with the defense spending findings from this study but not in line with previous studies, external threat factors for conflict and terrorism exhibited negative (though weak) coefficients. This implies that member states that experience these threats are likely to lower their level of investment. The Russian threat index remained positive and significant, suggesting that as the threat of Russia (in regard to distance to nearest stationed troops and the threat level after the invasion of Crimea) increases, defense investment increases as well. Curiously, however, the coefficient on Russian defense spending for investment is consistently strong and negative, perhaps suggesting member states forgo long-term investment for military expenditure that will yield immediate expansion of procurement and operational capabilities. This is an important consideration given the current geopolitical climate. The level of Russian military expenditure is undoubtedly increasing starting with its 2022 invasion of Ukraine (for which data is not yet available). This data shows that, historically, an increase in Russian spending is associated with a decrease in EU defense investment, predicting that Russia's expanding military expenses will mean lower

EU defense investment starting in 2022. Based on the differing effects of these external threat factors, it is important for European leadership to anticipate, react to, and provide incentives for investment based on the external threats faced by its member states.

6.3. Defense Investment Collaboration

An important conclusion that can be drawn from the models derived for the defense investment collaboration analyses is that further research is needed into the determinants of defense investment collaboration once more data is available. Clearly, the determinants of defense investment collaboration do not exactly mirror those of defense spending and defense investment. This suggests that there are various factors at play, such as game theory, strategic interactions, national interests, among others that determine to what extent member states will participate in defense collaboration.

The models in this research did find some key important indicators of collaboration. For example, whether a country is an EU15 country proved to be a key determinant of collaboration (as confirmed in the QCA). This is an important finding, as EU leadership should further investigate how to bridge the gap between EU15 and accession countries. Though this research reasoned that this is due to lower levels of trust from shorter periods for repeated interactions, the EU should further research what causes this divide. Additionally, the QCA analysis suggests having strong defense industries is commonly associated with more frequent involvement in defense investment collaboration projects. This is something that CARD and the PESCO board should consider when new projects and their participants are proposed, as having a weak defense industry could be holding certain member states back from pursuing collaborative efforts.

The Heckman and OLS models further confirmed that Russian defense spending increases the likelihood of a member state having defense investment collaboration. The results also confirmed that the existence of *specific* external threats tends to decrease the likelihood and amount of defense investment collaboration. For example, the variable for conflict showed to be a positive determinant of collaboration in the Heckman and QCA models, while the Russian threat index and terrorism variables were consistently negative (albeit weak) indicators. This suggests that the impact of threats is conditional on the existence of additional threats. This warrants future research, because it is important to understand how the threats being faced by a country interact to determine their defense investment collaboration profile. Furthermore, the fact that the Russian threat index was consistently negative for defense investment collaboration suggests that the increased Russian threat will not act as a unifying factor in the efforts to spur defense collaboration, and instead may lead to a deterioration in defense investment collaboration efforts. As has been previously theorized, this might be due to member states choosing to forgo investment in long-term projects for individualistic expansion in spending levels that leads to immediately available equipment and operational capabilities.

This is a very important finding, as it indicates a strong rift between the determinants of defense spending, defense investment, and defense collaboration. Whereas defense spending studies have consistently found the existence of external threats to positively influence the level of defense expenditure, this study suggests the opposite is true for investment and collaboration. The EU should seriously consider how it will go about further stimulating investment and cross-country collaboration at a time where all member states are feeling pressure from China and Russia. This research suggests that member states may sacrifice investment and collaborative investment for defense spending, further deepening the investment gap outlined by the European Commission. This is a phenomenon that requires further research, as an enhanced understanding of how external threats impact defense investment and collaboration levels can allow the EU to make more effective policy.

7. Conclusion

The main goal of this research was to investigate the following research question: What are the key determinants of European defense spending, defense investment, and defense investment collaboration from 2005-2021? Though defense spending has been thoroughly investigated in previous research, this study investigated the determinants for this sample in particular to lay a foundation for the determinants of defense investment and defense investment collaboration, which were expected to be similar to those of defense spending. The results show that the major factors determining defense spending levels for this sample in this period were not entirely reflected in defense investment and defense investment collaboration determinants.

Using data from the EDA and mixed methodologies, this research showed the determinants positively influencing defense spending levels for the countries in this sample were the change in US defense expenditure (Odehnal & Neubauer, 2018) and the threat of Russia (Christie, 2019). The study also confirmed findings from previous studies that NATO free riding plays a role in defense spending level determination (Nikolaidou, 2008; Kuokštytė et al., 2021), but was unable to find support that domestic political determinants (Kuokštytė et al., 2021) and fiscal capacity (Christie, 2019; Alozious, 2022) played a key role in determining defense spending for this sample. Regarding defense investment, this study showed that the strongest positive determinants were the change in US defense spending and the threat of Russia, consistent with the determinants of defense spending. The determinants that exhibited a negative effect on defense investment did differ from those found for defense spending. The models show that free-riding behavior takes place not only among NATO member countries but also among non-NATO members as defense spending levels in the NATO alliance increase. The other key negative determinants were the level of terrorism and involvement in international conflict, implying that various imminent threats to national security vary in their impact on defense investment levels. The study was unable to find evidence regarding impact of a strong domestic defense industry on defense investment levels (García-Estévez & Trujillo-Baute, 2014); nor was it able to find evidence of the importance of fiscal capacity as a determinant (Christie, 2019; Alozious, 2022).

Using a combination of OLS and Heckman two-step models, with a supplemental QCA analysis, this research found that the core determinants that impacted the likelihood and levels of defense investment collaboration are the change in Russian defense spending levels and whether a country is an EU15 member. Importantly, and contradictory to existing research about defense spending, the models demonstrate that certain external threats have a downward impact on defense investment collaboration, as opposed to the common conclusion from previous studies that national security risks tend to be positively associated with defense initiatives (Christie, 2019; Kuokštytė, 2021). This suggests that as countries come under threats to

national security, as is currently the case in the tense geopolitical environment, they are less likely to collaborate on defense investment.

The core scientific contribution of this research is that it found that the determinants of defense investment and defense investment collaboration do not necessarily mirror those of defense spending found in previous research (Christie, 2019; Nikolaidou, 2008; Kuokštytė et al., 2021; Odehnal & Neubauer, 2018). This confirms that defense investment and defense investment collaboration should be treated as separate dependent variables from defense spending, and that it should not be assumed that the variables influencing defense spending will have the same impact on defense investment and defense investment collaboration. Additionally, external threats, commonly viewed as a positive driver of defense spending (Christie, 2019; Kuokštytė et al.; Eilstrup-Sangiovanni, 2014) consistently showed to be negative determinants of defense investment and defense investment collaboration. This is a crucial consideration for the EU as it embarks on policymaking to close the defense investment gap in a time of escalating geopolitical tensions that has most member states on edge.

The core societal contribution of this research is that it shows that existing research is not sufficient for institutions like the EU to base regulation regarding defense investment and defense investment collaboration on. This research indicates that factors outside of existing scientific research and evidence play an important role in the security landscape of the EU, and if the EU hopes to successfully navigate the current tumultuous geopolitical climate, it needs to establish a stronger understanding of what factors are contributing to its defense investment and defense investment collaboration gap. For example, the EU needs to question the existing belief that higher levels of external threats will encourage defense investments and collaborative efforts, which is especially important given the 2022 invasion of Ukraine. Until then, the EU will likely continue to make missteps and fall behind with a fragmented defense structure.

The first shortcoming of this research that was often addressed was the limited amount of data. This study aimed to rectify this issue by creatively incorporating different measures and proxies for variables missing substantial data, but it is important that these factors are revisited once more complete and public data is available. A second shortcoming of this study that was also addressed by running various iterations of models is the issue of a lack of precedent in how to best analyze defense investment and defense investment collaboration as dependent variables. By using mixed methodologies, both quantitative and qualitative, this study aimed to compare findings across analyses to confirm or further question any initial conclusions. A stronger understanding of the appropriate models for these new dependent variables should be established, and this study can offer a strong starting point.

Further research should be done surrounding the importance of defense industries in determining levels of defense investment and defense investment collaboration, once more complete defense industry data becomes available. This can help CARD determine a better strategy for including more member states

in collaborative projects, instead of constantly having those countries with the strongest industries always leading projects. This can help reduce the free-riding problem and create a more cohesive Europe. Additionally, more extensive research should be done into examining the impact of external threats of defense spending, investment, and collaboration behavior, as this research has proven that these are not consistent across the three dependent variables. Finally, future research should consider the importance of overlapping institutional behavior on defense spending, investment, and collaboration; the models derived here demonstrate how NATO membership has varying impacts on international collaboration and defense spending/investment behavior, and this is especially crucial to understand in the EU context where there is a heightened risk of regulatory and institutional overlap.

8. References

Aflaki, S., Basher, S. A., & Masini, A. (2021). Technology-push, demand-pull and endogenous drivers of innovation in the renewable energy industry. *Clean Technologies and Environmental Policy, 23*, 1563-1580. https://doi.org/10.1007/s10098-021-02048-5

Alozious, J. (2022). NATO's Two Percent Guideline: A Demand for Military Expenditure Perspective. *Defense and Peace Economics, 33*(4), 475-488. https://doi.org/10.1080/10242694.2021.1940649

Armingeon, K., Engler, S. & Leemann, L. (2022). *Comparative Political Data Set 1960-2020* [Data set]. Department of Political Science, University of Zurich. https://www.cpds-data.org/index.php/data#Supplement

Bergmann, M., Wall, C., Monaghan, S., & Morcos, P. (2022, August 18). *Transforming European Defense*. Center for Strategic and International Studies. https://www.csis.org/analysis/transforming-european-defense

Bone, J. E., Wallace, B., Bshary, R., Raihani, N. J., & Mesoudi, A. (2016). Power Asymmetries and Punishment in a Prisoner's Dilemma with Variable Cooperative Investment. *PLoS ONE, 11*(5), e0155773. https://doi.org/10.1371/journal.pone.0155773

Cieslik, A. & Goczek, L. (2018). Control of corruption, international investment, and economic growth - Evidence from panel data. *World Development, 103*, 323-335. https://doi.org/10.1016/j.worlddev.2017.10.028

Christie, E. H. (2019). The Demand for Military Expenditure in Europe: The Role of Fiscal Space in the Context of a Resurgent Russia. *Defense and Peace Economics, 30*(1), 72-84. https://doi.org/10.1080/10242694.2017.1373542

Coulomb, F. & Fontanel, J. (2005). An Economic Interpretation of French Military Expenditures. *Defense and Peace Economics, 16*(4), 297-315. https://doi.org/10.1080/10242690500115915

Davies, S., Pettersson, T. & Öberg, M. (2022). Organized violence 1989-2021 and drone warfare. *Journal of Peace Research, 59*(4), 593-610. https://doi.org/10.1177/00223433221108428

De Vore, M. R. & Stai, N. K. (2019). When Collaboration Works. *European Review of International Studies, 6*(2), 18-42. https://doi.org/10.3224/eris.v6i2.02

DistanceFromTo. (n.d.). *Distance Between Cities on Map*. https://www.distancefromto.net/

Eichenberg, R. C. & Stoll, R. (2003). Representing Defense: Democratic Control of the Defense Budget in the United States and Western Europe. *Journal of Conflict Resolution, 47*(4), 399-548. https://doi.org/10.1177/0022002703254477

Eilstrup-Sangiovanni, M. (2014). Europe's Defence Dilemma. *The International Spectator, 49*(2), 83-116. https://doi.org/10.1080/03932729.2014.910728

European Commission. (2016). *European defence action plan*. https://eeas.europa.eu/sites/eeas/files/com_2016_950_f1_communication_from_commission_to_inst_en_v5_p1_869631.pdf

European Commission. (2022a). *Investment Gaps in EU Defence.* https://ec.europa.eu/commission/presscorner/detail/en/FS_22_3145.

European Commission. (2022b*). Defence investment gaps and measures to address them*. https://commission.europa.eu/publications/defence-investment-gaps-and-measures-address-them_en

European Council. (n.d.). *Timeline: EU cooperation on security and defence.* https://www.consilium.europa.eu/en/policies/defence-security/defence-security-timeline/

European Defence Agency. (2022). *Defence Data 2020-2021: Key findings and analysis*. https://eda.europa.eu/publications-and-data/brochures/eda-defence-data-2020-2021

European Defence Agency. (2023). *Publications and Data* [Data set]. https://eda.europa.eu/publications-and-data

European Defence Agency. (n.d.). *What is the European Defence Agency?* https://eda.europa.eu/home

European Union External Action. (2021, August 12). *The Common Security and Defence Policy*. https://www.eeas.europa.eu/eeas/common-security-and-defence-policy_en

Eurostat. (2022a). *Government deficit/surplus, debt and associated data* [Data set]. https://ec.europa.eu/eurostat/databrowser/view/GOV_10DD_EDPT1__custom_5710516/default/table?lang=en

Eurostat. (2022b). *Government finance statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_finance_statistics#General_government_surplus.2Fdeficit

Fiott, D. (2017). The EU, NATO and the European defence market: do institutional responses to defence globalisation matter? *European Security, 26*(3), 398-414. https://doi.org/10.1080/09662839.2017.1352582

García-Estévez, J. & Trujillo-Baute, E. (2014). Drivers of R&D investment in the defence industry: evidence from Spain. *Defense and Peace Economics, 25(*1), 39-49. https://doi.org/10.1080/10242694.2013.857464

Genschel, P., Kemmerling, A. & Seils, E. (2011). Accelerating Downhill: How the EU Shapes Corporate Tax Competition in the Single Market. *Journal of Common Market Studies, 49*(3), 585-606. https://doi.org/10.1111/j.1468-5965.2010.02136.x

Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M., & Strand, H. (2002). Armed Conflict 1946-2001: A New Dataset. *Journal of Peace Research, 39*(5), 615-637. https://doi.org/10.1177/0022343302039005007

Global Terrorism Database. (2020). *Global Terrorism Database* [Data set]. https://www.start.umd.edu/gtd/contact/download

Hanckel, B., Petticrew, M., Thomas, J., & Green, J. (2021). The Use of Qualitative Comparative Analysis (QCA) to address causality in complex systems: a systematic review of research on public health interventions. *BMC Public Health, 21*(87), 1-22. https://doi.org/10.1186/s12889-021-10926-2

Hofmann, S. C. (2011). Why Institutional Overlap Matters: CSDP in the European Security Architecture. *Journal of Common Market Studies, 49*(1), 101-120. https://doi.org/10.1111/j.1468-5965.2010.02131.x

Houdé, A. & Wessels, R. A. (2022). A Common Security and Defence Policy: Limits to Differentiated Integration in PESCO? *European Papers, 7(*3), 1325-1356. https://doi.org/10.15166/2499-8249/614

International Foundation for Electoral Systems (2023). *Election guide*. https://www.electionguide.org/countries/

Karnitschnig, M. & Kosc, W. (2022, November 21*). Meet Europe's coming military superpower: Poland*. Politico. https://www.politico.eu/article/europe-military-superpower-poland-army/

Kollias, C., Manolas, G., & Paleologou, S. M. (2004). Defence expenditure and economic growth in the European Union: A Causality Analysis. *Journal of Policy Modeling, 26*(5), 553-569. https://doi.org/10.1016/j.jpolmod.2004.03.013

Kollias, C. & Paleologou, S. M. (2019). Military spending, economic growth and investment: a disaggregated analysis by income group. *Empirical Economics, 56*(3), 935-958. https://doi.org/10.1007/s00181-017-1379-2

Krook, M. L. (2010). Women's Representation in Parliament: A Qualitative Comparative Analysis. *Political Studies, 58*(5), 886-908. https://doi.org/10.1111/j.1467-9248.2010.00833.x

Kuokštytė, R., Kuokstis, V., & Miklasevskaja, I. (2021). External and domestic political determinants of defence spending: a time-series cross-section analysis of EU member states. *European Security, 30*(2), 197-217. https://doi.org/10.1080/09662839.2020.1843437

Malizard, J. (2015). Does military expenditure crowd out private investment? A disaggregated perspective for the case of France. *Economic Modelling, 46*(1), 44-52. https://doi.org/10.1016/j.econmod.2014.10.049

Marchenko, Y. V. & Genton, M. G. (2012). Heckman Selection-t Model. *Journal of the American Statistical Association, 107*(497), 304-317. https://doi.org/10.1080/01621459.2012.656011

Martill, B. & Gebhard, C. (2023). Combined differentiation in European defense: tailoring Permanent Structured Cooperation (PESCO) to strategic and political complexity. *Contemporary Security Policy, 44*(1), 97-124. https://doi.org/10.1080/13523260.2022.2155360

Monaghan, S. (2023, March 1). *Solving Europe's Defense Dilemma: Overcoming the Challenges to European Defense Cooperation.* Center for Strategic and International Studies. https://www.csis.org/analysis/solving-europes-defense-dilemma-overcoming-challenges-european-defense-cooperation

Moretti, E., Steinwender, C., & Van Reenen, J. (2019). *The intellectual spoils of war? Defense R&D, Productivity, and International Spillovers* (NBER Working Paper 26483*).* https://cepr.org/voxeu/columns/intellectual-spoils-war-how-government-spending-defence-research-benefits-private

Müllner, V. & Nečas, K. (2022). The Impact of Public Budget Distortion on the Defence Capabilities of the New European Nato Member States. *International Conference KBO, 28*(2), 32-38. https://doi.org/10.2478/kbo-2022-0045

NATO. (2022). *Information on defence expenditures* [Data set]. nato.int/cps/en/natohq/topics_49198.htm

Nikolaidou, E. (2008). The Demand for Military Expenditure: Evidence from the EU15 (1961-2005). *Defence and Peace Economics, 19*(4), 273-292. https://doi.org/10.1080/10242690802166533

Odehnal, J. & Neubauer, J. (2020). Economic, Security, and Political Determinants of Military Spending in NATO Countries. *Defence and Peace Economics, 31*(5), 517-531. https://doi.org/10.1080/10242694.2018.1544440

Oneal, J. R. (1990). Testing the Theory of Collective Action: NATO Defense Burdens, 1950-1984. *The Journal of Conflict Resolution, 34*(3), 426-448. https://doi.org/10.1177/0022002790034003003

Pappas, I. O. & Woodside, A. G. (2021). Fuzzy-set Qualitative Comparative Analysis (fsQCA): Guidelines for research practice in Information Systems and marketing. *International Journal of Information Management, 58.* https://doi.org/10.1016/j.ijinfomgt.2021.102310

Permanent Structured Cooperation. (n.d.). *Deepen defence cooperation between EU member states*. https://www.pesco.europa.eu/about/

Robertson, P. E. (2022). The Real Military Balance: International Comparisons of Defense Spending. *The Review of Income and Wealth, 68*(3), 797-818. https://doi.org/10.1111/roiw.12536

Rondeli Foundation (2023). *Russian Military Forces: Interactive Map*. https://gfsis.org.ge/maps/russian-military-forces

Sempere, C. M. (2018). What Is Known About Defence Research And Development Spill-Overs? *Defence and Peace Economics, 29*(3), 225-246. https://doi.org/10.1080/10242694.2016.1239364

SIPRI. (2022a). *SIPRI Arms Industry Database* [Data set]. https://www.sipri.org/databases/armsindustry

SIPRI. (2022b). *SIPRI Arms Transfers Database* [Data set]. https://www.sipri.org/databases/armstransfers

SIPRI. (2022c). *SIPRI Military Expenditures Database* [Data set]. https://milex.sipri.org/sipri

Statista. (2023). *Total bilateral aid commitments to Ukraine between January 24, 2022 and February 24, 2023, by type and country or organization.* https://www.statista.com/statistics/1303432/total-bilateral-aid-to-ukraine/

Statistics Netherlands. (n.d.). *European Union*. https://www.cbs.nl/en-gb/news/2009/19/number-of-households-at-risk-of-poverty-in-the-netherlands-relatively-low/european-union#:~:text=The%20EU%2015%20includes%20Belgium,Slovakia%20and%20the%20Czech%20Republic.

Toshkov, D. (2016). *Research Design in Political Science*. Bloomsbury Publishing.

Transparency International. (2022). *Corruption Perceptions Index* [Data set]. https://www.transparency.org/en/cpi/2022

Uppsala Conflict Database Program / Peace Research Institute Oslo. (2022). *UCDP/PRIO Armed Conflict Dataset version 22.1* [Data set]. https://ucdp.uu.se/downloads/

Williams, L. K. (2015). Estimating the defense spending vote. *Electoral studies, 39,* 243-255. https://doi.org/10.1016/j.electstud.2015.03.020

World Bank. (2022a). *Arms exports (SIPRI trend indicator values)* [Data set]. https://data.worldbank.org/indicator/MS.MIL.XPRT.KD

World Bank. (2022b). *GDP (current US$)* [Data set]. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

World Bank. (2022c). *GDP Growth (annual %)* [Data set]. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

World Economic Forum. (2019). *3 Charts that show who pays the most for the defence of Europe*. https://www.weforum.org/agenda/2019/02/3-charts-that-show-who-pays-most-for-the-defence-of-europe-b63fb5f2f4/

9. Appendix

Table A.1.

Data & Sources

Variable	Description	Source
Defense Spending	Defense spending, represented in millions of euros	EDA (2023)
Defense Spending (as % of GDP)	Defense spending, represented as a percentage of GDP of each state	EDA (2023); SIPRI (2022c)
Defense Investment	Defense investment, which includes both R&T and procurement (millions of euros)	EDA (2023)
Defense Investment Collaboration on Procurement	Defense investment collaboration (with strictly other EU countries) on procurement activities (millions of euros)	EDA (2023)
Defense Investment Collaboration on R&T	Defense investment collaboration (with strictly other EU countries) on R&T activities (millions of euros)	EDA (2023)
Defense Investment Collaboration (total)	Defense investment collaboration (with strictly other EU countries) on R&T and procurement (millions of euros)	EDA (2023)
Debt-to-GDP Ratio	Public debt ratio to a state's GDP in a given year	Eurostat (2022a)
US Defense Spending (also as a % of GDP)	US defense spending as a fraction of its GDP, in a given year	SIPRI (2022c)
Russian Defense Spending (as a % of GDP)	Russian defense spending as a fraction of its GDP, in a given year	SIPRI (2022c)
Defense Expenditure NATO Countries (as % of GDP)	Defense expenditure level of all NATO countries in a given year, represented as a portion of national GDPs	NATO (2022)
NATO	Dummy for NATO members	NATO (2022)
EU15	Dummy for EU15 members	Statistics Netherlands (n.d.)
Corruption Perception Index	Index to measure level of trust of other governments in a certain government	Transparency International (2022)
GDP Growth	Year-over-Year GDP Growth	World Bank (2022c)

GDP (millions of 2021 USD)	GDP, in millions of 2021 US Dollars	World Bank (2022b)
Right-wing government	Share of parliament that is controlled by right-wing	Armingeon et al. (2022)
Election year	Dummy indicating whether a parliamentary or presidential election will take place.	International Foundation for Electoral Systems (2023)
Private defense industry strength (% of SIPRI top 100)	From the SIPRI top 100 military companies, this is the share of this ranking that a country holds for a given year	SIPRI (2022a)
Private defense industry strength (Arms Exports as % of GDP)	A percentage reflecting the percentage of arms exports (in TIV) as a portion of GDP in a given year.	World Bank (2022a)
Involved in armed conflict	Dummy for whether a state is involved in armed conflict (internationally) for a specific year.	Uppsala Conflict Database Program / Peace Research Institute Oslo (2022); Davies et al. (2022); Gledistsch et al. (2002)
Terrorism	The number of terrorism attacks faced by a country in a given year	Global Terrorism Database (2020)
Proximity to Russian Military Forces	Distance, in kilometers, from a country's capital to the nearest Russian deployed forces	Rondeli Foundation (2023); DistanceFromTo (n.d.)
Crimea	Dummy for invasion of Crimea, 0 from 2005-2013 and 1 from 2014-2021	N/A
Threat Index	Index for Russian threat, 0 from 2005-2012, 1 in 2013, and 3 from 2014-2021	Christie (2019)

Table A.2.

Defense Investment: Additional Models (Fixed Effects)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Defense Investment, t-1	0.5432***	0.4913***	0.4356***	0.4235***	0.4990***
	(0.05645)	(0.0455)	(0.0692)	(0.0702)	(0.0450)
Defense Industry Strength (t-1) (Share of SIPRI Top 100)	0.0447		-0.2371	-0.2616	-0.0543
	(0.2908)		(0.5594)	(0.5742)	(0.2945)
NATO Member	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity

Change in US Defense Spending	-0.3144 (0.8133)	2.9146** (1.4281)	3.4941*** (1.2777)	4.4051** (1.7504)	3.4364*** (1.2963)
Change in Russian Defense Spending	-0.6867 (0.4348)	-1.2902** (0.6380)	-1.4025** (0.5539)	-1.1793** (0.5366)	-0.9950 (0.6605)
Defense Spending of NATO Countries				-1.3372 (1.4892)	
Defense Spending of NATO Countries (t-1)	0.4909 (1.6016)	-0.2613 (2.3878)	-1.9420 (1.1951)		-2.3167* (1.3391)
NATO*Defense Spending of NATO Countries					
NATO*Defense Spending of NATO Countries (t-1)	-1.9821 (0.2908)	-3.4893 (2.6593)			
Terrorism (t-2)	-0.00004 (0.0002)	-0.0007** (0.0003)	-0.0008*** (0.0002)	-0.0008*** (0.0003)	-0.0007** (0.0003)
Conflict	-0.0204** (0.0002)	-0.0193* (0.0108)	0.0073 (0.0130)	0.0047 (0.0135)	-0.0217** (0.0106)
Russian Threat Index	215.425* (121.0064)	435.3202** (195.1031)	482.07** (199.3204)	544.4535** (212.8642)	430.5615*** (192.207)
Change in Fiscal Capacity (t-1)			0.0004 (0.0006)	0.0005 (0.0006)	
Debt to GDP Ratio (t-1)	-0.0001 (0.0001)	-0.00001 (0.0002)			
Change in Debt-to-GDP Ratio					-0.0007 (0.0005)
Election (t+1)				0.0020 (0.0063)	
Right Wing Government (t-1)				0.00004 (0.0001)	
Constant	0.0981* (0.0494)	0.1882*** (0.0428)	0.1483*** (0.0320)	0.1328*** (0.0393)	0.1727*** (0.0365)
Observations	295	413	205	205	413
R Squared (Within)	0.4001	0.3665	0.3682	0.3625	0.3671
R Squared (Between)	0.0744	0.1592	0.7329	0.7046	0.7897
R Squared (Overall)	0.2165	0.2427	0.5670	0.5493	0.5166

Table A.3.

Defense Investment Collaboration (Procurement & R&T): Additional OLS Models

Variables	Procurement		R&T	
	Model 1	Model 2	Model 1	Model 2
Defense Investment Collaboration (R&T), t-1			0.5936*** (0.0478)	0.6025*** (0.0470)
Defense Investment Collaboration (Procurement), t-1	0.5433*** (0.567)	0.05516*** (0.0562)		
Defense Industry Strength (t-1) (Share of SIPRI Top 100)	0.0489 (0.2928)	0.0461 (0.2929)	0.0006 (0.0044)	0.0005 (0.0044)
NATO Member	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity
EU15	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity
Change in US Defense Spending	-0.2702 (0.8189)	-0.1942 (0.8161)	0.0327*** (0.0117)	0.0332*** (0.0117)
Change in Russian Defense Spending	-0.6880 (0.4420)	-0.6910 (0.4422)	0.00004** (07.63e-06)	-0.0003 (0.0060)
Defense Spending of NATO Countries (t-1)	0.4472 (1.6080)	-1.0218 (0.8501)	0.0279 (0.0232)	0.0080 (0.0123)
NATO*Defense Spending of NATO Countries (t-1)	-1.9521 (1.8138)		-0.0259 (0.0256)	
Terrorism (t-2)	-0.0004 (0.0002)	-0.00005 (0.0002)	5.31e-06 (3.04e-06)	4.89e-06 (3.01e-06)
Conflict (t-1)	-0.0202** (0.0079)	-0.0207*** (0.0079)	0.00007 (0.0001)	0.00005 (0.0001)
Russian Threat Index	215.2878* (121.5618)	186.9051 (118.703)	0.0948 (2.0977)	-0.5301 (2.0046)
Debt-to-GDP Ratio (t-1)	-0.0001 (0.0001)	-0.00008 (0.0001)	-2.12e-06 (1.98e-06)	-1.84e-06 (1.96e-06)
Election (t+1)	0.00021 (0.0038)	0.0024 (0.0038)	0.00005 (0.00005)	0.00005 (0.00005)
Corruption	-0.0005 (0.0006)	-0.0003 (0.0005)	0.00002** (7.63e-06)	0.00002*** (7.16e-06)
Right Wing Government (t-1)	0.00002 (0.00006)	0.00002 (0.00006)	1.20e-06 (9.17e-07)	1.13e-06 (9.14e-07)
Constant	0.0951* (0.0499)	0.0790 (0.0476)	-0.0011* (0.0007)	-0.0013* (0.0007)
Observations	295	295	314	314

R Squared (Within)	0.4011	0.3984	0.5116	0.5098
R Squared (Between)	0.0762	0.7199	0.6868	0.8044
R Squared (Overall)	0.2196	0.5297	0.6444	0.7623

Table A.4.

Defense Investment Collaboration (Total): Additional OLS Models

Variables	Model 1	Model 2	Model 3
Defense Investment, t-1	0.7878***	0.7886***	0.7895***
	(0.0449)	(0.0451)	(0.0451)
Defense Industry Strength (t-1) (Share of SIPRI Top 100)	0.0901	0.0741	0.0650
	(0.1996)	(0.2006)	(0.2011)
NATO Member	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity
EU15	Omitted, collinearity	Omitted, collinearity	Omitted, collinearity
Change in US Defense Spending	0.1080	-0.0260	-0.0329
	(0.5026)	(0.4917)	(0.4916)
Change in Russian Defense Spending	-0.2526	-0.2930	-0.2965
	(0.3074)	(0.3209)	(0.3207)
Defense Spending of NATO Countries (t-1)	-0.7302	-0.6673	-0.6864
	(0.6055)	(0.6025)	(0.6028)
Terrorism (t-2)	-9.59e-06	-8.42e-06	
	(0.0001)	(0.0001)	
Terrorism (t-1)			-0.0001
			(0.0001)
Conflict	-0.0098*	-0.0097*	-0.0095*
	(0.0056)	(0.0056)	(0.0056)
Russian Threat Index	-45.7661	-41.0142	-29.5434
	(102.4641)	(102.0971)	(101.9672)

Change in Debt-to-GDP Ratio (t-1)	0.0001 (0.0002)		
Change in Debt-to-GDP Ratio		0.0001 (0.0002)	0.0001 (0.0002)
Election (t+1)		-0.0021 (0.0027)	-0.0021 (0.0027)
Corruption	-0.00003 (0.0003)	-0.0001 (0.0003)	-0.0001 (0.0003)
Right Wing Government (t-1)		-1.28e-06 (0.00004)	-3.76e-06 (0.00004)
Constant	0.0349 (0.0288)	0.0354 (0.0289)	0.0369 (0.0290)
Observations	267	267	267
R Squared (Within)	0.6150	0.6156	0.6160
R Squared (Between)	0.9715	0.9742	0.9756
R Squared (Overall)	0.7850	0.7855	0.7853

Table A.5.

Defense Investment Collaboration (Procurement and R&T): Iterations of Heckman Models

Variable	Procurement		R&T	
	Round 1	Round 2	Round 1	Round 2
Defense Investment Collaboration (Procurement), t-1	20.6256** (9.9008)	0.7991*** (0.0498)		
Defense Investment Collaboration (R&T), t-1			1175.277*** (448.935)	0.8396*** (0.0326)
Change in US Defense Spending	51.3965 (71.2042)	-0.3132 (0.7242)	-15.1017 (63.3087)	0.0263** (0.0126)
Change in Russian Defense Spending	95.126*** (23.3309)	-0.7627 (0.6263)	84.7378*** (21.7027)	-0.0172* (0.0091)
Debt-to-GDP Ratio (t-1)	0.0022 (0.0052)	-0.00005 (0.00005)	0.0064 (0.0048)	-8.40e-07 (9.44e-07)

Corruption	-0.0045	0.0002	0.0016	1.66e-06
	(0.0154)	(0.0001)	(0.013)	(2.20e-06)
EU15	-0.1476		-0.3960	
	(0.5515)		(0.4592)	
Conflict (t-1)	0.4163	-0.0067	0.2368	0.00003
	(0.3773)	(0.0050)	(0.3117)	(0.00008)
Terrorism (t-2)	-0.0062	-0.0001	-0.0002	3.43e-06
	(0.0081)	(0.0001)	(0.0091)	(2.31e-06)
Russian Threat Index	-9116.78	-72.4380	-5641.489	-0.9096
	(6196.116)	(91.8678)	(5895.048)	(1.9529)
NATO	-0.6483		-0.0723	
	(0.4382)		(0.3452)	
Defense Spending of NATO (t-1)	121.5909**	-1.3110	162.7573***	-0.0307**
	(60.8074)	(0.9761)	(61.7128)	(0.0151)
Election (t+1)	0.1840	0.0017	0.2553	-1.99e-06
	(0.2878)	(0.0038)	(0.2761)	(0.00006)
Right Wing Government (t-1)	0.0034	-0.00005	0.0047	3.70e-07
	(0.0039)	(0.00005)	(0.0038)	(8.77e-07)
Private Defense Industry (SIPRI top 100)	-11.2139	0.1757	-21.2313*	0.0011
	(11.6114)	(0.1314)	(11.1643)	(0.0027)
Constant	-1.5056	0.0421	-3.7630*	0.0009*
	(2.1288)	(0.0331)	(2.0901)	(0.0005)
Observations	316	295	339	314
Inverse Mills Ratio	0.0008		-0.0005	
	(0.0218)		(0.0003)	

Table A.6.

Defense Investment Collaboration (Total): Iterations of Heckman Models

Variable	Model 1		Model 2	
	Round 1	Round 2	Round 1	Round 2
Defense Investment Collaboration (Total), t-1	16.3211**	0.9604***	16.3211**	0.9712***
	(7.3066)	(0.0802)	(7.3066)	(0.0927)
Change in US Defense Spending	4.5704	-0.1045	4.5704	-0.1226
	(66.2323)	(1.1361)	(66.2323)	(1.2303)

Change in Russian Defense Spending	79.6995*** (22.0929)	0.8978 (0.9499)	79.6995*** (22.0929)	0.9840 (1.0790)
Debt-to-GDP Ratio (t-1)	0.0012 (0.0048)	6.99e-07 (0.00008)	0.0012 (0.0048)	-1.30e-06 (0.00009)
Corruption	-0.0162 (0.0142)	0.00004 (0.0002)	-0.0162 (0.0142)	
EU15	-0.2506 (0.5116)		-0.2506 (0.5116)	
Conflict (t-1)	0.6117 (0.3734)	-0.0016 (0.0078)	0.6117 (0.3734)	-0.0003 (0.0100)
Terrorism (t-2)	-0.0068 (0.0078)	-0.00009 (0.0002)	-0.0068 (0.0078)	-0.0001 (0.0002)
Russian Threat Index	-12979.32** (6356.297)	-196.1083 (200.5905)	-12979.32** (6356.297)	-208.6673 (225.1582)
NATO	1.1502*** (0.4397)		-1.1502*** (0.4397)	-0.0023 (0.0096)
Defense Spending of NATO (t-1)	128.4091** (56.6261)	1.0274 (1.5550)	128.4091** (56.6261)	1.1123 (1.7254)
Election (t+1)	-0.0210 (0.2624)	-0.0025 (0.0059)	-0.0210 (0.2624)	-0.0025 (0.0064)
Right Wing Government (t-1)	0.0026 (0.0037)	-0.00002 (0.00008)	0.0026 (0.0037)	-0.00001 (0.00008)
Private Defense Industry (SIPRI top 100)	-1.0403 (11.1816)	0.0462 (0.2264)	-1.0403 (11.1816)	0.0518 (0.2434)
Constant	-0.7178 (1.9881)	-0.0328 (0.0507)	-0.7178 (1.9881)	-0.0326 (0.0540)
Observations	292	267	292	267
Inverse Mills Ratio	0.0466* (0.0255)		0.0506* (0.0307)	

Table A.7.

Heckman Model Defense Investment Collaboration (Total): PESCO Dummy

Variable	Round 1	Round 2
Defense Investment Collaboration (Total), t-1	17.0882** (7.5250)	0.9667*** (0.0796)
Change US Defense Spending	18.3413	-0.0971

	(69.3072)	(1.1136)
Change Russian Defense Spending	82.4507***	0.8821
	(22.3848)	(0.9185)
Debt-to-GDP Ratio (t-1)	0.0027	-2.06e-06
	(0.0049)	(0.00008)
Corruption	-0.0145	
	(0.0145)	
EU15	-0.3723	
	(0.5026)	
Conflict (t-1)	0.6124	-0.0017
	(0.3761)	(0.0002)
Terrorism (t-2)	-0.0066	-0.00009
	(0.0079)	(0.0002)
Russian Threat Index	-12051.14*	-211.7024
	(6355.448)	(197.4001)
PESCO	-0.3222	0.0003
	(0.3630)	(0.0108)
NATO	-1.122**	
	(0.4381)	
Defense Spending NATO Countries (t-1)	115.5723**	0.8760
	(58.3002)	(1.4949)
Private Defense Industry (SIPRI top 100)	-1.0496	0.0043
	(11.3973)	(0.2146)
Constant	-0.3820	-0.0272
	(2.0187)	(0.0466)
Observations	292	267
Inverse Mills Ratio	0.0448*	
	(0.0246)	

Table A.8.

Determinants of Defense Investment Collaboration (Total): PESCO Dummy

Variable	Model 4 (Fixed Effects)
Defense Investment Collaboration (Total), t-1	0.7780*** (0.0476)
Change US Defense Spending	-0.1395 (0.6021)
Change Russian Defense Spending	-0.1648 (0.3192)
Debt-to-GDP Ratio (t-1)	-0.00003 (0.0001)

Corruption	-0.00009 (0.0004)
EU15	Omitted, collinearity
Conflict (t-1)	-0.0100* (0.0056)
Terrorism (t-2)	-2.09e-06 (0.0001)
Russian Threat Index	-48.5713 (104.5378)
PESCO	0.0043 (0.0056)
NATO	Omitted, collinearity
Defense Spending NATO Countries (t-1)	-0.4711 (0.6003)
Private Defense Industry (SIPRI top 100)	0.0931 (0.2014)
Constant	0.0332 (0.0331)
Observations	267
R Squared (Within)	0.6152
R Squared (Between)	0.9727
R Squared (Overall)	0.7825
Hausman	Chi Squared: 12.25 Prob > Chi Squared: 0.0567

Table A.9.

PESCO Projects and their Coordinators/Participants

Project	Coordinator	Participants
EUROPEAN UNION TRAINING MISSION COMPETENCE CENTRE (EU TMCC)	DE	AT, CZ, DE, ES, FR, IE, IT, LU, NL, RO, SE
Armoured Infantry Fighting Vehicle / Amphibious Assault Vehicle / Light Armoured Vehicle	IT	GR, IT, SK

Chemical, Biological, Radiological and Nuclear (CBRN) Surveillance as a Service (CBRN SaaS)	AT	AT, HR, FR, IT, SI
COUNTER UNMANNED AERIAL SYSTEM (C-UAS)	IT	CZ, IT, SE
CYBER RAPID RESPONSE TEAMS AND MUTUAL ASSISTANCE IN CYBER SECURITY (CRRT)	LT	EE, HR, LT, NL, PL, RO, SI
DEPLOYABLE MILITARY DISASTER RELIEF CAPABILITY PACKAGE (DM-DRCP)	IT	GR, ES, HR, AT, IE, IT
ENERGY OPERATIONAL FUNCTION (EOF)	FR	BE, ES, FR, IT, SI
EU COLLABORATIVE WARFARE CAPABILITIES (ECOWAR)	FR	BE, FRR, PL, RO, ES, ES
EU RADIO NAVIGATION SOLUTION (EURAS)	FR	BE, DE, ES, FR, IT, PL
TIGER MARK III	FR	DE, ES, FR
EUROPEAN MEDICAL COMMAND (EMC)	DE	BE, CZ, EE, DE, ES, FR, HU, IT, LU, NL, PL, RO, SE, SK
EUROPEAN PATROL CORVETTE (EPC)	IT	FR, GR, IT, ES
EUROPEAN UNION NETWORK OF DIVING CENTRES (EUNDC)	RO	BG, FR, RO
HARBOUR & MARITIME SURVEILLANCE AND PROTECTION (HARMSPRO)	IT	GR, IT, PL, PT
INTEGRATED EUROPEAN JOINT TRAINING AND SIMULATION CENTRE (EUROSIM)	HU	FR, DE, HU, PL, SI
MAIN BATTLE TANK SIMULATION AND TESTING CENTER (MBT-SIMTEC)	GR	CY, FR, GR
MATERIALS AND COMPONENTS FOR TECHNOLOGICAL EU COMPETITIVENESS (MAC-EU)	FR	FR, DE, PT, RO, ES
NETWORK OF LOGISTIC HUBS IN EUROPE AND SUPPORT TO OPERATIONS (NetLogHubs)	DE	BE, BG, CY, DE, GR, ES, FR, HR, HU, IT, LT, NL, LU, PL, SI, SK
ROTORCRAFT DOCKING STATION FOR DRONES	IT	IT, FR
STRATEGIC AIR TRANSPORT FOR OUTSIZED CARGO (SATOC)	DE	CZ, DE, FR, NL
UPGRADE OF MARITIME SURVEILLANCE (UMS)	GR	BG, CY, FR, GR, ES, HR, IE, IT
AIR POWER	FR	HR, FR, GR

AUTOMATED MODELLING, IDENTIFICATION AND DAMAGE ASSESSMENT OF URBAN TERRAIN (AMIDA-UT)	PT	FR, PT, ES
CO-BASING	FR	BE, CZ, DE, ES, FR, NL
CYBER AND INFORMATION DOMAIN COORDINATION CENTER (CIDCC)	DE	FR, DE, HU, NL
CYBER THREATS AND INCIDENT RESPONSE INFORMATION SHARING PLATFORM (CTIRISP)	GR	CY, GR, HU, IE, IT, PT
DEPLOYABLE MODULAR UNDERWATER INTERVENTION CAPABILITY PACKAGE (DIVEPACK)	BG	BG, GR, FR, RO
ESSENTIAL ELEMENTS OF EUROPEAN ESCORT (4E)	ES	IT, PT, ES
EU CYBER ACADEMIA AND INNOVATION HUB (EU CAIH)	PT	ES, RO, PT
EU TEST AND EVALUATION CENTRES (EUTEC)	FR, SE	FR, SE, SK
EUROPEAN GLOBAL RPAS INSERTION ARCHITECTURE SYSTEM (GLORIA)	IT	FR, IT, RO
EUROPEAN MEDIUM ALTITUDE LONG ENDURANCE REMOTELY PILOTED AIRCRAFT SYSTEMS – MALE RPAS (EURODRONE)	DE	CZ, DE, ES, FR, IT
EUROPEAN SECURE SOFTWARE DEFINED RADIO (ESSOR)	FR	BE, DE, ES, FI, FR, IT, NL, PL, PT
FUTURE MEDIUM-SIZE TACTICAL CARGO (FMTC)	FR	FR, DE, ES, SE
HELICOPTER HOT AND HIGH TRAINING (H3 TRAINING)	GR	GR, IT, RO
INTEGRATED UNMANNED GROUND SYSTEM (UGS)	EE	BE, CZ, EE, FI, FR, DE, LV, NL, PL, ES
MARITIME (SEMI-) AUTONOMOUS SYSTEMS FOR MINE COUNTERMEASURES (MAS MCM)	BE	BE, FR, GR, IE, LV, NL, PL, PT, RO
MEDIUM SIZE SEMI-AUTONOMOUS SURFACE VEHICLE (M-SASV)	EE	EE, FR, LV, RO
NEXT GENERATION SMALL RPAS (NGSR)	ES	DE, PT, ES, RO, SI
SMALL SCALABLE WEAPONS (SSW)	IT	IT, FRR

STRATEGIC C2 SYSTEM FOR CSDP MISSIONS AND OPERATIONS (EUMILCOM)	ES	DE, ES, FR, IT, LU, PT
AIRBORNE ELECTRONIC ATTACK (AEA)	ES	FR, ES, SE
CBRN DEFENCE TRAINING RANGE (CBRNDTR)	RO	FR, IT, RO
COMMON HUB FOR GOVERNMENTAL IMAGERY (COHGI)	DE	AT, FR, DE, LT, LU, NL, RO, ES
CYBER RANGES FEDERATIONS (CRF)	EE	BG, EE, FI, FR, IT, LV, LU
DEFENCE OF SPACE ASSETS (DOSA)	FR	AT, FR, DE, IT, PL, PT, RO, ES
ELECTRONIC WARFARE CAPABILITY AND INTEROPERABILITY PROGRAMME FOR FUTURE JOINT INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (JISR)	CZ	DE, CZ
EU BEYOND LINE OF SIGHT (BLOS) LAND BATTLEFIELD MISSILE SYSTEMS (EU BLOS)	FR	BE, CY, FR, SE
EU MILITARY PARTNERSHIP (EU MILPART)	FR	AT, EE, FR, IT
EUFOR Crisis Response Operation Core (EUFOR CROC)	DE	AT, CY, DE, GR, ES, FR, IT, NL
EUROPEAN HIGH ATMOSPHERE AIRSHIP PLATFORM (EHAAP) – PERSISTENT INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (ISR) CAPABILITY (EHAAP)	IT	FR, IT
EUROPEAN MILITARY SPACE SURVEILLANCE AWARENESS NETWORK (EU-SSA-N)	IT	FR, DE, IT, NL
EUROPEAN TRAINING CERTIFICATION CENTRE FOR EUROPEAN ARMIES (ETCCEA)	IT	IT, GR
GEO-METEOROLOGICAL AND OCEANOGRAPHIC (GEOMETOC) SUPPORT COORDINATION ELEMENT (GMSCE)	DE	AT, BE, DE, GR, FR, LU, PT, RO
INDIRECT FIRE SUPPORT CAPABILITY (EUROARTILLERY)	SK	HU, IT, SK
JOINT EU INTELLIGENCE SCHOOL (JEIS)	GR	CY, GR
MARITIME UNMANNED ANTI-SUBMARINE SYSTEM (MUSAS)	PT	FR, PT, ES, SE
MILITARY MOBILITY (MM)*	NL	AT, BE, BG, CY, CZ, DE, EE, FR, ES, FI, HR, HU, IT, LT,

		LU, LV, NL, PL, PT, RO, SE, SI, SK, CA, NO, US
ONE DEPLOYABLE SPECIAL OPERATIONS FORCES (SOF) TACTICAL COMMAND AND CONTROL (C2) COMMAND POST (CP) FOR SMALL JOINT OPERATIONS (SJO) – (SOCC) FOR SJO	GR	CY, GR
SPECIAL OPERATIONS FORCES MEDICAL TRAINING CENTRE (SMTC)	PL	HU, PL
TIMELY WARNING AND INTERCEPTION WITH SPACE-BASED THEATER SURVEILLANCE (TWISTER)	FR	FI, FR, DE, IT, NL, ES

Note. Projects with an asterisk (*) are projects that involve non-EU members

Table A.10.

PESCO QCA Analysis Raw Data (2021)

Country	PESCO Partici-pant	PESCO Coor-dinator	CPI	Debt to GDP Ratio	EU15	Russian Threat Index	Private Def Industry (% SIPRI top 100)	Shares Border w/ Russia	Int'l Conflict
Mean	n/a	n/a	63.37	76.59	n/a	0.0000179	0.00601	n/a	n/a
AUT	9	1	74.00	82.30	1	2.97E-06	0.00000	0	1
BEL	12	1	73. 00	109.20	1	2.36E-06	0.00000	0	1
BLG	6	1	42.00	23.90	0	6.52E-06	0.00000	0	0
CRO	7	0	47.00	78.40	0	2.70E-06	0.00000	0	0
CYP	9	0	53.00	101.00	0	0.0000551	0.00000	0	0
CZR	9	1	54.00	42.00	0	7.57E-06	0.00000	0	1
EST	7	3	74.00	17.60	0	0.0000396	0.00000	1	1
FIN	5	0	88.00	72.40	0	0.0000631	0.00000	1	1
FRA	45	14	71.00	112.80	1	1.61E-06	0.04279	0	1
GER	24	9	80.00	68.60	1	0.0000125	0.01503	0	1
GRC	18	6	49.00	194.50	1	2.31E-06	0.00000	0	0
HUN	8	1	43.00	76.80	0	4.65E-06	0.00000	0	0
IRE	5	0	74.00	55.40	1	1.03E-06	0.00000	0	0
ITA	32	11	56.00	150.30	1	1.40E-06	0.02511	0	1
LAT	5	0	59.00	43.60	0	0.0000444	0.00000	1	1
LIT	4	1	61.00	43.70	0	0.0001375	0.00000	1	1
LUX	8	0	81.00	24.50	1	2.51E-06	0.00000	0	1
NLD	15	1	82.00	52.40	1	2.87E-06	0.00000	0	1
POL	13	1	56.00	53.80	0	0.0000492	0.00249	1	0
PRT	14	3	62.00	125.50	1	2.83E-07	0.00000	0	1

ROM	18	2	45.00	48.90	0	0.0000204	0.00000	0	1
SVK	6	1	52.00	62.20	0	5.02E-06	0.00000	0	0
SLV	7	0	57.00	74.50	0	2.23E-06	0.00000	0	0
ESP	28	4	61.00	118.30	1	3.96E-07	0.00158	0	1
SWE	10	1	85.00	36.30	1	0.0000113	0.00616	0	1

Table A.11.

Multivariate Regression Analysis for Determinants of PESCO Participation Levels, 2021 Data

Variable	Coefficient	p-value
Corruption Perception Index	-0.1928*	0.071
Debt-to-GDP Ratio	0.0419**	0.022
EU15	3.9870	0.166
Private Defense Industry (% of SIPRI top 100)	678.6139***	0.000
Russian Threat Index	-35615.42	0.273
Border with Russia	1.1637	0.789
International Conflict	5.0630*	0.084
Constant	14.6574**	0.016
Observations	25	
R Squared	0.8719	

* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.