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EU Demand for Defense, 1990–2019: A Strategic Spatial Approach

Justin George [1] and **Todd Sandler** [2,*]

[1] Department of Agricultural, Food, and Resource Economics, Michigan State University, 426 Auditorium Road, East Lansing, MI 48824, USA; kappiaru@msu.edu
[2] School of Economic, Political and Policy Sciences, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX 75080, USA
* Correspondence: tsandler@utdallas.edu

Abstract: For 1990–2019, this study presents two-step GMM estimates of EU members' demands for defense spending based on alternative spatial-weight matrices. In particular, EU spatial connectivity is tied to EU membership status, members' contiguity, contiguity and power projection, inverse distance, and arms trade. At a Nash equilibrium, our EU demand equations are derived explicitly from a spatially based game-theoretical model of alliances. Myriad spatial linkages among EU members provide a robust free-riding finding, which differs from the spatial and non-spatial literature on EU defense spending. Even though the EU applies common trade policies and allows for unrestricted labor movement among members, members' defense responses adhered to those of a defense alliance. Moreover, EU defense spending exhibits positive responses to GDP and transnational terrorist attacks, and a negative response to population. During the sample period, EU members did not view Russia as a military threat.

Keywords: European Union (EU), spatial autoregression and connectivity; alliance; strategic free riding; Nash equilibrium

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1. Introduction

First introduced by Olson and Zeckhauser [1], the economic theory of alliances is a game-theory-based representation that continues to exert major influences on empirical studies of the demand for military expenditure (ME) (see, e.g., Douch and Solomon [2]; Dudley and Montmarquette [3]; Hilton and Vu [4]; Kim and Sandler [5]; McGuire and Groth [6]; Smith [7,8]). That theory emphasizes the nonrival and nonexcludable benefits that one ally's defense provision confers on other allies. Defense is nonrival among allies because one ally's consumption of defense-derived deterrence of potential adversaries does not detract, in the least, from the deterrence gained by other allies from each ally's defense provision. Non-excludability of benefits characterizes defense since, once provided, all allies receive the associated benefits when allied countries are united through common interests (e.g., joint infrastructure, resident citizens, resource supply lines, trade, and foreign direct investment). The two publicness properties of defense result in alliance free riding in which allies do not fully reveal their true preferences for defense by relying to some extent on the defense provision (spillovers) of their allies [1,9]. Consequently, free riding motivates an ally to reduce its defense spending in response to collective increases in that of the other allies [10,11]. This negative relationship between defense spending and defense spillovers provides an easy-to-implement test of the free-riding prediction. The more one ally views its defense as a substitute for the ME of its allies, the greater is the downward slope of the defense reaction curve in terms of spillovers. Another theoretical prediction of alliance theory is that large, rich allies carry a disproportionately large defense burden for poor allies in terms of their GDP devoted to defense (i.e., ME/GDP) [1,12]. If, however, defense spending gives rise to alliance-wide and country-specific, jointly produced outputs, then the anticipated negative reaction to defense spillovers and the expected disproportionate burden sharing may be curbed or even reversed [13–15]. In the former case, free riding is reduced.

The primary purpose of the current study is to present spatial-based, two-step generalized method of moments (GMM) estimates for European Union (EU) members' demands for ME during 1990–2019 and a post-2007 subperiod. Our spatial autoregression (SAR) estimates correspond to seven spatial-weight matrices that capture EU membership, members' contiguity with one another, members' contiguity with Russia, inverse distance between countries' capitals, arms trade among countries, and two alternative power projection representations. Even though the EU is not a traditional defense alliance that commits members to view an attack on one as an attack on all with the pledge of a collective response as does Article 5 of North Atlantic Treaty Organization (NATO), the EU faces concerns that may evoke a coordinated response to a security threat. Hence, EU members' defense possesses publicness properties made more poignant by the nearness of countries that raise free-rider concerns and justifies the economics of alliances as a theoretical foundation for defense demands [16]. Previous nonspatial investigations of European countries' defense spending do not uncover free riding due to quite different modeling assumptions, especially in regard to defense spillovers (e.g., [2,17,18]).

The current study is most similar to Xiaoxin and Bo [19] who also apply a spatial approach to a sample of European countries for 2000–2018. Like the current study, Xiaoxin and Bo [19] consider spatial connectivity in terms of contiguity, inverse distance, and arms trade. However, crucial differences distinguish the two investigations. First, the current study has ME, and not ME/GDP, as its dependent variable. As a consequence, we uncover evidence of EU free riding in terms of ME, while they find defense burdens responding positively to the defense burdens of other European countries, consistent with defense burden convergence. Second, the current analysis accounts for US defense spending and power projection, which is not the case for Xiaoxin and Bo [19]. Third, unlike Xiaoxin and Bo [19], we only include EU members in the sample after they join the EU. We are interested in the EU members' behavior and not that of European countries in general, since we view the EU institution as an important driver of defense responses. Our set of countries during each year differs from that of Xiaoxin and Bo [19] because non-EU countries, not part of NATO, such as Belarus, Ukraine, and others, are excluded from all runs in the current study. Fourth, the threat variables greatly differ between the two studies. Fifth, we present strong evidence of free riding that is not solely based on arms trade as in Xiaoxin and Bo [19]. The current study is complementary to their interesting analysis; both analyses have different insights to offer.

The present study possesses some noteworthy findings about EU members' defense spending. Based on seven measures of spatial linkage, there is robust evidence of defense free riding among EU members during the last three decades. Free riding is particularly strong after 2007. Additionally, free riding characterizes EU countries when augmented by some non-EU NATO allies. For alternative threat measures involving Russia, EU countries are not viewing Russia as a threat. EU defense spending generally responds negatively to population, consistent with social welfare spending crowding out defense spending as population size increases. Transnational terrorist attacks against EU assets (i.e., people and property) consistently increase EU defense spending when Russian ME is included as a threat variable. We also show that US power projection supports EU free riding, even though the United States does not belong to the EU.

The remainder of the paper contains six sections. A brief literature review is contained in Section 2. Section 3 presents some relevant background on the EU, including how it expanded over the years and its security concerns. In Section 4, we indicate the game-theoretic model behind our EU defense demand equations. Section 5 offers our empirical methodology and data sources, while Section 6 interprets the empirical findings. Concluding remarks and policy implications are gathered in Section 7.

2. Literature Review

In recent years, spatial econometric techniques are fruitfully applied to the estimation of defense demand in alliance and non-alliance settings. For instance, Flores [20], Goldsmith [21], and Skogstad [22] investigate spatial-based defense demands for 168, 120, and 124 countries, respectively, while George and Sandler [23] examine defense demands for the NATO alliance. The first three studies use ME/GDP as the measure of defense demand, while the fourth study casts ME as its measure of defense demand. Another noteworthy spatial analysis of defense demand is by Yesilyurt and Elhorst [24] who investigate the determinants of defense burdens (ME/GDP) for 144 countries using four spatial econometric models and eight different spatial-weight matrices.

The studies employing ME/GDP as the dependent variable generally find a positive response of one country's defense burden to those of other spatially tied or neighboring countries—a result in potential opposition to free riding. By contrast, George and Sandler [23] estimate a robust negative relationship between an ally's ME and the aggregate ME of other spatially linked allies, consistent with free riding. Their approach and the one applied here derive the set of allies' defense demand equations from a constrained optimization that accounts for resources, defense spillovers, and other strategic considerations, so that ME is implicitly defined by the first-order conditions (FOCs) of each country's decision maker. By contrast, articles with ME/GDP as the dependent variable replace ME/GDP for defense spending without clearly showing how this switch follows from the underlying theory—e.g., what utility function or modeling assumptions are consistent with defense burden, not ME, being the dependent variable.

The literature's estimated positive relationship among countries' defense burdens may arise from the tendency for these burdens to converge to a common value [25,26]. Once converged or nearing convergence, defense burdens are apt to rise and fall in sync, making for a positive burden-sharing relationship among allies. That positive relationship may also arise from an alliance mandating allies' adherence to having a set percentage of GDP devoted to ME—e.g., the 2014 Wales Summit two percentage of GDP rule for NATO. Additionally, a country's defense burden is affected by its defense spending and GDP, which can mask the causal determinants of ME demand. Our methodology is to stay with the more traditional approach of casting ME as the dependent variable and GDP as one of the independent variables [4,6].

Spatial econometric representations of defense demand permit a variety of spatial connectivities. For a 1991 cross section, Goldsmith [21] includes contiguity among countries and the inverse distance between countries' capitals as the key measures of spatial connectivities. With inverse distance, a larger separation between countries' capitals results in smaller weights being placed on their defense efforts because one country's forces would take longer to be redeployed to defend the other country's assets, resulting in less defense spillovers. Flores [20] allows for spatial weights based on contiguity, alliance membership, and set distances, while Skogstad [22] includes spatial weights based on contiguity, inverse distance, and power projection. Both of these empirical analyses involve cross sections. For a panel of European countries, Xiaoxin and Bo [19] employ spatial connectivity based on contiguity, inverse distance, and arms trade. For NATO, George and Sandler's [23] spatial weights stem from contiguity, inverse distance, and power projection for a panel covering 1968–2015 and select subperiods.

3. On the EU

In 1951, the Treaty of Paris established the European Coal and Steel Community (ECSC) to regulate some industrial outputs in its six members (Belgium, France, Italy, Luxembourg, the Netherlands, and West Germany). ECSC was the first supranational organization to link sovereign European states to foster economic coordination. European integration progressed further with the Treaty of Rome in 1957 and the creation of the European Economic Community (EEC) with its six inaugural members being those of the ECSC [27] (The background facts for this paragraph come from the EU Enlargement Factsheet [27]. Unified Germany replaced West Germany in 1990). From EEC's outset, enlargement was allowed for European countries that respect the rule of law, the principles of democracy, the preservation of civil liberties, the protection of human rights, the furtherance of equality, and the rights of minorities. Until 2019, there have been seven enlargement waves that raised membership from 6 to 28 countries. Denmark, Ireland, and the UK joined in 1973; Greece entered in 1981; Spain and Portugal became members in 1986; Austria, Finland, and Sweden joined in 1995; Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia enlisted in 2004, Bulgaria and Romania entered in 2007; and Croatia joined in 2013. The UK left the EU in 2020, but was a member during the years covered by our empirical study. Another eight countries are in the accession process, but were not members in 2019. For the purposes of the baseline empirical analysis, we consider 28 member countries according to their accession date if admitted after 1990.

The EEC was initially intended to promote greater economic and political cooperation in Europe among members. Economic cooperation involves the elimination of trade barriers within the EEC and the establishment of a common trade policy with non-EEC members, which meant that the EEC started as a customs union. At first, political cooperation took the form of a common agricultural policy. The Treaty on European Union (also known as the Maastricht Treaty) was enacted in 1991 and entered into force in November 1993 when the EEC changed its name to the EU. Political union within the EU was enhanced over time by supranational infrastructure in the form of the Council of the EU, the European Commission, European Court of Justice, and the European Parliament. The latter's legislators are elected by member countries' voters. Within the EU, political policy stances are taken with respect to the environment (e.g., climate change), human rights, employment practices, justice, foreign affairs, and security. When the Schengen Agreement of 1985 allowed for the unrestricted movement of EU citizens, the EU transformed itself from a customs union to a common market.

Since 1990, the EU faces many common security challenges including nearby internal conflicts in Bosnia and Herzegovina during 1992–1995 among Serbs, Croats, and Muslims, and an armed conflict in the late 1990s between ethnic Serbs and Albanians. If those conflicts had not been quelled, they could have spread to neighboring countries and affected EU commerce and other interests. Even the Chechen conflict spilled over to the EU in the form of transnational terrorist attacks (e.g., Belgium, France, Germany, Spain, and the UK), which raised security issues in terms of efforts to coordinate counterterrorism policies and to share intelligence. Coordination is needed because enhanced counterterrorism actions taken by one EU member may transfer a planned attack to a less-secure neighbor country [28].

Starting in 2011, civil wars in Libya and Syria brought security externalities to the EU through refugee flows, disrupted resource flows, and transnational terrorism. In the case of Libya, NATO-led operations to depose Muammar Qaddafi resulted in a failed state that continues to pose security threats to EU interests. To address nearby internal conflicts in the Middle East, Africa, and Central Asia, the EU must engage in and support peacekeeping operations (PKOs) through the United Nations and other regional organizations.

The rising nationalism of the Putin regime poses an external threat, especially for EU countries near or adjoining Russia. The threat is more poignant in light of Russia's annexation of Crimea in 2014, after which Russian-based rebel incursions in eastern Ukraine added to EU security worries. However, the question remains whether the most at-risk EU countries are responding appropriately to this potential threat with increased defense pending.

4. Spatial-Based Theoretical Model of EU Member's Defense Demand

We formulate a theoretical model for an EU member's demand for defense spending based on the aggregate ME of other members, threat proxies, and other country-specific exogenous considerations. When relating a country's ME to those of other countries, we primarily consider the members of a particular common market such as the EU. The EU's Common Security and Defense Policy (CSDP) is tied integrally to internal and external security threats of member states [29] in which the CSDP promotes EU military coordination, EU-supported peacekeeping activities, EU-NATO cooperation, defense industrial development, counterterrorism cooperation, and other EU security policies. EU peacekeeping activities may involve the deployment of forces drawn from member states or the funding of peacekeeping operations by other regional organizations (e.g., the African Union) [30]. Although the EU is not a defensive alliance, EU members' security is joined by geography, similar security interests, economic concerns, and common threats. That connectivity means that an EU member's defense demand is dependent, in part, on other members' ME, so that EU membership is a basis for specifying members' strategic defense demands, analogous to a military alliance.

We present an underlying theoretical model for an EU member's defense demand that is sufficiently general to allow for alternative spatial considerations arising from members' geographical location vis-à-vis one another and that of a potential adversary [20,22,23,31,32]. Additionally, the model permits EU members' ME to be influenced by non-EU NATO allies (e.g., Norway, Turkey, and the United States), transnational terrorist attacks, and arms-trade connectivity. Alternative spatially weighted defense spillovers allow the defense demand representation to be particularized to myriad connectivity scenarios.

We commence with an N-member common market scenario where each member's ME decision is made by a unitary entity (i.e., the country's executive decision maker), who maximizes country i's social welfare, U^i, by allocating i's national income, I^i, between real defense spending, q^i, and real consumption, c^i, in country i. The unit price of defense is given by p, while that of consumption is normalized to equal 1. Thus, each common market member faces a resource or budget constraint,

$$I^i = c^i + pq^i \tag{1}$$

where national income is equated to gross domestic product, GDP.

Defense spending within the common market implies a degree of publicness in which one member's ME may augment the security of other members, not unlike a defense alliance [1,3,7,8,11,33]. However, those defense benefits may vary based on the providing country's location relative to the benefit-recipient country or countries, so that nearer recipients obtain more defense spillovers than more distant ones. That anticipation is particularly true of conventional land forces, which can be deployed more quickly among nearby countries.

A key component of the defense demand model is security spillovers or spill-ins, stemming from the ME of the other $N-1$ common market countries. Defense spillovers, Q_{-i}, of member i are denoted by

$$Q_{-i} = \sum_{k \neq i}^{N} \delta^k q^k \tag{2}$$

where $k = 1, \ldots, N$ and $k \neq i$, so that the spatially weighted defense provision of the other member countries is included. The δ^k weights can assume many alternative forms [20–24]. If only membership in the common market determines defense benefit spillovers, then $\delta^k = 1$ for all members, and 0 for nonmembers. In that scenario, location is not driving spillovers and each member's defense provision is perfectly substitutable, consistent with purely public defense spending [34]. If border contiguity determines defense spillovers among common market members, then $\delta^k = 1$ for member countries sharing a land or water border with country i, and $\delta^k = 0$ for members not contiguous with member i. Like Skogstad [22], we can expand the contiguity measure of spillovers to assign a weight of 1 to noncontiguous allied countries with a marked ability to project their power. Within the EU, such countries may include the UK, France, and Germany. Outside the EU, a unit weight may be given to the United States given its massive ability to project power and its security commitment to many EU members. If, instead, spillovers are dependent on spatial propinquity, then δ^k may equal the inverse distance between the capitals of countries i and k. The inverse-distance weight allows closer countries to derive more defense spillovers from one another [21]. Alternatively, the defense spillover weight may be tied to the extent of arms trade among market members, where larger arms trade flows between two countries enhance their derived defense spillovers [19]. Those flows may, in part, lift spillovers owing to countries' military forces becoming more interoperable, thereby bolstering joint defense deployment. Such arms trade linkages also tie the security interests of the trading members together.

To complete the Nash-equilibrium demand derivation, we consider i's social welfare function (To ensure sufficiency, the social welfare function is assumed to be strictly quasi-concave.),

$$U^i = U^i\left(c^i, q^i + Q_{-i}, \mathbf{X}^i, \mathbf{T}^i\right), \quad i = 1, \ldots, N, \tag{3}$$

where i's decision maker's perceived welfare rises at a diminishing rate with private consumption and the common market's aggregate defense spending, $Q = q^i + Q_{-i}$. Thus, we assume that $U^i_c = \partial U^i/\partial c^i > 0$, $U^i_Q = \partial U^i/\partial Q > 0$, $U^i_{cc} = \partial^2 U^i/\partial c^{i2} < 0$, and $U^i_{QQ} = \partial^2 U^i/\partial Q^2 < 0$, which are common economic assumptions. To ensure the satisfaction of second-order conditions (SOCs), we assume that $U^i_{cQ} > 0$ so that private consumption and aggregate defense are Edgeworth-Pareto complements enhancing one another's marginal utility. We also note that

$$\partial U^i/\partial q^k = U^i_{q^k} = \delta^k U^i_Q > 0, \tag{4}$$

when $\delta^k \neq 0$, indicating that the defense spending of other common market members are plain complements [35,36]. In (3), the vector $\mathbf{X}^i$ contains exogenous determinants of country i's defense spending that include the country's population and trade openness. The threat vector $\mathbf{T}^i$ reduces social welfare and includes transnational terrorist attacks against country i's interests as well as proxies for an enemy's defense spending. The latter may assume the form of i's contiguity with the enemy.

By substituting the budget constraint in (1) and the spillover constraint in (2) into the social welfare function in Equation (3), we can express the representative EU member's maximization problem as:

$$\max_{q^i} U^i\left(I^i - pq^i, q^i + \sum_{k \neq i}^{N} \delta^k q^k, \mathbf{X}^i, \mathbf{T}^i\right), \; i = 1, \ldots, N, \tag{5}$$

for which each member treats the defense spillovers as a parameter, consistent with Nash-equilibrium levels of defense demand for the collective of member countries. (Unlike Douch and Solomon [2] or Smith [7,8], we do not assume an intermediate security function, because doing so will not affect the reduced-form demand for defense). In (5), each common market ally is choosing its best response defense spending in relationship to those of the other common market countries, thereby constituting a Nash equilibrium from which no country would unilaterally change its defense spending decision. The resulting FOCs associated with (5) are:

$$-pU^i_c + U^i_Q = 0, i = 1, \ldots, N. \tag{6}$$

By implicitly differentiating (6), we have:

$$\frac{\partial q^i}{\partial q^k} = -\frac{-p\delta^k U^i_{cQ} + \delta^k U^i_{QQ}}{p^2 U^i_{cc} - 2pU^i_{cQ} + U^i_{QQ}} < 0, \; i, k = 1, \ldots, N, \; i \neq k, \tag{7}$$

which indicates strategic substitutes [35–37] so that each country reacts negatively to increases in the defense spending of another common market country when $\delta^k \neq 0$. The denominator is negative by the SOCs, while the numerator is positive when multiplied by the minus sign. A trade-off between q^i and the aggregate defense spending of the rest of the common market, Q_{-i}, is also negative with $-pU^i_{cQ} + U^i_{QQ}$ in the numerator of dQ_{-1}/dq^i and the SOCs in the denominator, again indicating strategic substitutes. In the aggregate case, the only running variable is $i = 1, \ldots, N$.

The FOCs in (6) can be transformed into the following set of implicitly defined defense demands for the common market members:

$$q^i = q^i\left(I^i, p, \sum_{k\neq i}^{N} \delta^k q^k, \mathbf{X}^i, \mathbf{T}^i\right),\ i = 1, \ldots, N. \tag{8}$$

There are a number of issues to highlight with respect to these defense demands. First, they correspond to a static Nash-equilibrium set of demands for the EU countries or a suitably defined subset based on the spatial weights. Second, given the explicit theoretical framework for defense demand above, defense corresponds to ME and not to a defense burden (i.e., ME/GDP). Third, if defense is a normal good with a positive income elasticity as generally believed and found in the literature, then defense demand responds positively to GDP [34]. Fourth, by necessity, the relative price of defense is normalized to equal 1 because of a lack of defense price data [2,7,8]. Any bias from this normalization disappears provided the prices of defense goods inflate at the same rate as those of civilian goods, which was the case in a Stockholm International Peace Research Institute (SIPRI) [38] study. However, Solomon [39,40] finds a greater relative inflation rate for Canadian defense goods compared to non-defense goods, where price data were available. Nevertheless, we must drop p because of lack of relative defense price data for EU member countries. Fifth, given similar security concerns of EU members, we anticipate that country i's defense spending responds negatively to defense spillovers (i.e., $dQ_{-1}/dq^i < 0$), indicative of strategic-substitute-driven free riding. Sixth, as a country-specific factor in vector $\mathbf{X}^i$, population may increase country i's defense demand when its decision maker places great importance on protecting the people from external threat. If, instead, larger populations create the need for more social spending that siphons off funds from defense, then defense demand may respond negatively to population [41]. A larger population may also reduce defense demand by allowing the country to substitute relatively cheaper manpower for defense capital [42]. The true or net influence of population on defense demand is an empirical question owing to opposing forces. As another country-specific factor, trade openness (imports and exports as a share of GDP) is likely to have a negative influence on defense spending when greater trade augments linkages among countries that reduce the gain from conflict given greater interrelated interests [19]. Finally, threat factors—transnational terrorist attacks, Russian ME, or proximity to Russia—may increase defense demand. On the contrary, transnational terrorist attacks may not induce a larger defense spending response in the presence of other non-military means for countering terrorism through law enforcement, intelligence, homeland security spending, or the counterterrorism actions of INTERPOL [43]. In the case of Russia, this may not be true if EU members do not view Russia as a security threat.

5. Data and Methodology

5.1. Empirical Methodology

Based on our theoretical model, a country's ME is a function of the aggregate ME of other countries in an implicit or explicit alliance. This means that the spillover term is an important explanatory variable in the demand equation for ME. However, a straightforward inclusion of the spillover term in an ordinary least squares (OLS) regression can cause estimation problems due to endogeneity [44,45]. To address this concern, we use

SAR models, a class of spatial models, used in the empirical literature to account for the spillover terms [23,24,30].

The SAR representation of the demand for ME can be depicted as:

$$Y_{it} = \rho \sum_{k \neq i} w_{ikt} Y_{kt} + \beta \mathbf{X}_{it} + \mu_i + \tau_t + \varepsilon_{it}, \tag{9}$$

where Y_{it} is the log of ME for country i during year t. In (9), $\sum_{k \neq i} w_{ikt} Y_{kt}$ represents defense spillovers, corresponding to the spatially weighted sum of ME of other EU countries. Additionally, Y_{kt} is the log of ME for country k in year t, and w_{ikt} is the spatial weight representing the relative connectivity between countries i and j in year t. In spatial models, the spillover term is also called the spatial lag of the dependent variable because it is comparable to the time-lagged variable in a time-series model. While the time-lagged term captures the temporal dependence between two time periods, the spatial-lagged term represents the spatial dependence between a given geographical unit and other units in the dataset. The relative strength of the spatial dependence among units is captured by the spatial weight, w_{ikt}. $\mathbf{X}_{it}$ is the vector of time-varying controls that influence country i's ME, including its GDP, population, and trade openness. In (9), ρ and β represent the estimated spatial spillover and control coefficients, respectively. μ_i and τ_t correspond to country- and year-level fixed effects, respectively. Finally, ε_{it} is the idiosyncratic error term.

Generally, spatial weights (w_{ikt}) could be geographical (e.g., distance between members), political (e.g., alliance or common market membership), or economic (e.g., trade between two members) connectivity measures. In our study, we initially utilize five such weights. First, we assign a weight of 1 to all EU members. Second, we use contiguity, which assigns a value of 1 to member k's ME if members i and k share borders, and 0 otherwise. Third, we employ the inverse of the distance between the capital cities of two members. Fourth, we consider arms trade as a spatial weight where δ^k denotes the value of all transfers of major conventional weapons between members i and k. Members might place more importance on the ME of other members with whom they have an active military trade relationship. Fifth, we allow for a spatial weight measure that assigns a value of 1 to each EU member that shares its borders with Russia. Given the recent geo-political tensions between Russia and the EU, an EU member may view the ME of allies contiguous to Russia as a sign of an emerging security threat. Following Neumayer and Plümper [31], and George and Sandler [23], we do not row-standardize the spatial weights. Under row-standardization, for each year, the spatial weight of a given country is divided by the sum of spatial weights of all other sample countries. As explained in George and Sandler [23], row-standardization imposes implicit assumptions that are theoretically undesirable for the study of any military alliance or common market that changes its membership size over time. With row-standardization, EU expansion would diminish the ME influence of key EU members that spend more on defense as the membership expands.

Because of endogeneity concerns, we estimate our SAR models using the two-step efficient GMM estimator, where the spatial lags of the explanatory variables (except ME spillovers) are used as external instruments for the spatial lag of the ME variable [46]. All regressions are estimated using standard errors that are robust to heteroskedasticity and autocorrelation.

5.2. Data

For the empirical analysis, we include all EU countries for 1990–2019, based on their year of accession to the EU if after 1990. Our time frame choice coincides with the formation of the Russian federation, which EU countries may view as a military threat. Early 1990s also witnessed the emergence of religious fundamentalist terrorism and an associated wave of transnational terrorism that influenced national security policies of many EU countries [47].

Our dependent variable, the log of ME, is drawn from the SIPRI [48] Extended Military Expenditure Database, which records consistent ME time series data for most countries during 1949–2019. To foster its reliable and consistent country-level ME estimates, SIPRI [48] relies on government documents, international statistics, journals, and news reports. In the current study, ME is measured in constant 2018 US dollars. Independent variables include GDP, population, and trade openness, drawn from the World Development Indicators (WDI) [49]. Like ME, GDP is measured in constant 2018 US dollars. We use the GDP deflator variable provided by WDI to calculate GDP values in constant US dollars. In particular, WDI relies on the World Bank and OECD National Accounts data to calculate the deflator values. The trade openness variable corresponds to the sum of total imports and exports as a share of GDP. The number of transnational terrorist attacks is drawn from the International Terrorism: Attributes of Terrorist Events (ITERATE) data set [50] (Mickolus et al. 2020), which records observations on transnational terrorist events by venue country during 1968–2019.

As discussed earlier, the construction of the spatial-lagged variables requires data on various measures of spatial weights. The data on distance between capital cities are from Gleditsch and Ward [51]; data on the contiguity relationships between countries are obtained from Correlates of War (COW) Direct Contiguity Dataset [52,53]. Finally, spatial weights, representing the value of arms trade between countries, are drawn from the SIPRI Arms Transfer Database [54], which contains information on all transfers of major conventional weapons from 1950 to 2019. Specifically, we apply the trend-indicator value (TIV), a measure intended to represent the transfer of military resources based on the known unit production costs of a core set of weapons [54]. During the sample period, the average TIV between two countries, which engaged in some form of military trade, is 73.23 million dollars. In the absence of row-standardization, the straightforward inclusion of such large TIV values as spatial weights results in very large spillover terms with small difficult-to-interpret coefficients. Hence, for the purpose of spatial weighting, we divide all TIV values by 1,000,000, thereby representing the arms-trade spatial weights in millions of dollars.

6. Empirical Results

Tables 1–5 report two-step GMM estimates of the determinants of the demand for ME of EU countries from 1990 to 2019. Country and year fixed effects are included, except when EU membership weights are used to construct the spatial-lagged term (In that model, we omit the year fixed effects because their inclusion, when equal weights (e.g., EU membership) are applied, renders the estimates inconsistent). In each of the models, we display the adjusted R^2, Kleibergen-Paap LM statistic for testing instrument strength, and Hansen J-statistic for testing the overidentifying restrictions for instruments.

Table 1 reports five models where the only difference involves the type of spatial-lagged (SL) variables included. For all SL of ME terms in Table 1, the coefficients are spillover elasticities, given the log of the dependent variable and the log of the spillover measures. The coefficients of the five spatial-lagged terms depict a significant and negative influence on the log of ME, indicating that EU countries reduce their defense spending in response to increases in the weighted MEs of other EU members. That result holds for Model 1 where equal unit weights are assigned to EU members. Despite EU not being a traditional defense alliance, its members show clear evidence of free riding with regard to their military spending decisions. Since EU members are quite politically homogenous, geographically close, and confront similar international security threats, EU countries apparently view their fellow members' ME as strategic substitutes for their own ME.

The spatial-lagged term in Model 2 captures how an EU country's percentage change in ME responds to percentage changes in the ME of other EU members with which it shares land or water borders. The negative coefficient of that spillover term, albeit at 10 percent significance level, suggests the presence of free riding among contiguous EU members. A similar finding is reported for an inverse-distance-weighted spatial-lagged term in Model 3, further supporting the free-riding outcome among EU members. The defense-spending responsiveness to inverse distance is greater than for the previous two models.

Table 1. EU military expenditure (ME), 1990–2019.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
SL of ME (EU membership)	−0.0005 ***				
	(−4.06)				
SL of ME (contiguity)		−0.00107 *			
		(−1.92)			
SL of ME (inverse distance)			−0.165 **		
			(−2.54)		
SL of ME (contiguity with Russia)				−0.745 ***	
				(−7.80)	
SL of ME (arms trade)					−0.00000344 **
					(−2.11)
Ln (GDP)	0.856 ***	0.875 ***	0.907 ***	0.580 ***	0.500 ***
	(7.81)	(6.57)	(7.38)	(4.80)	(2.81)
Ln (Population)	−1.080 ***	−1.180 ***	−1.042 ***	−0.295	−1.080 **
	(−2.63)	(−3.02)	(−2.83)	(−1.05)	(−2.37)
Terrorist attacks	0.00125 *	0.000216	0.0000260	0.000233	0.000780 *
	(1.83)	(0.49)	(0.06)	(0.63)	(1.72)
Trade Openness	−0.00104	−0.0001	−0.00008	0.0003	−0.0045 ***
	(−1.42)	(−0.13)	(−0.11)	(0.53)	(−3.92)
Year FE	NO	YES	YES	YES	YES
Adjusted R^2	0.994	0.994	0.995	0.997	0.389
Kleibergen-Paap LM test statistic	106.0	25.57	22.45	37.06	17.94
Hansen J statistic (prob > χ^2)	0.344	0.0425	0.0406	0.996	0.272
N	628	612	628	628	277

Significance levels (SL): * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. *t*-statistics in parentheses. All models include country fixed effects. Italics: variables.

Table 2. EU military expenditure, 2008–2019.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
SL of ME (EU membership)	−0.00264 **				
	(−2.28)				
SL of ME (contiguity)		−0.009 ***			
		(−3.44)			
SL of ME (inverse distance)			−1.917 ***		
			(−3.66)		
SL of ME (contiguity with Russia)				−0.643 ***	
				(−4.91)	
SL of ME (arms trade)					0.0000008
					(0.06)
Ln (GDP)	1.469 ***	1.211 ***	1.149 ***	0.889 ***	1.052 ***
	(8.05)	(5.06)	(5.59)	(4.33)	(6.48)
Ln (Population)	−1.398 *	−1.558 **	−1.623 **	−0.485	−0.988 *
	(−1.90)	(−1.99)	(−2.36)	(−0.79)	(−1.93)
Terrorist attacks	−0.00240	−0.007 **	−0.007 **	−0.005 **	−0.0015
	(−0.73)	(−2.37)	(−2.47)	(−2.35)	(−0.34)
Trade Openness	−0.00208	−0.00167	−0.00102	−0.000312	−0.00213
	(−1.55)	(−1.05)	(−0.67)	(−0.29)	(−1.60)
Year FE	NO	YES	YES	YES	YES
Adjusted R^2	0.994	0.994	0.995	0.712	0.631
Kleibergen-Paap LM test statistic	72.04	9.500	18.99	26.24	7.874
Hansen J statistic (prob > χ^2)	0.00103	0.348	0.0489	0.0894	0.892
N	331	319	331	331	138

Significance levels: * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. *t*-statistics in parentheses. All models include country fixed effects.

Table 3. EU and non−EU NATO countries' military expenditure, 1990–2019.

Variable	(1)	(2)	(3)	(4)	(5)
SL of ME (EU membership)	−0.0004 ***				
	(−3.46)				
SL of ME (contiguity)		−0.001 **			
		(−2.28)			
SL of ME (inverse distance)			−0.391 ***		
			(−3.19)		
SL of ME (contiguity with Russia)				−0.656 ***	
				(−6.29)	
SL of ME (arms trade)					−0.000005 ***
					(−4.04)
Ln (GDP)	0.590 ***	0.638 ***	0.600 ***	0.523 ***	0.514 ***
	(4.91)	(5.80)	(5.23)	(4.51)	(4.45)
Ln (Population)	−0.197	−0.204	−0.249	0.114	−0.658
	(−0.50)	(−0.58)	(−0.68)	(0.36)	(−1.55)
Terrorist attacks	0.000783	−0.000605	−0.000578	−0.000398	0.000489
	(1.54)	(−0.95)	(−0.91)	(−0.61)	(1.10)
Trade Openness	−0.00126 *	−0.000894	−0.000454	−0.000479	−0.00547 ***
	(−1.89)	(−1.28)	(−0.71)	(−0.83)	(−4.74)
Year FE	NO	YES	YES	YES	YES
Adjusted R^2	0.994	0.995	0.995	0.996	0.538
Kleibergen-Paap LM test statistic	131.3	44.06	22.74	35.64	17.42
Hansen J statistic (prob > χ^2)	0.297	0.773	0.0627	0.290	0.376
N	796	780	796	791	338

Significance levels: * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. t-statistics in parentheses. All models include country fixed effects.

Table 4. EU military expenditure, 1990–2019 (Alternate spatial weights).

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	1990–2019		2008–2019		1990–2019 (EU and non-EU NATO countries)	
SL of ME (US + contiguity)	−0.001 **		−0.01 ***		−0.001 **	
	(−2.00)		(−3.70)		(−2.28)	
SL of ME (US + UK + France + contiguity)		−0.001 **		−0.01 ***		−0.001 **
		(−2.00)		(−3.70)		(−2.27)
Ln (GDP)	0.876 ***	0.876 ***	1.462 ***	1.458 ***	0.637 ***	0.636 ***
	(7.03)	(7.02)	(8.33)	(8.26)	(5.88)	(5.87)
Ln (Population)	−1.172 ***	−1.171 ***	−2.165 ***	−2.095 ***	−0.215	−0.213
	(−3.14)	(−3.14)	(−3.15)	(−3.02)	(−0.62)	(−0.62)
Terrorist attacks	0.000217	0.000220	−0.005 **	−0.005 **	−0.0006	−0.000604
	(0.50)	(0.51)	(−2.03)	(−2.05)	(−0.94)	(−0.94)
Trade Openness	−0.000134	−0.000131	−0.0009	−0.0008	−0.0008	−0.000839
	(−0.20)	(−0.19)	(−0.61)	(−0.55)	(−1.31)	(−1.31)
Year FE	YES	YES	YES	YES	YES	YES
Adjusted R^2	0.995	0.995	0.995	0.995	0.995	0.995
Kleibergen-Paap LM test statistic	26.00	25.97	10.11	10.11	44.09	44.13
Hansen J statistic (prob > χ^2)	0.0418	0.0382	0.00652	0.00674	0.769	0.781
N	628	628	331	331	796	796

Significance levels: ** $p < 0.05$ and *** $p < 0.01$. t-statistics in parentheses. All models include country fixed effects.

Table 5. EU military expenditure, 1990–2019 (alternate threat measure).

Variable	(1)	(2)	(3)	(4)	(5)
SL of ME (EU membership)	−0.0004 ***				
	(−2.85)				
SL of ME (contiguity)		−0.0017 ***			
		(−3.08)			
SL of ME (inverse distance)			−0.25 ***		
			(−3.45)		
SL of ME (US + contiguity)				−0.002 ***	
				(−3.11)	
SL of ME (US + UK + France + contiguity)					−0.002 ***
					(−3.11)
Ln (GDP)	0.908 ***	0.799 ***	0.879 ***	0.807 ***	0.802 ***
	(7.73)	(7.67)	(7.70)	(7.82)	(7.75)
Ln (Population)	−1.113 ***	−1.287 ***	−1.144 ***	−1.235 ***	−1.234 ***
	(−2.67)	(−2.98)	(−2.73)	(−2.91)	(−2.91)
Terrorist attacks	0.00116 **	0.00130 **	0.00135 **	0.00131 **	0.00130 **
	(2.47)	(2.11)	(2.32)	(2.06)	(2.04)
Trade Openness	−0.00123	−0.000792	−0.00114	−0.000948	−0.0009
	(−1.64)	(−0.89)	(−1.45)	(−1.21)	(−1.20)
Russian ME	−0.0173	−0.0566 **	−0.0421	−0.0574 **	−0.0562 **
	(−0.61)	(−2.08)	(−1.47)	(−2.10)	(−2.06)
Year FE	NO	YES	YES	YES	YES
Adjusted R^2	0.994	0.993	0.994	0.994	0.994
Kleibergen-Paap LM test statistic	92.94	21.55	40.30	21.67	21.79
Hansen J statistic (prob > χ^2)	0.0723	0.853	0.0216	0.817	0.714
N	604	588	604	604	604

Significance levels: ** $p < 0.05$ and *** $p < 0.01$. *t*-statistics in parentheses. All models include country fixed effects.

In Model 4, the spillover term represents how an EU member's ME responds to percentage changes in the ME of other EU members that share their borders with Russia. If EU countries perceive Russia as a major security threat, they are expected to react positively to the ME of EU members in close proximity to Russia. In contrast to that prior, the significant and negative coefficient of the spatial-lagged term in Model 4 implies that EU members actually reduce their ME in response to an increase in the ME of EU members contiguous to Russia. This suggests that EU countries do not consider Russia as a major security threat for the sample post-Cold War period, at least in terms of their ME response. This appears true despite Russia's annexation of Crimea in 2014, its conflict in Chechnya and elsewhere, and the recent rise of Russian nationalism. Finally, in Model 5, we use the value of arms trade among EU members to capture spatial spillovers, based on the assumption that an EU member places more weight on the ME of its EU arms-trading partners. The spillover term's coefficient is again negative and significant, thereby increasing the confidence in our previous free-riding results. Apparently, larger arms trade within the EU cements military ties or connectivity. That is, EU members can more readily view other members' arsenals as substitutable to their own arsenal if they share similar types of armaments that are interoperable and of a more current vintage.

Next, we consider the estimated coefficients of the control variables in Table 1. Consistent with the theoretical expectations, the log of GDP shows a significant and positive association with the log of ME in all models. That positive income elasticity indicates that defense is a normal, but inelastic, good with values that range from 0.5 to 0.9 over the five models. The population elasticity is significant and negative in all models except Model 4, with values less than –1. As discussed earlier, more populous countries need to allocate more money to domestic social welfare programs, thereby redirecting resources away from their military budgets. A population elasticity of less than –1 reflects a robust reallocation to social welfare concerns as population increases, consistent with EU countries wanting to cash in on the peace dividend after the Cold War. The number of transnational terrorist attacks has no significant association with ME, except in Models 1 and 5, where the anticipated positive coefficients are marginally significant at the 10 percent level. Trade openness does not significantly influence the demand for ME except in Model 5, where the negative coefficient suggests that greater trade openness limits the need for defense, as countries are more dependent on one another. The large values of the Kleibergen-Paap LM test statistic indicate that the instruments are strong. Moreover, the Hansen *J*-statistic rejects the null hypothesis of overidentifying restrictions at the 5 percent level, except for Models 2 and 3.

The global financial crisis of 2007–2008 had significant impacts on the defense spending trajectories of most EU countries. In the post-crisis years, many EU countries had to spend greater sums on various economic stimulus packages and social welfare programs, thereby diverting resources away from their military budgets. In 2009 alone, European defense expenditure fell by about 3 percent and continued to decline steadily until 2013 [48]. To test whether this decline in defense spending influenced EU members' free-riding behavior, we re-estimate the demand determinants of ME during 2008–2019, the post-crisis years, using the same five spatial weights.

As shown in Table 2, four of the five spatial-lagged ME spillover terms, the exception being the arms-trade-weighted spatial-lagged term, display negative and significant influences on the log of EU members' ME, indicating that defense free-riding behavior characterized the post-crisis years. The fall in arms trade among EU members may be behind the insignificance of the arms-trade spatial-lagged term in Table 2. The four significant spatial spillover elasticities are similar in values to the corresponding elasticities for 1990–2019. To test whether similar behavior characterized the pre-crisis period, we also estimate EU defense demand equations for 1990–2007. We could not, however, uncover any evidence of free riding in that earlier period, thus suggesting that EU members' free-riding behavior during the entire sample period was primarily driven by the post-2007 years (The results are available upon request). Turning to the control variables, we see that GDP and population variables generally display more elastic results than for the entire period covered by Table 1. In particular, income is now elastic with values greater than 1 in four of the five models. Additionally, population is generally tied to a larger negative response after 2007, consistent with the greater need to turn to social welfare programs after the financial crisis. Unlike the results for 1990–2019, the number of transnational terrorist attacks has a significant negative effect on EU members' ME. The direction of that effect is unanticipated since transnational attacks on an EU members' assets at home or abroad, both of which are measured in the data set, should raise their defense spending. This unanticipated finding may be driven by declines in transnational terrorist incidents in Europe and throughout the world as borders were made more secure following 9/11. Transnational terrorist attacks became more prevalent in countries hosting terrorist groups [47]. Such foreign-venue attacks are likely to elicit a smaller proactive response than home attacks, which pose a larger existential threat to the country. The unanticipated result may follow from counterterrorism measures by law enforcement, intelligence agencies, and INTERPOL assuming a greater importance, thus making the need for counterterrorism military actions less relevant.

Next, we estimate the ME demand equations for EU and non-EU NATO countries combined. The non-EU NATO countries included in the analysis are Albania, Montenegro, Macedonia, Norway, Turkey, and the United States. For the first three countries, we account for when they joined NATO. Since both NATO and EU have many common member countries and share various geo-political characteristics and threats, this pooling is justified. Moreover, we explore how EU members' free-riding behavior changed in response to the largest military spender in NATO—the United States—being included during the sample 1990–2019 period. As shown in Table 3, the free-riding behavior associated with the spatial lags of ME is amazingly consistent after adding non-EU NATO countries to the sample.

The only quantitative difference concerns the inverse-distance, spatial-lagged ME term, which displays a smaller free-riding elasticity. This may be due to greater distance between allies with the addition of the United States. A noteworthy change with the larger sample is that the population variable is no longer significant. That suggests that for non-EU NATO countries, there is no evidence of population size affecting social welfare crowding out ME spending. Both Turkey and the United States are populous countries that have, relative to EU countries, maintained their defense spending, which may have weakened the earlier influence of population on ME. In Table 3, the coefficients of transnational terrorist attacks and trade openness are mostly insignificant, similar to Table 1.

In Table 4, we use alternative spatial weights for 1990–2019 to capture how EU allies respond to power projections by the US and contiguous allies, and by the US, the UK, France, and contiguous allies. Even though the US is separated by an ocean from Europe, the US' huge power-projection capabilities in terms of aircraft carriers and transport planes make it similar to a contiguous country. The relatively high ME of those three powerful countries means that they are uniquely capable of exerting influence on the ME decisions of EU countries, particularly in terms of free riding. Models 1 and 2 report estimates for EU countries for 1990–2019, while Models 3 and 4 present estimates for EU countries for 2008–2019. Results for EU and non-EU NATO countries combined are reported in Models 5 and 6 for 1990–2019. Across all models, the spatial-lagged spillover terms are significant and negative, further supporting free riding and strategic substitutes. Those findings highlight that the EU relies partly on US power-projection abilities. The coefficients for the control variables are generally consistent with those from Tables 1–3, implying that defense spending is income normal and that population exerts a negative social welfare trade-off for Models 1–4. Transnational terrorist attacks are negative and significant for just 2008–2019, and trade openness is not significant.

Table 5 contains results for spatial regressions where Russian ME replaces Russian contiguity-weighted, spatial-lagged term as a threat measure. In addition, the two spatial-lagged power-projection ME terms are applied instead of the spatial-lagged arms-trade term. Unlike Model 4 in Tables 1–3, the threat measure (Russian ME) is a control in addition to five designated spillover terms. In Table 5, all five spillover elasticities are negative and significant, indicative of free riding. In Models 2, 3, and 5, EU members reduce their ME in response to an increase in Russian ME, which provides further evidence that EU countries are not apparently perceiving Russia as a major security threat. Other findings are consistent with the previous results—namely, GDP displays a robust positive elasticity and population shows a robust negative elasticity less that –1. A notable difference in the runs concerns transnational terrorist attacks, which indicate a significant positive influence on EU defense spending in all five models as originally predicted. As in earlier runs, trade openness has an insignificant effect on EU defense spending.

Up to this point, standard controls for the estimation of defense demand are used. At the urging of a reviewer, we estimate a set of robustness runs, displayed in Table 6, that allows for additional controls, such as the presence of a military industry, the number of armed conflicts, and the extent of globalization. The dummy variable measuring the presence of a military industry is constructed using the SIPRI Arms Industry Database [55]. That database provides information on both public and private arms-producing and military services companies in a sample country. For 1990–2019, we also allow for the number of armed conflict incidents that a sample country participated in, drawn from the Uppsala Conflict Data Program/Peace Research Institute Oslo (UCDP/PRIO) armed conflict dataset [56,57]. Finally, we add the KOF Globalization Index, which measures the economic, social, and political dimensions of globalization from 1970 to 2019 [58,59].

Table 6. EU military expenditure, 1990–2019 (robustness checks).

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
SL of ME (EU membership)	−0.000252 **				
	(−2.36)				
SL of ME (contiguity)		−0.000724 *			
		(−1.84)			
SL of ME (inverse distance)			−0.118 *		
			(−1.82)		
SL of ME (contiguity with Russia)				−0.830 ***	
				(−10.70)	
SL of ME (arms trade)					−0.00000381 **
					(−2.14)
Ln (GDP)	0.787 ***	0.793 ***	0.791 ***	0.512 ***	0.511 ***
	(7.55)	(6.74)	(6.84)	(5.42)	(2.78)
Ln (Population)	−1.189 ***	−0.776 **	−0.494	0.0662	−1.085 **
	(−3.32)	(−2.08)	(−1.35)	(0.25)	(−2.43)
Terrorist attacks	0.000886 **	0.000434	0.000251	0.000473	0.000880 **
	(1.97)	(1.29)	(0.77)	(1.64)	(2.07)
Presence of military industry	−0.0342	−0.0444	−0.0414	−0.0148	
	(−0.69)	(−0.90)	(−0.82)	(−0.35)	
No. of conflicts	0.0295	−0.0246	−0.0235	−0.0293	−0.0341
	(0.44)	(−0.55)	(−0.54)	(−0.70)	(−0.63)
KOF Globalization Index	−0.0103 ***	0.0159 ***	0.0140 ***	0.0112 ***	0.0173 *
	(−2.77)	(3.59)	(3.10)	(2.81)	(1.75)
Year FE	NO	YES	YES	YES	YES
Adjusted R^2	0.278	0.421	0.417	0.659	0.401
Kleibergen-Paap LM test statistic	9.535	5.233	5.295	35.62	5.913
Hansen J statistic (prob > χ^2)	0.339	0.0902	0.00727	0.749	0.372
N	600	585	600	600	267

Significance levels: * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. *t*-statistics in parentheses. All models include country fixed effects.

In Table 6, we introduce the three new determinants of the demand for ME and check whether their inclusion changes the results for the five spillover terms. Those new controls are added to the baseline models in Table 1. As shown in Table 6, the ME of EU members shows clear evidence of free riding (i.e., negative spillover values) even after the inclusion of additional controls, thereby increasing confidence in our initial results. Moreover, ME remains income normal, while population generally reduces ME, consistent with crowding-out. The KOF Globalization Index shows a significant and negative association with ME in Model 1. However, when we include year fixed effects to control for temporal shocks (Models 2–5), the globalization coefficient is significant and positive, suggesting that EU members with high degrees of economic, social, and political globalization tend to spend more on ME. That result is not surprising since countries that are more globalized show very high rates of economic growth [58]. Armed conflicts and the presence of a military industry have no significant effect on the ME of EU countries.

7. Concluding Remarks

Based on myriad spatial-linkage measures, our spatial estimates of EU military spending during the post-Cold War era provide a consistent, robust message that differs from past non-spatial and spatial EU defense spending estimates [2,17–19]. Most notably, free riding, indicative of strategic substitutes, characterizes EU members' ME for all seven spatial connectivity measures of this study. Free riding is particularly strong in the post-2007 period following the great recession, as social welfare programs assume a greater importance. The inclusion of non-EU NATO members, especially the United States, in the sample bolsters free riding under various empirical formulations. Even though the EU does not pledge its members to come to one another's defense in times of exigency as in a traditional military alliance, common market members act like allies who consider other members' ME substitutable for their own ME, leading to the prevalence of free riding. Additionally, we find that defense is an income normal good whose elasticity generally exceeds 1 during 2008–2019. Moreover, population displays an elasticity less than –1, indicative of social welfare demands crowding out defense as population increases. EU members' defense spending for threat measures is consistent with Russia not being viewed by members as a threat under alternative empirical specifications during 1990–2019. Finally, transnational terrorist attacks indicate a robust threat only when Russian ME is a control.

Our findings suggest some policy conclusions. First, if NATO were to dissolve or to decrease in importance, the EU appears to be in no position to rectify the alleged free-riding problem in Europe because EU members are content, like NATO members, to view other EU members' defense spending as strategic substitutes under a wide range of spatial connectivity assumptions. Thus, NATO's mission to protect Europe from external threats cannot be readily replaced by the EU. Second, since 1990, the EU appears more focused on cashing in on the post-Cold War peace dividend and on diverting defense spending to social welfare expenditure following the great recession. In the post-COVID period, this diversion of defense spending to social welfare is anticipated to continue for EU members as they address the economic downturn. If common defense is to assume a greater role in the EU, then members must change their thinking about threats facing them. Despite Russian aggression in Ukraine and elsewhere, this change in mindset has not yet occurred. Any such change must come from within the EU, perhaps motivated by even more aggressive actions by Russia. Third, if the EU were to assume a greater importance as a military alliance, then France, Germany, and the UK would need to raise their defense provision greatly to replace the dominant defense spending of the United States. However, our study still shows EU free riding on the United States, a non-EU member. As long as this reliance on the United States persists, the EU is unlikely to change its defense spending patterns. Fourth, with civil wars in North Africa, sub-Saharan Africa, and the Middle East, the EU faces unrest elsewhere that causes disruptions in terms of refugee flows, trade, and resource supply lines. To confront such challenges, the EU must begin to address its endemic free-riding problem, which may well require increased pledges of defense spending, like the recent 2 percent rule adopted by NATO in terms of defense burdens. Fifth, those civil wars mean that the EU must better coordinate its efforts at peacekeeping in nearby conflict-challenged regions. Such coordination has a long way to go, indicated by the eventual need to rely on US air power and munitions during a NATO-supported ouster of Qaddafi during 2011. Sixth, to be equipped to address peacekeeping outside of Europe, the EU members must build up their capacity to project power through greater transport aircraft and ships (e.g., aircraft carriers).

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