"Paying for Protection: Bilateral Trade with an Alliance Leader and Defense Spending of Minor Partners"

Daniel Albalate, Germà Bel, Ferran A. Mazaira-Font and Xavier Ros-Oton

UBIREA Institut de Recerca en Economia Aplicada Regional i Pública

Abstract

Military spending was the main government expenditure until the 20th century, and it still represents a significant fraction of most governments' budgets. We develop a theoretical model to understand how both military and trade alliances with military leaders can impact defense spending. By increasing the costs of military aggression by a non-ally, an alliance reduces the probability of war and allows minor partners reducing their military spending in exchange for a stronger trade relationship with an alliance leader and a higher trading surplus for the latter. We test our hypotheses with data on 138 countries for 1996–2020. Our results show that the importance of the trade relationship and the trade balance with the military alliance leader is a significant driver of military spending. The greater the weight of trade with the military leader and the higher its trade surplus, the lower is the defense spending of the minor partner.

JEL classification: H56, F19, F50, D74.

Keywords: Military alliances, Trade, Defense spending.

Daniel Albalate: Department of Economics, Statistics & Applied Economics. John Keynes 1-11, 08034 Barcelona. +34934021943, Spain. E-mail: albalate@ub.edu Associate Professor of Economics. Universitat de Barcelona. ORCID ID 0000-0002-4940-4589

Germà Bel: Department of Economics, Statistics & Applied Economics. John Keynes 1-11, 08034 Barcelona, Spain. + 34934021946. E-mail: gbel@ub.edu Professor of Economics. Universitat de Barcelona. ORCID ID 0000-0002-1330-8085

Ferran A. Mazaira-Font: Department of Economics, Statistics & Applied Economics. John Keynes 1-11, 08034 Barcelona. + 34934021943. E-mail: ferranmazaira@gmail.com Lecturer. Universitat de Barcelona. ORCID ID 0000-0002-2315-8834

Xavier Ros-Oton: Department of Mathematics & Informatics. Gran Via de les Corts Catalanes 585, 08007 Barcelona, Spain. + 34934039330. E-mail xros@icrea.cat ICREA Research Professor. Professor of Mathematics, Universitat de Barcelona. ORCID ID 0000-0003-1046-168X

1. Introduction

Military spending in Ukraine before the Russian invasion of February 2022 fluctuated between 3.8 (2020) and 3.2% (2021) of its GDP (SIPRI Military Expenditure Database).[1] In relative terms, this rate of expenditure was higher, as a proportion of GDP, than that in any other European country sharing a border with Russia (the case, for example, of Finland, Estonia, Lithuania, and Poland). In fact, with the exception of Russia (and Greece in 2021), no other country in Europe dedicated a higher percentage of its GDP to its defense needs. The limited war waged in the region of the Donbas since 2014 had obliged Ukraine to increase its military spending; however, back in 2008 – before the Great Recession – Ukraine was already dedicating 2.3% of its GDP to defense, with only the United Kingdom and Greece (and Russia) in Europe spending more. The fact that Russia's other European neighbors – most notably Estonia, Lithuania, Poland and Finland – had much smaller military budgets might reflect the fact that their partners in military and trade alliances afforded them a protective umbrella, with an alliance's main power typically playing a leading role in this respect. For example, in the case of the NATO alliance, U.S. military spending relative to GDP (3.7 and 3.5% in 2020 and 2021, respectively) is well above that of its partners.

The importance attached to forging military alliances is longstanding in the literature (e.g., Sun Tzu, VI c. B.C.; Aristotle, IV c. B.C.; Kautilya, III c. B.C.). Relations based on the provision of protection and safety in exchange for payments or services of a different nature have been a continuum in History. Indeed, the social institutions that regulated these relations constituted

[1] https://milex.sipri.org/sipri

the foundations of the feudal system (Brenner 1990). Subsequently, the transition from the 'redistributive world-empire' variant of feudalism to a capitalist world-economy (Wallerstein 1976) would be triggered – among other factors – by the expansion of trade, and empires would be replaced, Adam Smith (1776) argued, by a system of sovereign states and a balance of power organized along trading lines. As such, this relationship between the trade and military alliances forged between sovereign states today lies at the heart of international relations and the international political economy.

Seminal studies by Joanne Gowa (1989, 1994) provide the theoretical basis for the association between military alliances and trade. In testing this theoretical hypothesis, Gowa and Mansfield (1993) found that alliance membership had a positive effect on the bilateral trade of allied countries, while Gowa and Mansfield (1994) reported this influence to be stronger for goods produced under conditions of increasing rather than constant returns to scale. The existence of preferential trading agreements as a booster for trade among allies has been further analyzed by Mansfield and Bronson (1997), who concluded that when military alliances and preferential trading deals are combined the impact on trade is higher than when entered into singularly. In the same vein, a more recent study by Long and Leeds (2006) found that specifying economic agreements in alliance treaties is positively related to trade among partner states.

However, an earlier study by Morrow, Siverson and Tabares (1998) tended to find across several specifications a negative impact of military alliances on trade, this effect being stronger in bilateral than in multilateral alliances. Long (2003) argues that this disparity of results is attributable to the nature of the military alliance: that is, whether the military alliance constitutes a defense (mutual military assistance if one party is attacked) or a non-defense pact (neutrality, non-aggression, or consultation). Thus, defense pacts lead to greater trade among partners than is the case of non-defense pacts. This explanation is consistent with results presented in an empirical study by Survey (1989), who found that U.S. bilateral trade was higher (both imports and exports) with members of NATO.

On the specific costs and benefits of NATO membership, Olson and Zeckhauser's (1966) seminal study examined the divergent economic contribution made by members to the military alliance. The authors analyzed incentives for small state members to contribute proportionately less to the military effort than their larger counterparts and found evidence that the former did indeed enjoy a larger positive security externality (Long 2003). This issue attracted considerable attention during Donald Trump's tenure, with the president constantly demanding that the country's NATO partners increase their military spending,[2] while he reduced the US's contribution to NATO's collective budget. In a recent study, Alley and Fuhrmann (2021) identify the huge budgetary cost to the U.S. of its network of military alliances and wonder whether the financial toll is worthwhile.

However, Poast (2022, 526) argues that "the economic benefits of trade openness and support for the dollar are still notable and, by themselves, likely overwhelm the budgetary costs of maintaining the alliances". Indeed, in terms of the impact on trade, Egel et al. (2016) estimate that a 50% reduction in U.S. security commitments overseas could reduce the

[2] https://edition.cnn.com/2019/11/27/politics/trump-nato-contribution-nato/index.html (retrieved 20 February 2023)

country's annual bilateral trade in goods and services by 18 per cent (excluding, that is, trade with Canada and Mexico). As for support for the U.S. dollar, Eichengreen, Mehl, and Chiţu (2019) find that alliances increase the proportion of international units in foreign exchange reserves by about 30 percentage points. The dollar's current dominance as an international unit is supported by the status of the U.S. as a global power, which helps to guarantee the security of its allies. And this status "allows the U.S. government to place dollar-denominated securities at a lower cost because demand from major reserve holders is stronger than otherwise. The cost to the U.S. of financing budget and current account deficits is correspondingly less" (Eichengreen, Mehl, and Chiţu 2019, 322).

Overall, it is apparent that major partners in military alliances contribute proportionately more to military spending than do their minor partners, but that the former enjoy benefits from (1) increased trade and (2) from increased demand for their currencies, which together reduce the costs of financing their budget deficit and current account deficits. In return, minor alliance members enjoy greater positive security externalities, which sees them contributing proportionately less to the alliance in terms of military spending.

The aim of this article is to investigate the relationship between the benefits obtained by leading partners in military alliances in terms of trade and current account financing, and the benefits obtained by minor partners in terms of reduced military spending. More specifically, we examine how minor partners benefit a leading partner by increased bilateral trade deals in exchange for a reduction in the risk of war and, hence, of their military spending. To do so, we first develop a theoretical model relating bilateral trade and military spending and formulate our core hypotheses. We then empirically estimate the effect of the relevance of bilateral trade and the bilateral trade surplus with the leading partner on the minor partner's military spending. In conducting this estimate, we draw on a rich empirical literature analyzing the factors that influence military spending.

We find that the greater the minor partner's trade with the leading partner, the lower its military spending tends to be. Likewise, the greater the bilateral trade surplus (the lower the bilateral trade deficit) for the leading partner, the lower is the military spending of the minor partner. In this way, we make a novel and relevant contribution both to the existing literature on the relationship between military alliances and trade and on the determinants of military spending.

2. A theory of bilateral trade and military spending

Let us consider two rival economic and military superpowers, A and B, and a less powerful country both economically and militarily, C. Let us assume that country C, for historical, cultural, economic, and political reasons, is a political ally of A, which means it is under no military threat from A. But, at the same time, is no ally of B. Further, the economic surplus generated by countries i and C because of economic trade shall be denoted by $S_i > 0$.

Following the rationalist view of war (see, among others, Fearon 1995; Powel 1999; Martin et al. 2008; Grossman 2013), we assume that military conflicts may occur as a result of a cost-benefit analysis. As in Martin et al. (2008), we consider that two countries can engage in a negotiation on how to share the trade surplus when at peace. However, during this process, disputes might break out and these might be resolved and end peacefully, or they might escalate into conflict. Even in instances where the negotiation does not fail, wars may occur if either of the two parties believes they could be better off by using military force.

The timing of the negotiation is the following: Country C suggests a deal to country i, which consists of a fraction α_i of S_i that would be captured by i. If α_i is greater than or equal to n_i, which represents the negotiation power of country i , the deal is accepted, and each country secures their share. Otherwise, both countries obtain 0.

Since A and C are allies, we assume that there is no risk of escalation to war. However, when negotiating with B, C acknowledges that there is a risk of military conflict. Let us assume that the expected utility loss for C of a military conflict (and eventual invasion) is W_C. Let us also assume that C estimates the potential gains for B as $\widetilde{W}_B$, where $\widetilde{W}_B$ follows a symmetric triangular distribution with mean W_B and range $[W_B - \theta, W_B + \theta]$, $W_B > S_A + S_B$, and $W_B - W_C < S_A + S_B$. Hence, war is Pareto dominated by peace and the expected gains for B are higher than the total economic surplus from trade. However, these gains may come at a cost. Let us denote by Y the total production of C without trade agreements, and by m the military expenditure of C as a share of Y. It is clear that Y has to be much greater than S_A, S_B, W_B, and W_C.

Let us also consider that A, as an ally of C, could provide help to C in case of military conflict. Let us assume that both A and B have enough military strength to annihilate each other. Under a rationalist view, none of them would have any incentive to attack the other, no matter whether the other provides military aid to an ally in case of military aggression. That is, if B

attacks C, the military aid provided by A to C does not constitute a threat to B, since it only serves as an additional defense for C and acts only as a cost increase for B.

A would provide military help to C if and only if it has a positive utility for A. We can assume that peace itself has an intrinsic utility for A - for instance, because it ensures higher stability for capital flows and international trade. Moreover, if there is direct trade between A and C, it is also clear that A 's utility is higher the higher the trade benefit. Hence, we can assume, for simplicity, that A 's military aid would be of the form $p + \alpha_A S_A$, where p represents the fixed amount of military aid a leader would provide in exchange for the intrinsic value of peace. This help might be provided as military aid or as economic and political sanctions on B. We assume that C knows that a fraction k of the help would be in the form of military aid, and $1 - k$ as economic sanctions. The net gains of a military conflict for B are:

$$\widetilde{W}_B - \nu(mY + sk(p + \alpha_A S_A)) - (1 - k)(p + \alpha_A S_A) \qquad (1)$$

where ν represents the marginal costs for B of the military strength of C so that when $\nu > 1$ military force is more effective than economic sanctions, and $s > 1$ represents the relatively higher efficiency of the military capabilities of A with respect to C.

2.1 Probability of war

In line with the rationalist view of war, the leader of B considers military action against C only if she expects a net utility increase with respect to a trade agreement. Therefore, the leader of C estimates the probability of war as the probability of $\tilde{x} = \widetilde{W}_B - \nu(mY + sk(p +$

$\alpha_A S_A)) - (1-k)(p + \alpha_A S_A) > \alpha_B S_B$. If we then denote by $x = W_B - \nu(mY + sk(p + \alpha_A S_A)) - (1-k)(p + \alpha_A S_A)$ the expected net gains, the probability is:

$$Prob.\ war \equiv P_W = \begin{cases} \dfrac{(x + \theta - \alpha_B S_B)^2}{2\theta^2} & if\ x \leq \alpha_B S_B \\ 1 - \dfrac{(\alpha_B S_B - x - \theta)^2}{2\theta^2} & if\ x > \alpha_B S_B \end{cases} \tag{2}$$

The grey area in Figure 1 represents the probability of war; that is, the probability that the net gains $\tilde{x}$ are higher than the share of the trade surplus captured by B.

(Insert Figure 1)

2.2 Utility maximization problem

Based on the estimated probability of war, the ruler of C decides which allocations of the trade surplus to offer to A and B, and the military expenditure, to maximize the utility level u of a representative agent of her own country. The maximization problem for the ruler of C is:

$$\max_{\substack{n_A \leq \alpha_A \leq 1 \\ n_B \leq \alpha_B \leq 1 \\ 0 \leq m \leq 1}} Y(1-m) - P_W W_C + (1 - P_W)((1-\alpha_A)S_A + (1-\alpha_B)S_B) \tag{3}$$

Let us denote by $h = (1-\alpha_A)S_A + (1-\alpha_B)S_B + W_C$. Let us assume that $W_B - (S_A + p)(\nu sk + 1 - k) + \theta - S_B - \frac{\theta^2}{(n_A S_A + n_B S_B + W_C)\nu} > 0$ (that ensures that the potential gains for B from war are high enough to represent a real threat to C), and that n_i and W_C are large enough to ensure that the optimum is achieved with $P_W \ll 0.5$. Let us also assume that the uncertainty θ is lower than the maximum benefits of peace for C, which are $\hat{h} = (1-n_A)S_A + (1-n_B)S_B + W_C$.

The partial derivatives of the maximization problem (3) are:

$$\frac{\partial u}{\partial m} = Y\left[\frac{\nu(x+\theta\ - \alpha_B S_B)h}{\theta^2} - 1\right] \tag{4}$$

$$\frac{\partial u}{\partial \alpha_A} = S_A\left[\frac{(\nu ks + 1 - k)(x+\theta\ - \alpha_B S_B)h}{\theta^2} - 1 + P_W\right] \tag{5}$$

$$\frac{\partial u}{\partial \alpha_B} = S_B\left[\frac{(x+\theta\ - \alpha_B S_B)h}{\theta^2} - 1 + P_W\right] \tag{6}$$

Solving for the interior optimum in m, we obtain

$$m = \frac{W_B - (\alpha_A S_A + p)(\nu sk + 1 - k) + \theta - \alpha_B S_B - \theta^2/(h\nu)}{\nu Y} \tag{7}$$

Since we assume that $W_B - (S_A + p)(\nu sk + 1 - k) + \theta - S_B - \frac{\theta^2}{(n_A S_A + n_B S_B + W_C)\nu} > 0$, and since $Y \gg W_B$, then $0 < m < 1$. Moreover, (3) is a quadratic form in m with a negative coeffiecient in the second order term. Therefore, the interior optimum is also global.

By substituting in the expression of the probability of war, we obtain:

$$P_W = \frac{\theta^2}{2(\nu h)^2} \tag{8}$$

We also assume that uncertainty is lower than the maximum benefits of peace, that is, $\theta = \frac{\hat{h}}{\mu}$ with $\mu > 1$. Hence, $\frac{\partial u}{\partial \alpha_B} < S_B \left[\frac{1}{\nu} - 1 + \frac{1}{2\mu^2\nu^2}\right]$. Therefore, if $\nu > \frac{\mu + \sqrt{\mu^2+2}}{2\mu}$, (6) is negative no matter the values of n_i. For the case of maximum uncertainty, with $\mu \approx 1$, it suffices that $\nu > 1.37$. For more reasonable values, such as $\mu \approx 2$, it suffices that $\nu > 1.11$. As military expenditure is much more efficient than economic sanctions, we can assume that (6) will be always negative and therefore the $\alpha_B = n_B$.

Finally, substituting the previous results in (5) we obtain:

$$\frac{\partial u}{\partial \alpha_A} = S_A \left[\frac{\nu ks + 1 - k}{\nu} - 1 + \frac{\theta^2}{2(\nu h)^2}\right] \tag{9}$$

As is evident, if military aid or the relatively higher military efficiency of the superpower are sufficiently large, (9) is always positive and the optimum is $\alpha_A = 1$. More specifically, the conditions are $k > \frac{\nu-1}{\nu s-1}$ or $s > \frac{\nu-1+k}{\nu k}$. In contrast, if $\frac{\nu ks+1-k}{\nu} < 1$, then (9) equals 0 for $\alpha_A = 1 - \frac{1}{S_A}\left[\sqrt{\frac{\theta^2}{2\nu(\nu-\nu ks+1-k)}} - (1-\alpha_B)S_B - W_C\right]$. If $\alpha_A \in (n_A, 1)$, then the optimum is interior. Otherwise, (9) is always negative and the optimum is $\alpha_A = n_A$. Table 1 presents example solutions of the problem when using different parameters.

(Insert table 1)

Notice that either if the optimum α_A is at the boundaries or interior, the optimal military expenditure (7) reduces when the benefits from trade increase.

In conclusion, three main implications can be derived from the model. First, as can be seen in expression (7), and expression (9), the greater the benefits from between A and C $-S_A-$ and from peace $-p-$, the lower the military expenditure will be and the lower the probability of war, which is consistent with reports in the extant literature (see, among others, Copeland 1996; Martin et al. 2008). Second, the higher the efficiency of military force ν, the lower the military expenditure will be. Finally, as discussed in the introduction, the higher the military commitment k or the relatively higher military capabilities s, the lower the military expenditure by C and the higher the benefits from trade for military leader A, since country C renounces direct benefits from trade in order to be more valuable to A and to receive more protection. For instance, C may accept to incur trade deficits with A in exchange for a reduction in the risk of war.

More specifically, the empirical analysis conducted below tests the following hypotheses:

H1: The greater the volume of trade with the military leader, the lower the minor partner's military spending.

H2: The greater the military leader's trading surplus, the lower the minor partner's military spending.

3. Data and Methods

To test our hypotheses empirically, we employ data for the period 1996–2020 for 138 countries, for which information is fully available for both the dependent variable – military spending as a percentage of GDP (*%MSpending*) – and all covariates.[3] Our dependent variable is obtained from the SIPRI Database. Naturally, we exclude the U.S. from the sample, given that our primary purpose is to evaluate how bilateral trade between the U.S. and other countries affects the latter's military spending. Hence, our dependent variable is the defense spending of these countries as a percentage of their GDP (in constant terms).

Since our main hypothesis is that countries with stronger commercial ties with the U.S. have fewer incentives to spend on the military, due to the protection expected and received from the largest, most powerful army in the world, our key variables are related to existing bilateral trade volumes. First, in order to avoid confounding the effects of bilateral trade on the openness and total international trade of a country, we control for the degree of commercial openness of each country, which is a country's total annual exports and imports as a percentage of its GDP. This variable has typically been included in previous studies of military spending (see Bove and Nisticò 2014a, 2014b; Kollias et al. 2018; George, Hou and Sandler 2019, among others). Theoretically, openness facilitates access to arms markets and finance for arms procurement (Rosh, 1988); however, empirical studies usually find that trade has a

[3] Some countries had to be excluded due to missing data for some of the variables for our whole period. Table A-1 in the appendix presents the countries that could not be included.

peace-promoting influence diminishing the likelihood of conflicts and, with it, defense spending efforts (Seitz, Tarasov and Zakharenko 2015; Huang and Trosby 2011; Kollias et al. 2018).

Having controlled for the degree of openness, our first main variable is the bilateral trade conducted between each country and the United States, measured as the trade weight – including both imports and exports – that each country has within the U.S. GDP, that is, how much the trade of each country represents in U.S. GDP (in billions), per annum (*Trade_Weight*). The volume of trade is obtained from the Direction of Trade Statistics of the International Monetary Fund -IMF- (DOT-IMF). According to the theoretical model, our prediction is that the higher this share, the lower the military spending efforts of the U.S.'s commercial partner will be. By way of an alternative, we also consider the U.S. trading surplus with each country as a percentage of U.S. GDP (in billions) (*Trade_Surplus*). Testing the coefficients associated with these variables separately should validate, or otherwise, the main predictions of our model.

Among the rest of the covariates, we include four main groups of determinants of military spending. First, we include those related to the demographic and economic size of the country. Thus, we employ the total annual population in millions (*Pop*) and the square of this population (Pop^2) in order to account for any possible non-linear relationships. The values for this variable are drawn from the World Bank's (WB) World Development Indicators. The size of the economy is captured by the country's annual GDP, expressed at 2017 prices in PPP International U.S. dollars (*RGDP*), and calculated as the product of its GDP per capita and total population. The variable is obtained from the IMF's World Economic Outlook. Its square is also considered as a covariate (*RGDP^2*). Demographic and economic variables are typically found to be statistically significant drivers of military spending (Dunne et al., 2003; Collier and Hoeffler 2007; Nikolaidou 2007; Pamp and Thurner 2017; Hou 2018; Kollias et al. 2018; George et al. 2019; Droff and Malizard 2022).

The second group of covariates constitutes a country's political attributes. A diversity of political and regime-type variables has been employed in past studies (Dunne and Perlo-Freeman 2003; Albalate, Bel and Elias 2012; Yesilyurt and Elhorst 2017; Kollias et al. 2018; Hou 2018; Langlotz and Potrafke, 2019). In our model, the first of these variables is the political rights (*PR*) scores taken from the Freedom in the World Survey (Freedom House database). The variable takes a value between 1 and 7, where 1 represents maximum freedom and 7 the minimum. Freedom and democracy are usually found to be negatively correlated with military spending. The second variable here is *System*, which indicates whether the political system is Presidential (0), Assembly-elected Presidential (1) or Parliamentary (2). This variable is taken from Scartascini, Cruz and Keefer (2021) and is available at the Database of Political Institutions (DPI2020) maintained by the Inter-American Development Bank (IADB).

Third, we account for variables related to current and past military conflicts as drivers of current military spending. These variables are binary and take a value of one if the country is currently engaged in a civil war/violent internal conflict (*Cwar*) or was previously engaged in an international war (*Pwar*). A civil war is considered as a conflict involving a minimum of 25 battle-related deaths per year and per dyad between the government of a State and at least one opposition group without intervention from other States, while a past conflict is considered as having occurred if the country was involved in a war between 1987 and 1992.

Information on these two variables is drawn from the PROP Conflict Recurrence Database. A third variable on potential conflicts or threats is included by considering the *Emulation* variable, as defined in Collier and Hoeffler (2007) and Albalate et al. (2012). For each country, we take its neighboring countries (shared borders) and compute the share of aggregate military spending in terms of its own aggregate GDP. This is similar to the Security Web variable employed in earlier studies (Dunne and Perlo-Freeman 2003; Kollias et al. 2018). The expectation is that having armed neighbors is an indication of a potential conflict and, as such, countries adapt their military spending to that of their neighbors (Yesilyurt and Elhorst 2017). Yet, the literature reports mixed findings on its contribution (e.g., Collier and Hoeffler 2007; Albalate, Bel and Elias 2012; Pamp and Thurner 2017; for non-significant effects).

The last group of covariates is those related to military alliances. Previous research has shown the importance of accounting for international defense agreements in estimating countries' military spending (Digiuseppe and Poast 2018). The expectation is that when a country belongs to a military alliance it tends to have, *ceteris paribus*, higher military spending (Albalate, Bel and Elias 2012; Droff and Malizard 2022), but the empirical evidence has been mixed in determining whether arms and alliances are substitutes or complementary (Digiuseppe and Poast 2018). There are two principal military alliances in the world for the period considered in this study. To account for the participation of countries in these alliances, we created the variable NATO and the variable CSTA, to account for participation in either the *North Atlantic Treaty Organization* or the *Collective Security Treaty Alliance*. These are binary variables taking a value of 1 if the country belongs to either alliance in a given year and 0 otherwise. The main actors in NATO and the CSTA are the U.S. and Russia, respectively, and, as such we are considering the alliances made by the world's two largest armies in the period examined. Finally, if a country has nuclear weapon capabilities, we also expect them to spend more on defense. Here, a dummy variable with a value of 1 is attributed to a country acknowledged internationally as having nuclear weapons, and 0 otherwise.

Table 2 presents the descriptive statistics of the variables employed in our empirical exercise and their sources.

(Insert table 2)

We adopt different regression methods to evaluate our hypotheses. First, we run a cross-sectional regression with an OLS estimator and robust-to-heteroskedasticity standard errors for the year 2019. We chose 2019 because it is the most recent year for which largely complete data are available prior to the Covid-19 shock of 2020. Note this analysis only considers cross-sectional variation in one year and, as such, it presents only a limited picture of a point in time. As Dunne and Perlo-Freeman (2003) stress, focusing on cross-sectional analyses limits our understanding of dynamic processes at work within countries.

Second, we estimate an unbalanced pooled data model, considering all observations for the period 1996–2020, with time-fixed effects (yearly specific dummies) to exploit both time and cross-sectional dimensions for a long period of time (25 years) in all observations available. This model also employs an OLS estimator to estimate coefficients.

Third, we consider the panel data structure of our data, accounting for unobserved heterogeneity and autocorrelation with panel-corrected standard errors (PCSEs). Panel data are recommended after implementing the Breusch-Pagan test, which rejected the null hypothesis of no panel effects (p-value=0.000). Autocorrelation is found in our time series according to the Wooldridge autocorrelation test for panel data.

Finally, we employ a dynamic panel data model to account for inertia in military spending and to address potential endogeneity and/or reverse causality concerns. The PCSEs and the dynamic panel data models have been typically employed in the literature on military demand and spending (see for example Dunne and Perlo-Freeman 2003; Pamp and Thurner 2017; and Hou 2018 for dynamic models on military spending). The specific estimating equation for panel data dynamic models is:

$$\begin{aligned}
\%MSpending_{it} \\
&= \alpha + \%MSpending_{i,t-1} + \%MSpending_{i,t-2} + \%MSpending_{i,t-3} \\
&+ \beta_1\, Trade_Weight_{it} + \beta_2\, Openness_{it} + \beta_3\, Pop_{it} + \beta_4 Pop_{it}^2 \\
&+ \beta_5\, RGDP_{it} + \beta_6\, RGDP_{it}^2 + \beta_7\, PR_{it} + \beta_8\, System_{it} + \beta_9\, Emulation_{it} \\
&+ \beta_{10}\, Cwar_{it} + \beta_{11}\, Pwar_{it} + \beta_{12}\, NATO_{it} + \beta_{13}\, CSTA_{it} \\
&+ \beta_{14}\, Nuclear_Weapon_{it} + year_t + s_i + u_{it} \qquad \mathbf{(10)}
\end{aligned}$$

where i and t are the country (i) and year (t) of the observation, respectively, $year_t$ denotes the presence of a common time trend, s_i is the country fixed effect and u_{it} is the error term. As above, we also estimate equation 2 by replacing $\beta_1\, Trade\_Weight_{it}$ with $\beta_1\, Trade\_Surplus_{it}$ (2.b).

4. Results

The first approach to testing our main hypothesis, estimating a cross-sectional regression (OLS) for the year 2019 (that is, prior to the Covid-19 shock in 2020 and the Russian Invasion of Ukraine in 2022), indicates that the coefficients associated with both the *Trade_Weight* and the *Trade_Surplus* variables are both negative and statistically significant. This means, very much in line with expectations, that the greater the commercial importance of a country in the U.S. economy, the less this country dedicates to defense spending. The same outcomes are obtained when we run a pooled data model, considering time effects with yearly specific binary variables. Table 3 shows our main results for both the cross-sectional and pooled data models for the *Trade-Weight* and *Trade_Surplus* variables. In addition to bilateral trade variables, most of the other covariates are found to be relevant drivers of military spending in our pooled data model estimates.

(Insert table 3)

Our demographic and economic variables, used to capture the size of the economy, are statistically significant and present non-linear relationships. Indeed, a U-shaped function is associated with the population variable, while the reverse is the case for real GDP. Our political variables are also relevant according to the estimates conducted, with both political rights and emulation being statistically significant: the former outcome suggests that regimes with weaker political rights spend more on their military; the latter indicates that countries tend to increase spending in line with the spending of their neighbors. Our pooled models also point to the importance of conflicts, with the civil war variable presenting a positive sign in pooled models (3) and (4). In contrast, a past conflict presents a negative sign, suggesting that while there might have been a period of high expenditure associated with that war, spending has subsequently fallen. Interestingly, NATO allies are positively associated with military spending in pooled models, while CSTA allies exhibit the contrary relationship. Finally, countries with a nuclear capability spend more on the military than their counterparts.

However, these models also suggest a counterintuitive relationship between trade openness and military spending. Contrary to the main findings reported in the literature, the coefficient associated with openness is statistically significant in some models; however, it presents a positive sign. This is certainly a source of concern and one that points to potential problems with these simple methods.

Although these models seem to corroborate our theoretical predictions, they do not always account correctly for potential features of our data that might bias the estimated coefficients and affect standard errors. First, (1) the pooled data model does not account for unobserved heterogeneity, and a panel data approach is needed, as confirmed by the Breusch-Pagan test. Second, (2) the Wooldridge test for autocorrelation (Wooldridge 2002) confirms that serial correlation is a source of concern in our panel, by rejecting the null hypothesis of no first-order autocorrelation (F= 7.46, p-value= 0.0071). Thus, we estimate a Prais–Winsten (AR1) regression with correlated PCSEs. Third, (3) static panel data models do not account for the dynamic nature of military spending and its inertia and, moreover, they are unable to address any endogeneity concerns that may emerge if there are reasons to believe that it is military spending that shapes bilateral trade with the U.S. and not vice versa. Although we did not find any strong arguments or mechanisms that might result in such endogeneity, we did find clear evidence of inertia.

For all these reasons, our preferred model for testing our prediction is that of dynamic panel data.[4] This model implements the Arellano–Bond estimator (Arellano and Bond 1991), which uses moment conditions where lags of the dependent variable and first differences of the exogenous variables are instruments for the first-differenced equation. The moment conditions of these generalized method of moments (GMM) estimators are valid only if there is no serial correlation in the idiosyncratic errors. Because the first difference of white noise is necessarily autocorrelated, we focus our attention on second and higher autocorrelation. Based on the Arellano–Bond autocorrelation test result, we reject higher-order autocorrelation in our model (Order 1, Prob>Z = 0.008; Order 2, Prob>Z = 0.414; Order 3, Prob>Z = 0.367; see Table A2 in the appendix). Table 4 reports our main results after running the aforementioned panel data models.

(Insert Table 4)

The results obtained from the PCSE and dynamic panel data model confirm our hypotheses and model predictions, to the effect that the greater the commercial relevance of a country with respect to U.S. GDP, the lower its efforts in terms of military expenditure. The same result is obtained for the weight of the U.S. trade surplus in its bilateral trading activity with other countries: here, the higher the trade surplus achieved by the U.S. with a given country, the lower the military spending of that country.

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[4] Lagged dependent variables become statistically insignificant from the second lag on. More lags do not change our main results.

Therefore, our empirical estimates point in the direction predicted by our models. This suggests a substitution effect between military spending and trade, with a country able to protect its commercial partners. Undoubtedly, all countries need safety and protection, and our results confirm that this need can be satisfied by means of their own military spending efforts or by their becoming a trade ally of the U.S. The greater the benefits the U.S. reaps from bilateral trade, the lower the effort its commercial partners must incur to feel protected from external threats. Note that we detected, as expected, a positive effect of lagged military burden for a one-year lag, confirming previous reports to the same effect in the literature (Dunne and Perlo-Freeman 2003; Pamp and Thurner 2017; Pamp, Dendorfer and Thurner 2018; Hou, 2018).

Finally, the panel models in Table 4 confirm the consistent role across models played by political rights (*PR*), *Emulation* and the common time trend (decreasing trend). Our economic and demographic variables are only statistically significant in the PCSE models, while trade openness appears to be statistically significant but now presenting the expected negative sign only in the dynamic models.

5. Discussion/Conclusion

Throughout history, warfare has played a fundamental role in the evolution of human societies. Indeed, until the 20th century and the expansion of the welfare state, military spending was the main item in the government budget. In Ancient Rome, military spending represented more than two-thirds of total government expenditure (McLaughlin 2014), while during the Middle and Modern Ages, it continued to represent more than 50 per cent of government spending in most western countries (Kennedy 1987). For instance, in France, war expenditure accounted for some 57 per cent of total spending in 1683 and for around 52 per cent in 1714 (Bonney 1999). In some regions of the Dutch state, it is reported to have climbed above 90 per cent during the Franco-Dutch war (Hart 1999). In the course of history, military alliances, of many different kinds, have been of vital importance, often founded on the provision of protection or guarantees of safety in return for payments and services. As the balance of power in recent centuries has become increasingly organized around trade relations, the relationship between the trade and military alliances forged by sovereign states has become a central issue in both international relations and scholarly analyses.

Seminal studies by Gowa (1989, 1994) and Gowa and Mansfield (1993, 1994) have laid the groundwork for the analysis of the effect of military alliances on trade, and studies by other scholars have followed in their wake (e.g., Mansfield and Bronson 1997; Morrow, Siverson and Tabares 1998; Long 2003; Long and Leeds 2006). Generally speaking, alliances are found to have a positive influence on trade between partners, especially when certain characteristics (e.g., parallel trade agreements, defense-pact, etc.) are fulfilled. Since alliance leaders tend to incur greater military spending, the question has been raised as to whether these additional costs (Alley and Fuhrmann 2021) are offset by their benefits (Egel et al. 2016, Eichengreen, Mehl and Chiţu 2019; Poast 2022). However, much less attention has been paid to what – if anything – minor partners in these alliances might obtain, beyond protection from third-party aggression.

In this paper, we built a theoretical model to understand how defense and trade alliances affect military spending. By uniting forces, countries reduce the risk of war and the need to invest in the military in two ways: First, by increasing the opportunity cost of war, they make themselves more valuable to each other; and, second, by intensifying their trade relations with military leaders, they ensure their protection. The more valuable non-leaders can make themselves to the leader, the greater the protection the leader will be prepared to provide in case of military aggression against the non-leader, and the higher the cost for a non-allied country to initiate military conflict with the non-leader.

Our results show that trade relations with an alliance leader are a highly significant driver of military spending for minor partners. For each percentage point of U.S. GDP attributable to trade between a certain country and the U.S., the military spending of that country falls by 0.5 percentage points. Moreover, when the trade balance is especially favorable to the U.S., this effect is even greater.

While most of the extant literature on military alliances and trade has focused on the effects of such pacts on commerce and examined their benefits and costs to the alliance leader, it has been assumed that almost the sole benefit for minor partners is the increased protection they obtain. This study has taken the analysis of the outcomes of military alliances for minor partners further. As such, our main findings are that increasing the weight of trade with the alliance leader and, in particular, bilateral trade surplus in favor of alliance leader – which can be interpreted as a payment for protection – brings minor partners an additional benefit insofar as they are able to reduce their direct defense spending. Thus, our study provides a more comprehensive analysis of the benefits and costs of trade partnerships for military protection.

One of the most significant impacts that the Russian invasion of Ukraine seems likely to have in the near future is an increase in global military spending, but especially that of European NATO members as they seek to reduce their almost absolute reliance on U.S. military power when faced with a military threat. Our analysis suggests that these developments will result in a decrease in the weight of the bilateral trade of minor partners with the U.S. and an improvement in their bilateral trade balance with this major power. These developments constitute, we believe, a very interesting avenue for future research.

Appendix:

(Insert table A1)

(Insert table A2)

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Table 1. Results of the bilateral trade optimization problem for different parameters of $\boldsymbol{k}, \boldsymbol{v}, \boldsymbol{s}$, and $\boldsymbol{\theta}$, with Y = 100, $\boldsymbol{S_A = 6}$, $\boldsymbol{S_B = 5}$, $\boldsymbol{W_C = W_B = 10}$, $\boldsymbol{p = 0}$, and $\boldsymbol{n_A = n_B = 0.5}$

Input parameters				**Results**				
$\boldsymbol{k}$	$\boldsymbol{v}$	$\boldsymbol{s}$	$\boldsymbol{\theta}$	$\boldsymbol{m}$	$\boldsymbol{\alpha_A}$	$\boldsymbol{\alpha_B}$	$\boldsymbol{P_W}$	$\boldsymbol{u}$
0.5	1.3	1.1	4.5	5.7%	0.5	0.5	2.5%	99.5
0.8	1.3	1.1	4.5	2.1%	1.0	0.5	3.8%	100.0
0.5	1.5	1.1	4.5	4.8%	0.5	0.5	1.9%	100.4
0.5	1.3	1.5	4.5	1.5%	1.0	0.5	3.8%	100.6
0.5	1.3	1.1	6.5	6.4%	0.5	0.5	5.2%	94.8

Table 2. Descriptive statistics and sources

VARIABLE	MEAN	STD DEV	MIN	MAX	SOURCE
%MSpending	2.08	2.02	0	34.37	SIPRI Database
Trade_weigth	0.11	0.39	0.00	4.06	IMF (DOT-IMF).
Trade_surplus	0.01	0.07	-1.34	0.77	IMF (DOT-IMF).
Openness	0.73	2.03	0.00	71.88	IMF
Pop (in millions)	34.27	133.73	0.01	1,411	WB (WEI-WB)
RGDP (10^9 Int. USD 2017)	403.15	1223	0.032	22,935	IMF (WEO-IMF)
PR	3.45	2.18	1	7	Freedom House (FH-FWS)
System	0.75	0.93	0	2	(IADB)
Emulation	0.02	0.02	0	0.21	SIRPI & IMF
Cwar	0.11	0.32	0	1	PROP Conflict Recurrence Database
Pwar	0.02	0.13	0	1	PROP Conflict Recurrence Database
NATO	0.12	0.32	0	1	NATO
CSTA	*0.04*	0.19	0	1	CSTO
Nuclear_weapon	*0.03*	0.18	0	1	Federation of American Scientists
Year	2008	7.21	1996	2020	

Table 3. Estimates for the cross-sectional and pooled data models

	OLS (2019) (1)	**OLS (2019) (2)**	**POOLED (1996-2020) (3)**	**POOLED (1996-2020) (4)**
Trade_Weigth	**-0.5533*** (0.1488)**	**-**	**-0.5391*** (0.0418)**	**-**
Trade_Surplus	-	**-2.73e-07*** (7.54e-08)**	**-**	**-2.19e-07*** (1.93e-08)**
Openness	-0.1296 (0.3177)	-0.1523 (0.3138)	0.2629*** (0.0799)	0.2421*** (0.0790)
Pop	-0.0088 ** (0.0037)	-0.0087** (0.0038)	-0.0103*** (0.0009)	-0.0104*** (0.00095)
Pop^2	5.69e-06** (2.36e-06)	5.50e-06** (2.37e-06)	6.12e-06*** (6.47e-07)	6.30e-06*** (6.43e-07)
Rgdp	0.0003* (0.0002)	0.00039* (0.0002)	0.00050*** 0.000056)	0.00048*** (0.00005)
Rgdp^2	-1.92e-08** (8.03e-09)	-1.34e-08* (7.09e-09)	-2.31e-08*** (2.87e-09)	-1.86e-08*** (2.60e-09)
Pr	0.2692 *** (0.0692)	0.2694*** (0.0681)	0.2798*** (0.02259)	0.2874*** (0.0227)
System	-0.0122 (0.1370)	-0.0074 (0.1356)	0.0010** (0.0004)	0.0227** (0.0004)
Emulation	53.36*** (10.95)	52.81*** (10.87)	40.70*** (3.376)	40.23*** (3.323)
Cwar	0.1280 (0.4510)	0.1195 (0.4445)	0.7675*** (0.1175)	0.75750 *** (0.1191)
Pwar	-0.8096 (0.6346)	-0.80583 (0.6736)	-0.3139** (0.1700)	-0.3042** (0.1718)
Nato	0.3552 (0.2468)	0.3182 (0.2445)	0.1914*** (0.0513)	0.1567*** (0.0511)
Csta	-0.6436 (0.7790)	-0.6425 (0.7732)	-0.9555*** (0.1231)	-0.9528*** (0.1235)
Nuclear_Weapon	1.6281** (0.6412)	1.4792** (0.7046)	1.5947*** (0.1034)	1.483*** (0.1129)
TIME FE	no	no	yes	yes
N. OBSERVATIONS	138	138	3,381	3,390
R2	0.44	0.45	0.34	0.34

Notes: ***, **, and * denote, respectively, significance at the 1%, 5%, and 10% levels. Robust Standard errors in parentheses. Information on 13 countries was unavailable for 2019.

Table 4. Estimates for Panel Data models.

	PCSE (AR1) (5)	PCSE (AR1) (6)	PCSE (AR1) (7)	PCSE (AR1) (8)	DYNAMIC (9)	DYNAMIC (10)
%Mspending (-1)	-	-	-	-	0.5311*** (0.1139)	0.5317*** (0.1139)
%Mspending (-2)	-	-	-	-	0.0430 (0.0710)	0.0428 (0.0709)
%Mspending (-3)	-	-	-	-	-0.0608 (0.0744)	-0.0614 (0.0744)
Trade_Weigth	**-0.0062*** (0.0007**	-	**-0.0062** (0.0007)**	-	**-0.5048** (0.2613)**	
Trade_Surplus	-	**-1.84e-09*** (3.53e-10)**	-	**-1.76e-09*** (3.48e-10)**	-	**-1.56e-07* (8.34e-08)**
Openness	0.00055 (0.0016)	0.00050 (0.0017)	0.0011 (0.0017)	0.0010 (0.0017)	-0.5386** (0.2345)	-0.5230** (0.2267)
Pop	-0.0001*** (0.0000)	-0.0001*** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0018 (0.0071)	-0.0029 (0.0074)
Pop^2	7.29e-08*** (1.05e-08)	7.45e-08*** (1.02e-08)	7.28e-08*** (9.80e-09)	7.26e-08*** (9.89e-09)	-1.14e-07 (3.02e-06)	4.91e-07 (3.04e-06)
Rgdp	3.69e-06*** (7.73e-07)	3.07e-06*** (8.10e-07)	4.32e-06*** (7.64e-07)	3.77e-06*** (7.92e-07)	0.00034 (0.0002)	0.0003 (0.0002)
Rgdp^2	-1.35e-10*** (3.00e-11)	-9.80e-11*** (3.14e-11)	-1.59e-10*** (3.02e-11)	-1.23e-10*** (3.04e-11)	-1.01e-08 (7.52e-09)	-7.66e-09 (7.01e-09)
Pr	0.0028*** (0.0003)	0.0028*** (0.0003)	0.0027*** (0.0003)	0.0027*** (0.0003)	0.0822** (0.0327)	0.0822** (0.0323)
System	0.00001 (7.91e-06)	0.0000 (7.80e-06)	0.0000* (7.31e-06)	0.0000* (7.29e-06)	0.0940 (0.1411)	.0871 (.1439)
Emulation	0.2498*** (0.0304)	0.0303*** (0.0303)	0.2399*** (0.0311)	0.2375*** (0.0310)	12.135** (5.692)	12.077** (5.655)
Cwar	0.0007 (0.0010)	0.00084 (0.0011)	0.0007 (0.0010)	0.0008 (0.0010)	-0.1080 (0.1490)	-0.1054 0.1491
Pwar	0.0001 (0.0033)	-0.0001 (0.0030)	0.0007 (0.0029)	0.0017 (0.0030)	-	-
Nato	-0.0003 (0.0008)	-0.0001 (0.0009)	-0.0010 (0.0008)	-0.0007 (0.0009)	0.1190 (0.2066)	0.1205 (0.2069)
Csta	-0.0063** (0.0024)	-0.0062** (0.0026)	-0.0072*** (0.0024)	-0.0070*** (0.0025)	0.5538 (0.8744)	0.5221 (0.8423)
Nuclear_Weapon	0.0171*** (0.0021)	0.0182*** (0.0030)	0.0181*** (0.0027)	0.0184*** (0.0032)	-1.225 (1.038)	-1.116 (0.9778)
Time Trend	-0.0003*** (0.0001)	-0.0003*** (0.0001)	-	-	-0.0159** (0.0071)	-0.0153** (0.0071)
Time Fe	No	No	yes	yes	no	No
N. Observations	3,406	3,406	3,406	3,406	3,143	3,142
R2	0.44	0.43	0.44	0.44	-	-
Wald Chi2	405.30***	-	544.82***	506.96***	773.95***	796.78***

Notes: ***, **, and * denote, respectively, significance at the 1%, 5%, and 10% levels. Robust standard errors in parentheses. Pwar is excluded due to collinearity in dynamic models (9) and (10).

Table A.1 List of countries that could not be included in the empirical analysis.

Andorra	Estonia	Maldives	Seychelles
Antigua y Barbuda	Grenada	Micronesia	Sierra Leone
Aruba	Haiti	Monaco	South Sudan
Bahamas	Holy See	Nauru	The Comoros
Barbados	Hong Kong	North Korea	The Marshall Islands
Bhutan	Kiribati	Palestine	Tonga
Channel Islands	Kosovo	Papua New Guinea	Turk Cyprus
Djibouti	Latvia	Saint Kitts and Nevis	Tuvalu
Dominica	Lesotho	Saint Vincent and the Grenadines	Yemen, North
Dominican Republic	Liechtenstein	Santa Lucia	Yemen South
Equatorial Guinea	Macao	Serbia	

Table A2. Arellano-Bond test for zero autocorrelation in first-difference errors.

ORDER	Z	PROB>Z
1	-2.6486	0.0081
2	0.8169	0.4140
3	-0.9013	0.3674

UBIREA
Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics
Universitat de Barcelona
Av. Diagonal, 690 • 08034 Barcelona

WEBSITE: www.ub.edu/irea • **CONTACT:** irea@ub.edu