Sovereign Gravity

The Military Alliance Effect on Trade*

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Abstract

International insecurity can severely disrupt trade. This paper studies treaties aimed at preventing such insecurity: military alliances. Taking a structural gravity approach, we show that alliances increase trade by 60% on average. The effects of military alliances are dynamic and heterogeneous. They depend to a large extent on the type of alliance and the economic size of partners. An instrumental variable strategy and an event study confirm the causal interpretation of the results. Investigating the mechanism behind the impacts of military alliances, we demonstrate that alliances increase trade by reducing international insecurity. General equilibrium analysis moreover shows that the growth in trade generated by military alliances brings substantial welfare gains for signatories and losses for non-aligned countries.

Keywords: Military Alliances, Trade, Structural Gravity, International Insecurity, Trade Elasticities, Welfare

JEL-Classification: F13, F15, F51, F62, D74

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1 Introduction

Since 2000, the number of major conflicts has quadrupled worldwide to involve more than 130 countries.[1] This massive increase in international insecurity can severely disrupt trade. The vast majority of trade costs are not associated with direct policy instruments, but with hidden transaction costs (Anderson and Van Wincoop, 2004). A significant proportion of these hidden transaction costs have to do with the insecurity of trade (Anderson and Marcouiller, 2002). Blomberg and Hess (2006) show that common exposure to violence reduces bilateral trade by 7%, a figure that increases to 35% in the case of civil war. Sandkamp et al. (2022) determine that each additional maritime piracy incident reduces bilateral exports by 0.1%. Korovkin and Makarin (2023); Rohner et al. (2013); Yu et al. (2015) demonstrate the importance of conflict signals in shaping international trade costs. Martin et al. (2008) show that military interstate disputes reduce bilateral trade by 38% on average. Glick and Taylor (2010) demonstrate the overall negative impact of war on trade. They show that major interstate conflicts reduce trade by 80% between enemies and by 13% between belligerents and neutral countries, with a significant lasting effect in peacetime. Introducing conflict risk into a conventional general equilibrium model of trade, Thoenig (2023) exhibits the major interplays between interstate wars, diplomatic negotiations and trade.

This paper examines one way of reducing trade insecurity: *the military alliances*. These international agreements are specifically designed to reduce insecurity among their members. They are based on two pillars: (1) enforcement of military cooperation policies, and (2) international security as a way to promote trade.[2] Many alliances exist such as the North Atlantic Treaty Organization (NATO), the Treaty on Collective Security and the Arab-Maghreb Union. However, the *Pax Mongolica* is an iconic example of such an alliance. In the 13th and 14th centuries, this set of treaties[3] ensured the security and development of trade in Eurasia. The end of the agreement saw a huge increase in conflicts and a sharp drop in trade – enough to prompt Europeans to take an unprecedented step in search of new trade roads (Findlay and O'Rourke, 2009). There are basically two categories of alliance: weak alliances – reducing the probability of open conflict between signatories – and defence pacts – enforcing collective and centralised management of members' security (Gibler, 2008). Their depth of military cooperation is significantly different, as are their expected effects on insecurity and trade.

[1] Authors calculation based on geocoded UCDP project data on conflict events (Sundberg and Melander, 2013).

[2] "An alliance is a formal contingent commitment by two or more states to some future action. The action involved could entail almost anything—detailed military planning, consultation during a crisis, or a promise by one state to abstain from an upcoming war. [...] empirical studies have developed a consensus that the operationalisation of the alliance variable depends on two factors. First, alliance members have to be independent nation-members of the international system (for example, so-called alliances between international terrorist organisations do not qualify), and second, a treaty text has to exist that identifies a military commitment that is defensive, a neutrality arrangement, or an "understanding" such as an entente," (Gibler, 2008). Details on alliances' content are provided in section A.

[3] The Pax Mongolica was a set of treaties between the former Mongol empire states – The Golden Horde (Western Steppe), the Yuan Empire (China), the Ilkhanat (Persia) and the Chagatai Khanate (Eastern Steppe) – the Italian republics and the Russian duchies (Findlay and O'Rourke, 2009).

Few previous papers have analysed the impacts of alliances on trade. Those that do are restricted to the Cold War period, find heterogeneous results and lack theoretical grounding. Drawing on the Tinbergen (1962) gravity equation, Mansfield and Bronson (1997) find a positive correlation between exports and alliances using a panel regression covering the 1960-1990 period. They conclude that an alliance increases exports by 20%. Taking a similar approach, Long (2003) estimates for the 1885-1990 period that defence pacts are associated with 37% higher exports, while weak alliances have no statistically significant effect.

Our study of the impact of military alliances on trade contributes to the literature in a number of ways. First, we identify the causal effect of alliances. On average, military alliances increase bilateral exports by 60%. Second, we investigate the mechanism behind this impact to show that alliances boost trade by significantly reducing international insecurity. Third, to the best of our knowledge, we are the first to investigate the welfare effect of the growth in trade induced by alliances. We show that the enforcement of an alliance brings substantial welfare gains for signatories, but losses for non-aligned countries.

This study is structured as follows. We present the focus on military alliances under structural gravity theory. We isolate the costs of insecurity in a model covering heterogeneous firms based on Chaney (2008) and Helpman et al. (2008). By reducing trade costs sensitive to insecurity, military alliances directly increase trade between partners. From this frame, we derive the gravity equation on which our empirical work is based. The analysis combines the Correlate of War database, built on the massive and meticulous work by Gibler (2008) to document active military alliances, with the CEPII[4] CHELEM dataset on international trade. Thus, we perform a structural gravity approach using a panel of 6,972 country pairs covering the period from 1967 to 2012.

We estimate the effects of military alliances on bilateral exports. Taking exporter-year, importer-year and exporter-importer fixed effects, our specifications focus on the within-country-pair variation of military alliances. Our set of fixed effects ensures that we properly control for multilateral resistance terms, market access and structural interstate relationships (Behrens et al., 2012; Feenstra, 2015; Redding and Venables, 2004). In addition, we control for Regional Trade Agreements (RTAs). The spread of RTAs and alliances over our period is highly distinct.[5] Yet, since we are investigating the specific effect of alliances, it is important to control for the standard agreements designed to affect trade. On average, enforcing a military alliance increases bilateral exports by 60%, which is equivalent to a tariff reduction of 12.8%.[6] This result is robust to a wide range of consistency checks, including additional controls (tariffs, depth of RTAs, Cold War, etc.), but also to other estimation techniques

[4]Centre d'Etudes Prospectuses et d'Informations Internationales.
[5]See graph 8 in appendices.
[6]Equivalence is made with the estimated trade elasticity in our sample $\theta = 3.7$.

preventing potential bias (intranational trade, negative weights, asymptotic bias, etc.). Nonetheless, the effects of alliances are highly heterogeneous. They are sensitive to the nature of the treaty and the economic size of partners. Thus, only defence pacts have a significant effect, while small countries benefit more than large economies from the enforcement of such agreements.

We carefully investigate the endogeneity of military alliances. Using an instrumental variable strategy supported by a plausible exogeneity test based on Conley et al. (2012), we confirm the causal interpretation of our results. We give a particular attention to the dynamic effect of alliances. Alliances signatures may be driven by past changes in international relations and require time to be fully enforced. Developing a Differenced Average Treatment on the Treated (DATT) approach based on Couch and Placzek (2010), we address the pre-trend issue and show that the signature of an alliance has an immediate positive effect on bilateral trade but needs four years to reach their maximum effect and stabilise.

Then, we turn to analysing the mechanism by which military alliances affect bilateral trade. We directly test whether alliances increase trade by reducing international insecurity. The first source of insecurity that alliances address is the risk of conflict between members. However, we show that this channel does not apply. Indeed, modern conflicts are in the extremely large majority related to fights against non-state actors (terrorism, civil wars, piracy, armed factions). Retrieving data on conflict events from the geocoded UCDP project, we construct an extensive measure of country-pairs' insecurity including conflicts with non-state actors. Using a two-stage strategy and considering the heterogeneity of alliance treaties, we show that: (i) defence pacts sharply reduce bilateral insecurity, and (ii) by reducing insecurity, they significantly increase bilateral exports. This explains the effects of defence pacts on trade as a whole. Therefore, our results strongly support both the validity and prevalence of the insecurity mechanism. Furthermore, by investigating the margins of this mechanism, we demonstrate that the defence pacts' effect is not driven by the reduction in bilateral insecurity's intensity but by a significant decrease in the members' risk of facing such issues.

In the last part of the paper, we investigate the welfare effect of alliances. We develop a general equilibrium analysis. In keeping with Arkolakis et al. (2012), we derive the welfare system from our theoretical model, pointing up the endogenous role of insecurity costs. Then, using the properties of the PPML estimator, we solve this system and perform a counterfactual analysis for 2012 in which all alliances are ended. This enables us to draw conclusions about the impacts of military alliances on real revenue – our measure of welfare. Military alliances bring their members substantial welfare gains. Interestingly, our results show that neutral countries experience a marked welfare cost at the same time. Moreover, performing a scenario analysis, we show the considerable potential welfare ramifications of reshaping the military alliance network in response to the war in Ukraine.

The paper is organised as follows. Section 2 describes the theoretical framework. Section 3 presents the data used in the analysis and some descriptive evidence. Section 4 investigates the effects of military alliances on bilateral exports, the sensitivity of our baseline results and heterogeneous effects. Section 5 addresses potential endogeneity concerns. Section 6 investigates the dynamic effect of alliances. Section 7 studies the mechanism through which alliances affect trade. Section 8 develops the general equilibrium analysis and draws conclusions about the welfare impact of military alliances. Lastly, section 9 presents a short conclusion.

2 Theoretical framework: Insecurity and structural gravity

When two countries sign an alliance, they enforce bilateral security cooperation policies (Gibler, 2008) – see appendix A for details and examples. In so doing, they improve security between partners. In other words, by reducing insecurity costs, alliances are supposed to increase trade. Below, we present the focus on military alliances under structural gravity theory and the resulting gravity equation. The full model and its extensions with fixed insecurity costs and bilateral trade-elasticities are detailed in the appendices (Section B).

We define insecurity as a variable cost induced by exposure to violence (destruction, war, conflicts, terrorism, piracy). As discussed by Martin et al. (2008), the insecurity cost can be either country-specific or country-pair-specific. Alliances are international treaties which focus on reducing the probability of conflict between the members and developing security cooperation policies for common purposes. They do not aim to reduce the global insecurity of a country, but the insecurity which concerns signatories (see appendix section A). Signing an alliance should, therefore, only affect the country-pair insecurity cost.[7]

From the perspective of a firm, the country-pair insecurity cost is interpretable as the risk of exports to be expropriated when sold in country j from country i. This risk is composed of two dimensions: first, the yearly country-pair's probability of facing international insecurity (E_{ij}), which we call the extensive margin of international insecurity, and second, knowing the country-pair ij is exposed to international insecurity (i.e. $E_{ij} = 1$), the probability of a traded product to be expropriated (I_{ij}), which we call the intensive margin of international insecurity.[8] I_{ij} is equivalent to the share of products that do not reach destination in case of insecurity. Thus, when a firm exports, it has the probability E_{ij} of facing the marginal cost $1/1 - I_{ij}$. Firms trading a number of units of their variety over several periods, they internalize this risk, which can be translated to a traditional iceberg trade cost τ, but

[7] Following this theoretical discussion, the empirical sections of the paper focuses on the bilateral effect of alliances. Yet, we further discuss the potential role of multilateral insecurity in the appendix section D.

[8] We further detail the role of each margin in section 7 dedicated to the alliances mechanism and their influence on international insecurity.

sensitive to insecurity with $\tau_{s,ij} = 1 + E_{ij}(1/(1 - I_{ij}) - 1)$.[9]

In monopolistic competition with a Constant Elasticity of Substitution (CES) demand function, this leads to the price function:

$$p_{ij}(\alpha) = \frac{\sigma}{\sigma - 1} w_i T_{n,ij} \alpha \tag{1}$$

where σ is the elasticity of substitution, w_i the wage in country i, α the firm's marginal cost (i.e. the inverse of productivity γ). $T_{n,ij} = \Pi^n \tau_{n,ij}$ is a product of variable trade costs with n the n potential source of iceberg cost, including $\tau_{s,ij}$ the variable insecurity cost, but also all variable trade costs sensitive to other parameters (geography, standard trade policies, institutions, etc.). Thus, in such a frame, any reduction in bilateral insecurity reduces exporting firms' prices.

From this theoretical frame, we can derive at the aggregated level the following structural gravity equation outlying the insecurity trade costs $\tau_{s,ij}$:

$$X_{ij} = N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} \tau_{s,ij}^{-\theta} T_{n \neq s,ij}^{-\theta} F_{n \neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]} \tag{2}$$

X_{ij} is the total exports from country i to country j, N_i, the number of firms in the exporting country, $\overline{\alpha}_i$, the maximum marginal cost of country i's technology, and w_i the wage in country i's economy. X_j is the total revenue of country j, and Φ_j, the importer's multilateral resistance term, while $T_{n \neq s,ij}$ and $F_{n \neq s,ij}$ are respectively the variable and fixed trade costs sets insensitive to insecurity.[10] Like other trade costs, insecurity costs ($\tau_{s,ij}$) have a negative elasticity.[11] Hence, by reducing the insecurity costs, the enforcement of a military alliance between countries i and j increases bilateral exports X_{ij}.

3 Data

The structure of the dataset is a country-pair panel. Our unit of observation, therefore, is a given exporter-importer-year combination. We study how variations in the ally status of the dyad affect bilateral exports.

[9] We can also interpret the reduction of the expropriation probability as a lower cost of insurance. In the case of an insurance market, a firm can pay insurance which, in exchange for a contribution equal to the share $\tau_{In,ij}$ of the value of each insured exported product, will provide the amount p (the price) for each expropriated product. Thus, in exchange for a variable cost $\tau_{In,ij}$, the firm obtains the guarantee that the exported products will be sold at the price p. Given that we are in a Melitz (2003) monopolistic competition case, firms face a returns-to-scale technology due to the presence of fixed costs and are price setters. Therefore the firm chooses the lower price between $p_{ij}(\alpha) = \frac{\sigma}{\sigma-1} w_i \tau_{s,ij} \alpha$ and $p_{ij}(\alpha) = \frac{\sigma}{\sigma-1} w_i \tau_{In,ij} \alpha$. Firms only take out insurance policies that will ensure $\tau_{In,ij} <= \tau_{s,ij}$. So, when the probability of expropriation decreases, there is a reduction in $\tau_{In,ij}$. Even in the presence of an insurance market, military alliances reduce bilateral insecurity costs.

[10] See section B.2 for the model extension with fixed insecurity costs.

[11] Note also that despite our assumption that all trade costs of the same nature (variable vs fixed) have the same elasticity, this does not mean that the model assumes that all policies have the same trade elasticity. Indeed, we do not assume that all trade costs are sensitive to the same policies or to the same extent.

3.1 Data description

Alliances data.– We use information on military alliances for each ijt from the Correlate of War project (Gibler, 2008). We have information on whether a given country pair are allies and, if so, the nature of the treaty. We can divide military alliances into two categories: weak alliances, which focus mainly on military cooperation to guarantee peace between signatories, and defence pacts, which enforce military cooperation to protect members from common threats and achieve common strategic objectives[12] (Long, 2003; Gibler, 2008). From 1967 to 2012, the majority of military alliances were defence pacts. Yet, most of them were enforced throughout the entire period. Consequently, in our sample the number of defence pacts and weak alliances contributing to the within variation – i.e. whose status changes over the period – is comparable (see table 1). For each country pair, we define ALL_{ijt}, a dummy variable which equals 1 if country i and j are allies at time t and 0 otherwise.

Insecurity and military cooperation data.– We collect data on conflict events from the geocoded UCDP project (Sundberg and Melander, 2013) to construct our measures of military cooperation and bilateral insecurity. The initial observation unit is an event. Information is available starting in 1989 with the year provided for each event. This project also has the advantage of identifying the belligerents (and co-belligerents) in each conflict event. In the large majority, observed events are related to conflicts between states and non-state organized actors (terrorism, civil wars, piracy, armed factions). We organise the information to create a dummy taking the value one if the country-pair cooperates militarily (i.e. is belligerent) in the event. Summing this dummy at the country-pair-year level, we obtain a continuous measure of bilateral military cooperation. By summing observations of conflict events, excluding the country-pair's cooperative events, we observe country-year exposure to insecurity.

Exports data.– International trade data are retrieved from the CEPII CHELEM base (de Saint-Vaulry, 2008). We extract bilateral exports in current dollars between the 84 available countries from 1967 to 2012.[13] Data exclude re-imports and re-exports. Flows are adjusted for freight and insurance costs.[14] Zero trade flows are observed and our export matrix is squared. The CHELEM database enables us to exclude arms exports, which improves our identification strategy. Therefore, in our case, CHELEM provides the best trade-off between quality of observations and panel size. Nevertheless, we discuss below a robustness check with extended trade data. The CHELEM base does not provide

[12] See section A for more information about military alliance treaties and examples.

[13] The full list of countries is presented in appendix table 15.

[14] In declarations, imports include freight and insurance costs while exports do not. Considering the reliability of countries' declarations, CHELEM's bilateral trade is harmonised in keeping with the RAS iterative method (see Stone (1963)). Prior to 1992-93, some countries, such as the former USSR and former Yugoslavia, are not recognised (or reported) as independent trade partners by the UN. The CHELEM base provides estimated values to fill these missing observations. The dataset therefore contains harmonised export values for all exporter-importer pairs (6,972) across the entire period.

information on intranational trade. We supplement our export data with within-country flows from the CEPII TradeProd database (De Sousa et al., 2012; Mayer et al., 2023).[15] Similarly to CHELEM, flows are adjusted for freight and insurance costs and harmonised according to the reliability of the countries' declarations. However, the dataset starts in 1990 and 19 CHELEM sample countries are unobserved.[16] Within-country trade flows are very important for the general equilibrium analysis performed in the last part of the paper. Yet, because of this data limitation, the baseline and the other partial equilibrium estimations use only international exports. In this way, we make use of the largest available panel. Nonetheless, a robustness check with intranational flows is discussed below.

Other data.– Information on Regional Trade Agreements (RTAs) and the standard gravity variable, such as distance, population, common language and religion, are retrieved from the CEPII's Gravity database (Head et al., 2010). Data on RTAs include preferential trade agreements, free trade agreements, customs unions and other less common forms of agreements. We round them out with RTA legally enforceable provisions from the Content of Deep Trade Agreements database (Hofmann et al., 2017). Information on Gross Domestic Product (GDP) is also taken from the CHELEM dataset. Information on tariffs is retrieved from the World Trade Integrated Solution, which combines data from UNCTAD TRAINS[17] and the World Trade Organization. Finally, we extract our data on corruption and the rule of law from the Variety of Democracy project (Coppedge et al., 2022; Pemstein et al., 2022).

3.2 Descriptive statistics

We have a panel of 6,972 country-pairs from 1967 to 2012. In our dataset, 46% of worldwide exports (in value) come under the umbrella of alliances: 72 countries are signatories to these treaties and 738 pairs are affected by one, including 362 making a switch during our period (cf. table 1).

In figure 1, the map of the world displays the number of alliances per country during our time-frame. As can be observed, alliances are heterogeneously distributed across countries. No clear correlation between level of economic development and being signatories to such treaties is observed. Intermediary or low-income countries are not excluded from the worldwide alliance system – South American countries have signed more alliances than any European countries, while Africa and Asia present a wide range of involvement. In figure 2, the same exercise is replicated with the number of switches

[15] Intranational flows are filled by linear interpolation of non-missing data, whereas the remaining missing values are extrapolated using country total exports (Baier et al., 2019; Fontagné and Santoni, 2021).

[16] Excluded countries are: Belarus, Bosnia and Herzegovina, Brunei, Croatia, Czech Republic, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Libya, Lithuania, Luxembourg, North Macedonia, Paraguay, Russia, Slovakia, Slovenia, Ukraine. A recent version of TradeProd includes data from 1966. Yet the covered period is very heterogeneous among countries especially before 1990 and after 2008. We, therefore, use the same TradeProd dataset as Fontagné and Santoni (2021) which is designed for general equilibrium analysis.

[17] United Nations Conference on Trade and Development Trade Analysis Information System.

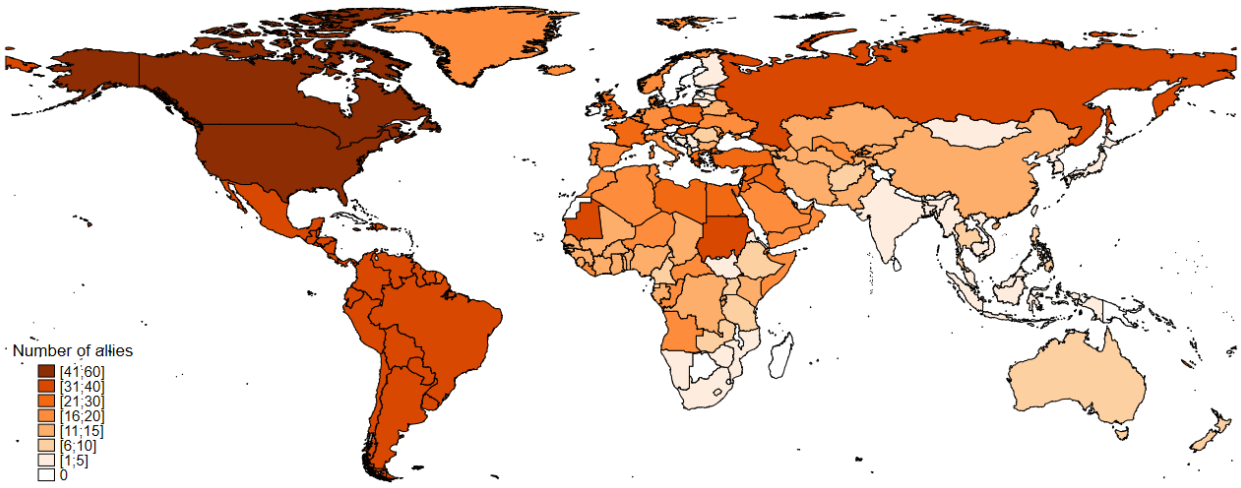
in alliance per country. Countries contributing to the switches are well dispersed around the globe, providing a good range of treated economies and international relationships.

Table 1: Alliances, treated and untreated countries

	Alliances	Defence pacts	Weak alliances
Countries treated	72	63	45
Countries never treated	12	21	38
Country-pairs treated	738	618	142
Country-pairs with a switch	362	244	142

Note: Author's calculation. We count each exporter-importer observation as a country-pair. All alliances are symmetric. Ex: *72 countries of our sample have an active alliance with at least one partner for at least one year in our panel.*

Figure 1: Number of alliances by country, 1967-2012 (COW data)

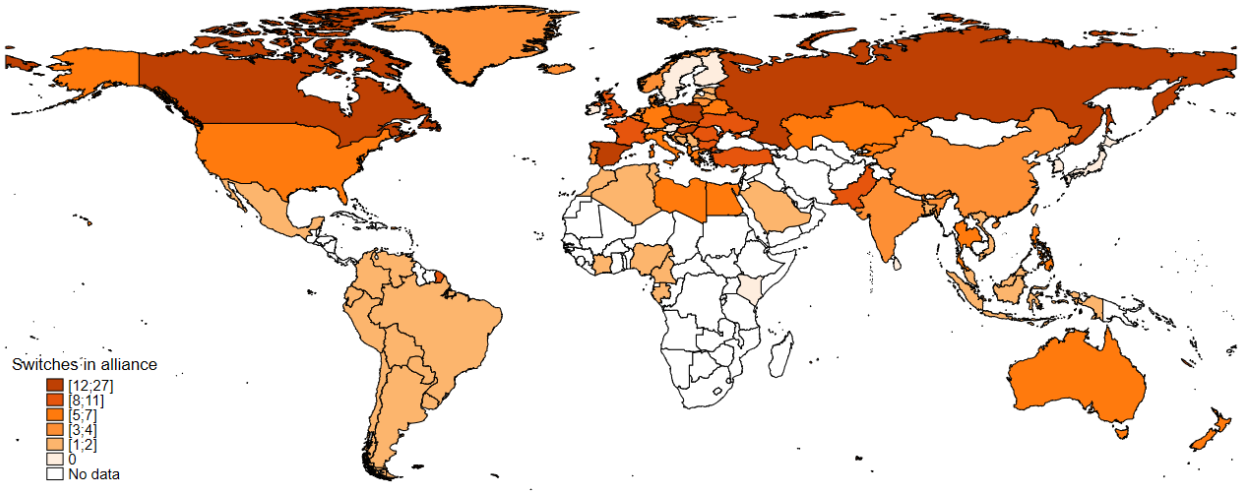


Note: alliances are counted at country-pair level; 60 means that the country has been allied with 60 other countries from 1967 to 2012; white areas are where no alliance has been observed.

A simple density graph (cf. figure 3) displays a positive correlation between bilateral exports and military alliances. The distribution of country-pair exports with military alliances lies more to the right than the distribution without, indicating a significantly higher average level of exports for country pairs with a military alliance than without.

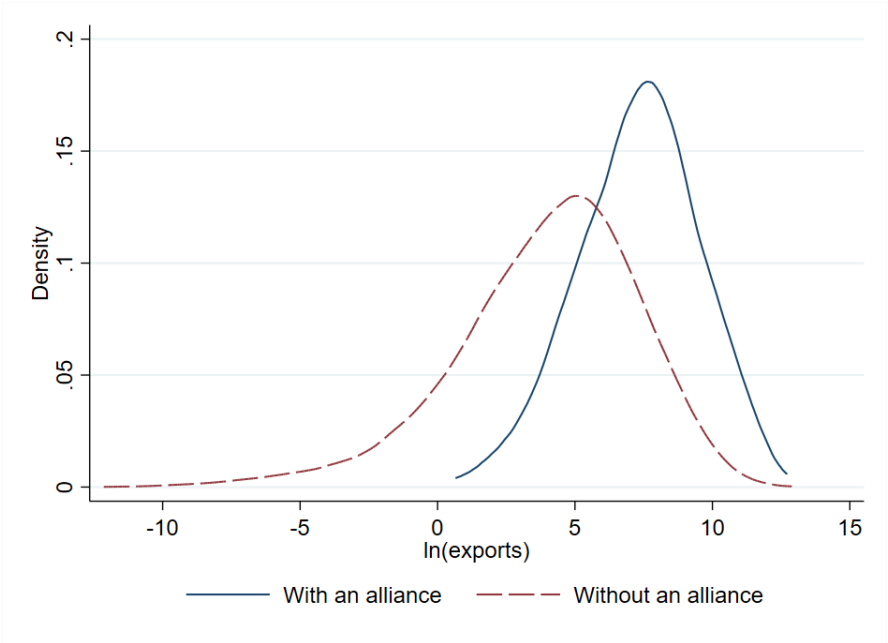
As shown by Vicard (2012), the signature of RTAs is linked to the risk of interstate conflict. Yet, the correlation between alliance enforcement and exports does not seem to be very dependent on the existence of RTAs. Figure 4 presents a further two density graphs. Graph 4a, displays export values depending on whether the pair has an RTA, an alliance, both or no agreement. Graph 4b reproduces graph 3 but with export values conditional on RTAs (i.e. exports unexplained by RTAs). Both graphs present interesting evidence that, irrespective of the existence of an RTA, enforcement of an alliance is positively correlated with bilateral exports.

Figure 2: Sample switches in alliance by country



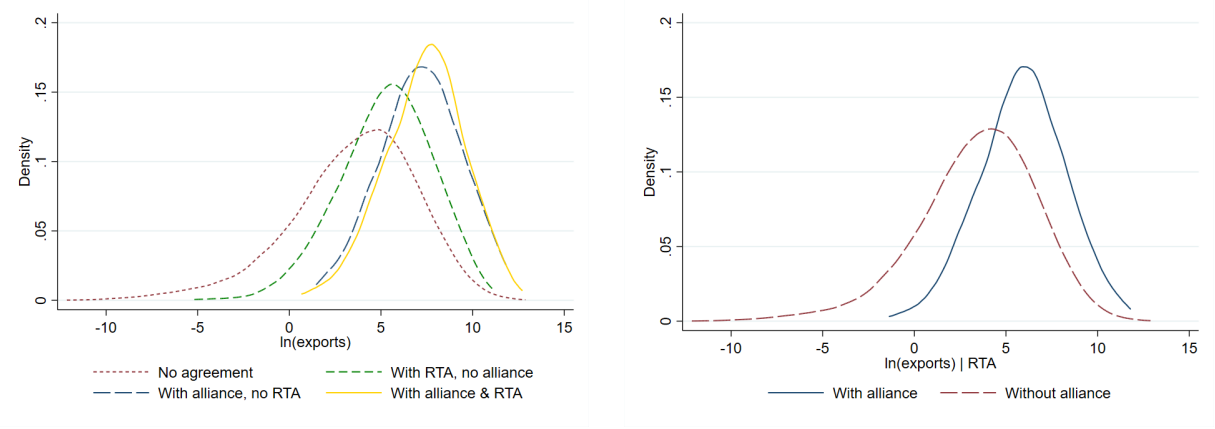
Note: Alliance switches are counted at country-pair level; 27 means that the country has signed or terminated a military alliance with 27 other countries from 1967 to 2012; white areas are countries excluded from our final sample.

Figure 3: Export values and alliances



Note: The K-density graph compiles exporter-importer exports for the latest year of available data (2012). It displays the distribution of country-pair exports depending on the presence or the absence of an alliance.

Figure 4: Export values, alliances and RTAs



(a) Export values

(b) Export values conditional on RTAs

Note: K-density graphs compile exporter-importer exports for latest year of available data (2012). Graph (a) displays the distribution of country-pair exports depending on the presence or the absence of an alliance or a Regional Trade Agreement. Graph (b) displays the distribution of country-pair exports unexplained by Regional Trade Agreements depending on the presence or the absence of an alliance.

4 Identification strategy

Following our theoretical discussion, the relationship between military alliances and exports can be estimated using a structural gravity model. Accordingly, our baseline specification is as follows:

$$X_{ijt} = exp(\beta_1 ALL_{ijt} + \beta_2 RTA_{ijt} + \lambda_{it} + \lambda_{jt} + \lambda_{ij}) * \epsilon_{ijt} \tag{3}$$

Our interest variable ALL_{ijt} is a dummy taking the value one if there is an alliance between country i and j at time t and zero otherwise. RTA_{ijt} is coded the same way as alliances, but for regional trade agreements. Alliances and RTAs may exist concurrently. Hence, we need to control for RTAs to capture any specific trade agreement effect between i and j.

λ_{it} and λ_{jt} the exporter-year and importer-year fixed effects. They capture the country, year and country-year-specific variables such as economic size and multilateral resistance terms (Baier and Bergstrand, 2007; Feenstra, 2015; Redding and Venables, 2004).[18] We also include exporter-importer fixed effects (λ_{ij}) to capture any omitted variables due to structural relations between countries such as distance, common language and colonial past. Military alliances active throughout the period are also captured. We hence estimate the within-effects of military alliances (i.e. country pair changes in status).[19]

[18] With this strategy, we focus on the bilateral effect of alliances (see the theoretical discussion in section 2). Any effect of alliances on trade through a reduction in multilateral insecurity costs are captured by the country-year fixed effects.

[19] We use a Poisson Pseudo Maximum Likelihood (PPML) estimator to retain a non-linear specification and address heteroscedasticity. In this way, we take into account zero trade observations and avoid the biases caused by a combination of log-linearisation and heteroscedasticity (Silva and Tenreyro, 2006). In addition, standard-errors are clustered at exporter-importer level.

Military alliances are expected to impact on all sectors by reducing insecurity costs. Yet, military alliances can also be associated with arms supply contracts. We therefore exclude the arms sector from the bilateral exports variable X_{ijt} to make sure that what is measured is a trade cost reduction and not a contract effect.

The reverse causality argument is unlikely to bias our baseline estimation. An alliance is not an economic treaty, but a long-lasting military pact with heavy political constraints. Therefore, to find a pair-specific export shock affecting the signature of a military alliance is a remote possibility. Nonetheless, we test alternative specifications and address residual endogeneity concerns in a further section.

4.1 Baseline Results

Table 2 reports the baseline results. The dependent variable is the exports from country i to country j in year t. The effect of military alliances on bilateral exports is positive and significant. Enforcing a military alliance increases bilateral exports by 60% on average. By contrast, the average effect of RTAs is 17%.[20] Translating the effects of alliances into tariff-equivalent variations under the standard trade elasticity calibration of $\theta = 3.7$[21] returns a tariff reduction of 12.8%. This equivalence appears reasonable given that we are dealing with a treatment assumed to have a sizeable impact on bilateral insecurity.[22] In subsequent sections, we are careful to test the robustness of this result and focus on understanding the heterogeneity and mechanism behind it.

4.2 Sensitivity analysis

This section proposes a battery of robustness checks for our baseline results.

Intra-national trade flows.– Data limitations are such that using intranational trade flows would significantly reduce our sample and limit the observation of military alliances' within-variations (see section 3 on data for more details). Thus, the baseline estimation considers international trade flows only. However, this means that the alliance coefficient cannot include the potential effect of alliances in terms of diverting trade from intranational flows to international flows (Dai et al., 2014). Therefore, as a robustness check, we replicate the baseline estimation using a smaller panel containing within-country trade flow data. Additionally, we follow Bergstrand et al. (2015) and control for the globalization trend

[20] Recently, Larch and Yotov (2023) reviewed estimated effects of RTAs in the literature depending on estimation strategies. They show that in structural gravity with PPML estimator, RTAs' coefficient should be around 0.14. With a coefficient of 0.16, our RTA estimate is in line with this general result.

[21] We directly estimate trade elasticity by including tariffs in the standard structural gravity estimation – see appendix table 28. The coefficient of $ln(1+tariffs)_{ijt}$ is directly interpretable as the trade elasticity(Anderson et al., 2018; Head and Mayer, 2014)

[22] In the literature, the negative effect of bilateral insecurity on trade is estimated between -35% and -80% depending on the proxy (Martin et al., 2008; Glick and Taylor, 2010). This assumption is directly treated (and confirmed) in section 7

Table 2: Exports and military alliances

Estimator:	PPML
Dependent variable:	Bilateral exports
Variables	(1)
Alliance	0.473^a
	(0.106)
RTA	0.161^a
	(0.033)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	320.666

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at country-pair level are in parentheses. a, b and c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

by interacting the year[23] with a dummy variable taking the value one for all intranational flows, and zero for international ones. Results are displayed in table 16 column 1.

Tariffs– We investigate the robustness of our results to the inclusion of tariffs. The tariff variable is defined as the log of the ad valorem exporter-importer-time average tariff rate plus one. The results of this sensitivity test are reported in table 16 column 2 to 4. The tariff coefficient is negative and significant. This additional control variable does not reveal any omitted variable bias. The lower coefficient of the alliance variable is merely the outcome of the considerable reduction in the timeframe and the country-pairs sample for our panel dictated by tariff data availability. To overcome this lack of country-pair-within variation due to the sample size, we include within-country trade flows – see column 5. This strongly increases alliances' coefficient as well as its precision. In addition, controlling for common GATT membership has no effect.[24]

RTA depth– In the baseline estimation, dummy variable RTA_{ijt} for the presence of an RTA between exporter and importer. This ensures that the coefficient of ALL_{ijt} is not biased by concomitant variations in RTAs and alliances. Yet, this method does not control for changes in RTA depth, which may be correlated with conflict related variables (Vicard, 2012). To address this point, we proxy RTA depth by the number of provisions in each agreement. We then introduce this new variable into our baseline estimation. We drop country-pair-year observations where an RTA is observed, but not its depth. Results are displayed in table 16 columns 6-7. We keep the RTA_{ijt} dummy in column one.

[23] Using a continuous variable for the year or a set of dummy variables does not affect our results.

[24] We introduced a dummy variable taking value one if both country i and j are members of the GATT. The alliance coefficient and standard error are unaffected by this additional control.

Its coefficient is not empirically interpretable since it corresponds to a fictive empty RTA (with no provision). In the second column, RTA_{ijt} is dropped. In both cases, the coefficient of ALL_{ijt} is barely affected. Furthermore, given that a substantial proportion of the countries in our sample are European, we include a control for common membership in the European Union in 16 column 9.[25] This does not affect our conclusions.

Distance and economic development.– Geographic distance and long-term differences in economic development are already captured by the country-pair fixed effect. Yet, both bilateral exports and signatures of alliance treaties could be affected by regionalisation or globalisation, i.e. by variations in transport costs and differences in economic development over time. Therefore, we build $ln(distance_{ij}) * year_t$ as an interaction variable between the distance and the year,[26] and $ln(|\frac{GDP_{it}}{Pop_{it}} - \frac{GDP_{jt}}{Pop_{jt}}|)$ as the log of the difference in per capita GDP in absolute value between exporter and importer. We include these variables in the baseline estimation. Results are reported in table 16 column 9. Their coefficients are weak and not significant, while the military alliance coefficient remains unchanged.

Extended Panel.– For quality reasons, our trade data limit our panel's sample of country-pairs and time-frame. We test the sensitivity of our results to alternative trade data allowing for a larger panel. We use the Correlate of War trade database (Keshk, 2017; Barbieri et al., 2009) to extend our panel from 46 to 143 years, and from 6,972 to 36,737 country pairs. Yet there are costs involved. First, we do not observe all country-pairs over the entire period. Second, data are not subject to the same harmonisation and verification process as CHELEM. This undermines quality, especially for developing countries. Third, we cannot exclude the arms sector. Results are reported in table 16 column 10 and 11.[27] We still observe a clear positive and significant effect of alliances on trade. Nonetheless, the data limitation and the panel change mean that we cannot directly compare with the baseline. After 2012, our panel is limited by alliances data. We proceed to an additional sensitivity test by extending our panel until 2020. We complete our sample using Alliance Treaty Obligations and Provisions (ATOP) data (Leeds et al., 2002).[28] ATOP has a larger time-coverage than the Correlate of War alliances data. Yet, ATOP is less precise and does not provide clear information about the content of treaties. Results are displayed in 16 column 12. The alliance coefficient is poorly affected by this additional panel extension.

Asymptotic bias.– Table 17 presents the corrected FE-PPML estimation developed by Weidner and

[25] The multilateral effect of being a member of the European union is captured the exporter-year and importer-year fixed effects.

[26] For ease of coefficient interpretation, the year variable is equal to the year minus 1966.

[27] In column 9, we do not control for RTAs to use the largest panel. Controling for RTAs in column 10 makes start the panel in 1948 instead of 1870.

[28] ATOP data stop in 2018. Yet, between 2019 and 2020, no alliance treaty has been reported by the United Nations. We assume, therefore, that the alliances active in 2019 and 2020 are the same as in 2018.

Zylkin (2021). The military alliance coefficient is affected by a small negative bias of the order of -0.01, while the associated standard error is slightly underestimated. Once the correction is applied, the alliance coefficient remains highly significant and very similar to the baseline.

Negative weights.– The baseline strategy is similar to a fixed-effects difference-in-differences estimation. Yet, the effects of military alliances could be dynamic.[29] In this case, a different effect would be found depending on the duration of the treaty, where the baseline coefficient would be the average. Moreover, the effects of military alliances on trade could also be heterogeneous across time and country pairs.[30] Therefore, our results could suffer from negative-weight biases (De Chaisemartin and d'Haultfoeuille, 2020). Thus, to address these econometric considerations, we regress equation (4) using the De Chaisemartin and d'Haultfoeuille (2024) estimator. The estimation is detailed in appendix section E. It concludes that signing an alliance increases bilateral exports by 40% at time t (the date of signature). The effect then gradually grows over time to attain 98% in $t+5$. Since the baseline results are the average of the effects of military alliances over time, the estimated effect of 60% is consistent with the observed dynamic and robust to the negative weights bias. De Chaisemartin and d'Haultfoeuille (2024)'s estimator is linear, which in a gravity setting may bias results (Silva and Tenreyro, 2006). Following Nagengast and Yotov (2023); Wooldridge (2023)'s method, which allows for ppml estimator, we confirm our results.

4.3 The heterogeneous effect of alliances

4.3.1 Heterogeneity of alliance treaties

There can be two types of alliances: *the weak alliances*[31] and *the defence pacts*. This distinction is based on the particularity of defence pact security cooperation policies (Gibler, 2008). In a nutshell, defence pacts are the only alliances designed to protect members from (common) external threats (see appendix section A for more details). We do not consider this distinction in the baseline. Yet, because of this fundamental treaty difference, we might expect defence pacts to have more of an effect on trade than weak alliances. Long (2003) provides a test of this difference using a non-structural gravity approach, concluding that only defence pacts are positively correlated with trade. In this section, we investigate whether the difference in alliance treaty categories produces heterogeneous effects, estimating within-effects using a structural gravity model.

We decompose the alliance variable into: i) a dummy taking the value one if there is an alliance with a defence pact between i and j at time t, and ii) another dummy taking the value one if there

[29] We properly discuss the dynamic effect of alliances in section 6.
[30] We extensively discuss the heterogeneous effect of alliances in the following section 4.3.
[31] Non-aggression pacts, neutrality pacts and ententes.

is an alliance without a defence pact between i and j at time t. Then, we replicate our baseline estimation. The results are reported in appendix table 18 column 1. Defence pacts increase bilateral exports by 100%, while the weak alliance coefficient is not statistically significant. This shows that a high level of military cooperation policies is required for alliances to affect trade. Moreover, the fact that defence pacts account for the majority of alliances explains the intensity of our baseline result – the latter is driven by the effect of very deep agreements. Conclusions are robust to the Cold War and the particularities of international relations during this period. A full discussion about the Cold War is provided in appendix section F. In addition, we test whether our results are driven by the largest defence pact in our sample – NATO. We create a specific dummy variable for the treaty and retain the defence pact dummy variable for the others.[32] The estimation results presented in table 18 column 2 confirm our conclusions.[33]

4.3.2 Bilateral elasticities

In line with standard gravity theory, trade cost elasticities – including insecurity cost's one – are constant in our model (Head and Mayer, 2014).[34] Yet, recent literature has shown that the trade elasticity is decreasing with the value of bilateral trade (Carrère et al., 2020; Chen and Novy, 2022). As developed in section 2, military alliances are expected to affect trade by reducing trade costs' sensitive to insecurity. Therefore, this section investigates whether the effects of military alliances on bilateral exports are concerned by bilateral trade elasticities.

In keeping with Carrère et al. (2020), we use the Method of Moments-Quantile Regression estimation (Machado and Silva, 2019):

$$\widetilde{X}_{q,ijt} = \beta_1 ALL_{q,ijt} + \beta_2 RTA_{q,ijt} + BZ_{q,ijt} + \lambda_{q,it} + \lambda_{q,jt} + \epsilon_{q,ijt} \tag{4}$$

$\widetilde{X}_{q,ijt}$ is the inverse hyperbolic sine transformation of $X_{q,ijt}$. $\lambda_{q,it}$ and $\lambda_{q,jt}$ are exporter-year and importer-year fixed effects, while q is a defined quantile and Z a vector of bilateral variables: distance, interaction between distance and year, colonial past, common language, common currency, common religion and territorial contiguity. Given the sub-divisions performed by the quantile estimator, introducing dyadic-FE would entirely capture the effect of our variable of interest. The estimator is linear. So, the dependent variable is the natural log of exports augmented by one. We regress the equation for each percentile. The obtained $ALL_{q,ijt}$ coefficients, with bootstrapped 95% confidence intervals,

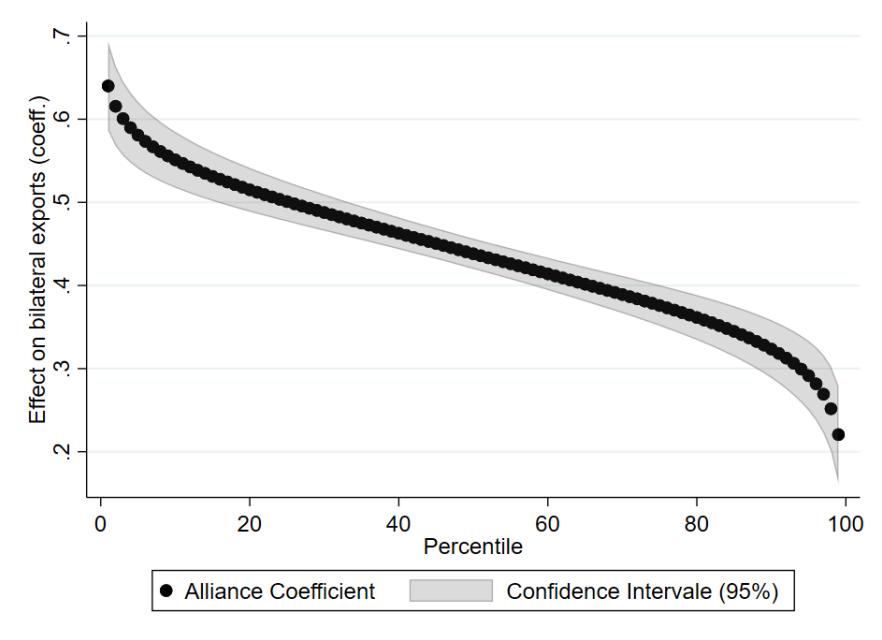
[32] Thus, in this estimation, the defence pact variable takes the value 0 if $NATO = 1$.

[33] In keeping with the definition of military alliances given by Gibler (2008), some recent NATO members (post-2003) are considered to belong to the international organisation, but not the alliance. We test the validity of our estimation including all NATO members in the alliance system. Results are barely affected.

[34] In equation 3, trade elasticities are determined by θ, the Pareto shape parameter of the productivity distribution which assumed to be constant across country-pairs.

are graphically displayed in figure 5. Similarly to the conclusions drawn by Carrère et al. (2020) with respect to distance, the alliance coefficients are decreasing in the value of trade. We plot the RTA coefficients in appendix graph 9. They also show a decrease in coefficients with the size of exports.[35]

Figure 5: Quantile estimates of alliances



Two main conclusions are drawn from these results. First, the effect of military alliances on trade depends negatively on the value of bilateral flows. This implies that small country-pairs benefit the most from the signature of a military alliance. Second, military alliance coefficients behave in the same way as variables that clearly affect trade through trade costs. This points to an alliance effect through a trade cost reduction mechanism. In appendix section B.3, we discuss the consistency of the bilateral trade elasticities with our theoretical framework and provide an extension of our gravity model.

5 Endogeneity

This section takes the identification of the causal effects of military alliances on trade a step further. Indeed, we still need to address potential reverse causality (a trade shock affecting the alliance signature decision) and country-pair-time varying omitted variables (such as a bilateral geopolitical shock). For this purpose, we develop an instrumental variable approach based on common outside alliances. The intuition behind this is the domino-like spread of international agreements, as tested for RTAs or

[35] Another way to test the presence of bilateral trade elasticities is to change the weight of observations in our baseline. Using import share as the dependent variable, we increase the weight of observations with small export flows (Sotelo, 2019). We report the results in appendix table 16 column 13. In line with our findings, we observe higher coefficients for both alliances and RTAs. Furthermore, adding in our baseline an interaction between ALL_{ijt} and country-pair specific weights $(\frac{\sum_{k\neq j} X_{ik,t-1}}{\sum_k X_{ik,t-1}} * \frac{\sum_{k\neq i} X_{kj,t-1}}{\sum_k X_{kj,t-1}})$ capturing to what extent each partner is relatively important for the other in its total trade, we also observe a negative correlation between the alliance effect and the relative importance of X_{ij}.

regionalism by Baldwin and Jaimovich (2012). Common allies present similar military interests and the inability of one country in the pair to use its alliances in a conflict against the other. Therefore, if countries i and j have many allies in common, it is highly probable they will develop an alliance together, while in partial equilibrium (i.e. controlling for aggregated prices, output and expenditures) the change in bilateral insecurity costs with external partners should not directly affect the trade inside the pair. We want to avoid capturing the inverse relation: an increase of the common outside alliances because of the signature of an alliance between countries i and j. Therefore, we ignore variations in common outside alliances while countries i and j are allied.[36] Additionally, we exclude also from the sum the alliance between country-pair ij – the country-pair of interest. Thus, we can write the instrumental variable as follows:

$$IV_{ijt} = \begin{cases} \sum_{k \neq i,j;t_{all}} (ALL_{ikt_{all}} * ALL_{kjt_{all}}), \text{ if } \exists t_{all}, t > t_{all} \ \& \ ALL_{ijt} = 1 \\ \\ \sum_{k \neq i,j;t} (ALL_{ikt} * ALL_{kjt}), \text{ otherwise} \end{cases} \tag{5}$$

We use an OLS/PPML two-stage approach to keep the IV strategy comparable with the baseline and prevent log-linearisation under heteroscedasticity from biasing our estimates (Silva and Tenreyro, 2006). In the first stage, we use OLS to estimate the effect of the IV on the probability of signing an alliance. The predicted probability is used to compute the instrumented alliances. Then, we estimate with a PPML the effect of the instrumented alliances on bilateral exports. In the second stage, clustered standard-errors are bootstrapped.[37] Results are reported in table 3. The (instrumented) military alliance coefficient is strongly positive and significant.[38] Therefore, the IV estimation confirms the causal interpretation of the effects of military alliances on trade.[39]

Using a non-linear second-stage estimator may induce consistency issues. Lin and Wooldridge (2019) recommend a control-function approach to address this. Instead of using alliances' predicted probabilities, we include first-stage residuals as control. Results, reported in appendix table 20, confirm the OLS/PPML two-stage conclusions. In addition, the control-function approach allows testing the

[36] Formally, as long as countries i and j are allies, we set the value of the sum of their common outside alliances at the year of signature t_{all}

[37] Bootstrapping not only the second stage but the whole process does not affect results.

[38] We observe a higher coefficient compared with the baseline results. This is due to alliance selection induced by the IV. By targeting alliances included in an international network, we mechanically select defence pacts, which tends to increase coefficient (see section 4.3.1). Reduction in second-stage standard errors results simply from bootstrapping.

[39] Supplementary sensitivity tests are performed on the IV results. Results are robust to the inclusion of an interaction variable between distance (in log) and year, which controls for the globalisation dynamic. To avoid potential biases due to RTA endogeneity, we also run an estimation in which we instrument them by common outside RTAs ($\sum_{k \neq i,j;t} RTA_{ikt} * RTA_{kjt}$). This does not affect the instrumented alliance coefficient. We provide a 2SLS estimation in appendix table 19. The alliance coefficient is still positive and significant. Yet, the OLS and 2SLS gravity estimations induce biased coefficients and standard errors – due to log-linearisation under heteroscedasticity (Silva and Tenreyro, 2006) – and observation weights different to PPML (Sotelo, 2019).

baseline's sensitivity to omitted variable concerns. The coefficient of the first-stage residuals is directly interpretable as the omitted variable bias addressed by the IV. Interestingly, focusing on defence pacts (column 2), the residuals' coefficient is significantly smaller, suggesting that defence pacts are less concerned by omitted variable issues than weak alliances. [40]

Table 3: Alliances and bilateral exports, IV

Dependent variable:	exports
Second stage	(1)
Estimator:	PPML
Instrument variable:	Common out. alliances
Alliance	0.655[a]
	(0.026)
RTA	0.159[a]
	(0.011)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	320.666
First-stage	
Estimator:	OLS
Instrumented variable:	Alliance
Common out. alliances	0.056[a]
	(0.007)
RTA	0.011
	(0.008)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	320.712
KPW F-stat	67
KPW LM-stat	11

Note: OLS, Ordinary Least Squares; FE, Fixed effects. Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at the exporter and importer levels are in parentheses. Second-stage standard errors are bootstrapped. a, b and c denote significantly different from 0 at the 1%, 5% and 10% level, respectively.

5.1 IV validity

The IV approach is based on the assumption of non-violation of the exclusion restriction. The common outside alliances can impact country i's exports to j only through enforcement of an alliance. If, as discussed the theoretical section 2, in partial equilibrium alliances affect trade only through a reduction in bilateral insecurity costs, our IV should respect this restriction. Yet, in a logic of geopolitical

[40] Furthermore, coefficients of instrumented alliances and defence pacts are very similar, which supports that defence pacts drive the estimated causal effect on trade.

alignment on international scene, the signature of an alliance may lead to a variation in trade costs with non-signatory partners. To qualitatively test it, we create two dummies: $ALL^{out}_{i,-j,t}$ and $ALL^{out}_{-i,jt}$. $ALL^{out}_{i,-j,t}$ takes value 1 if the exporter has signed an alliance with any country other than j (i.e. an outsider) and zero otherwise. Similarly, $ALL^{out}_{-i,jt}$ takes value 1 if the importer has signed an alliance with any country other than i. Both $ALL^{out}_{i,-j,t}$ and $ALL^{out}_{-i,jt}$ can be estimated in the presence of exporter-year, importer-year and country-pair fixed effects since they are country-pair-year specific (Dai et al., 2014). Both dummies are introduced in equation (4) estimated by a PPML. We report the results in appendix table 21.[41] $ALL^{out}_{i,-j,t}$'s and $ALL^{out}_{-i,jt}$'s coefficients are not significantly different from zero. So, on average, signing an alliance with an outsider does not affect exports from country i to j.[42] This result points to the validity of the instrument's exogeneity assumption.

Furthermore, we perform a *plausible exogeneity test* proposed by Conley et al. (2012). The approach aims at supporting the validity of our results even in the presence of a reasonable deviation from perfect alignment with the exclusion restriction assumption. We relax the assumption by allowing for ν, the correlation between the instrumental variable (common outside alliances) and errors, to deviate from zero. We then test whether the estimate of the instrumented variable (ALL_{ijt}) is robust to such a deviation from the exclusion restriction.

The union of confidence interval method calls first for setting the minimum (or maximum) value ν can take. To approximate this, we regress bilateral exports on the endogenous variable (ALL_{ijt}) and the instrumental variable (common outside alliances) with our standard set of fixed effects and controls. The coefficient associated with the IV represents an approximation of the degree of deviation from the exclusion restriction (Kippersluis and Rietveld, 2018). We obtain a small coefficient (-0.030). We then plug this degree of deviation into the plausible exogeneity test. In this way, we obtain the estimation of the (instrumented) alliance coefficient's upper and lower bounds under the relaxation of the exclusion restriction (see table 4).[43] The interval [0.408 ; 1.106] does not contain zero. Thus, we can safely argue that military alliances have an unambiguous positive causal effect on bilateral exports.

[41] We run the same estimation in column two, but decompose the ALL_{ijt} dummies into defence pacts and weak alliances. This does not affect the results.

[42] Our time frame include the Cold-War. During this period because strong geopolitical *blocks* of countries existed, signing an alliance with a country of on block may reduce trade with members of the other one. We further discuss this issue in the appendix section F. We show that in this specific context such a reduction in trade applies, but also that it the Differenced Average Treatment on the Treated approach we develop in a further section (6) perfectly addresses this issue.

[43] The Conley et al. (2012) estimator is based on the 2SLS estimator. We therefore have to log-linearise the gravity equation. We use the inverse hyperbolic sine transformation of exports to capture zero values. As discussed previously, log-linearisation under heteroscedasticity could bias the alliance coefficient. Nevertheless, estimated bounds are consistent with the OLS/PPML two-stage estimation which addresses this bias.

Table 4: Plausible exogeneity test

Dep var: exports	*Union of Confidence Interval estimations*		
Instrumented var.	ν	Min	Max
	-0.030	95% CI	95% CI
Alliance		0.408	1.106

Note: UCI based on the IV's ν coefficient from a regression of exports on interest variables and the IV

6 The dynamic effect of alliances

So far, we have focused on the within-average effect of alliances. However, alliances may require time to be fully effective and increase bilateral trade dynamically. Applying a simple event study approach on our baseline does not permit to identify the dynamic effect of alliances in the absence of pre-trend (see graph 10 in appendix). Therefore, we develop in this section a Differenced Average Treatment on the Treated (DATT) approach based on Couch and Placzek (2010). In the light of the results in section 4.3.1, we choose to increase the precision of the analysis by focusing on defence pacts. Therefore, we decompose variable ALL_{ijt} into *defence pacts* and *weak alliances*. Then, we estimate the defence pact DATT, using weak alliances as a control variable.

The observation of a pre-trend in the simple event-study suggests the presence of a selection bias. To address this issue, we perform dynamic propensity score matching on a staggered sample.[44] We define the propensity score $p(x_{ijt})_t$ as the likelihood of signing a defence pact conditional on a set of standard observable gravity variables. The propensity score is estimated for each separate year from 1967 to 2012. In this way, depending on the year, the variables are allowed to affect $p(x_{ijt})_t$ differently. Each treated country-pair observation is matched on $p(x_{ijt})_t$ with an untreated country-pair. A country-pair with no defence pact, but having had one in the past is never used as a control observation. We obtain a set of country-pair-year observations matched on $p(x_{ijt})_t$.[45]

In keeping with Couch and Placzek (2010), we estimate the equation:

$$X_{ijt} = exp(\sum_{k>k'} \delta^k D^k_{ijt} + \beta_2 Weak.ALL_{ijt} + \beta_3 RTA_{ijt} + \lambda_{it} + \lambda_{jt} + \lambda_{ij}) * \epsilon_{ijt} \quad (6)$$

k' must be a year or period prior to the year of signature of a defence pact between countries i and j. D^k_{ijt} is a dummy variable equal to 1 if t is the k^{th} year after (or the k^{th} year before if -k) the signature of a defence pact between countries i and j. $Weak.ALL_{ijt}$ and RTA_{ijt} are dummy

[44] This implies that previously treated country-pairs can never be part of the control group.

[45] See the appendix tables 22 and 23 for more details on dynamic propensity score matching. We evaluate the extent to which the matched treated and control groups are similar. We consider the standardised difference in means (B) and the variance ratio (R). To conclude that the groups are comparable, B must be inferior to 0.25, and R between 0.5 and 2 (Rubin, 2001; Stuart and Rubin, 2008). After matching, we obtain $B = 24.7\% < 25\%$ and $0.5 < R = 1.7 < 2$. Thus, in the set of matched observations, the control and treated groups are well balanced.

variables controlling respectively for the presence of a weak alliance and an RTA between countries i and j at time t. λ_{it}, λ_{jt} and λ_{ij} are respectively exporter-year, importer-year and exporter-importer fixed-effects. We use a PPML estimator.

The DATT compares the difference in bilateral exports between years k and k' for a country-pair signing a defence pact during our period, indicated by $D_{ij} = 1$, to the difference in bilateral exports between years k and k' for a country-pair with no defence pact, indicated by $D_{ij} = 0$. The expected difference between the year-to-year difference in exports is estimated for the set of treated country-pairs relative to the matched set of non-treated pairs (Couch and Placzek, 2010).

The results of the DATT estimation are graphically represented in figure 6. More details are provided in appendix table 24. t_{def} is the date of the defence pact's signature. We choose $k' <= t_{def}-5$. So, all k are estimated in comparison to $k' <= t_{def} - 5$ (the natural trend). As soon as the treaty is signed, the defence pact has a positive and significant effect on exports from i to j. In the following years, the effect keeps growing to stabilize in $t_{def} + 5$. Given that t_{def} the date of signature and not of enforcement, this period can be interpreted as the time of adjustment required for the defence pact to become effective and fully operational. For $k >= t_{def} + 5$ (the treated trend), the average estimated effect confirms our previous results: following their signature, defence pacts increase bilateral trade by 79%.[46] Moreover, for any $k < t_{def}$, we obtain a weak and insignificant coefficient. Therefore, the measured effect for any $k >= t_{def}$ is independent of any pre-trend.[47] Thus, in the light of our results, we can safely conclude that the defence pacts have an unambiguous gradual, positive and causal effect on trade.

7 From alliances to trade: the mechanism

This section analyses the mechanism behind the positive effect of alliances on trade.[48] As discussed in the theoretical section 2, alliances should affect trade by reducing the international insecurity between members. The first source of insecurity these treaties address is the risk of conflict between signatories.[49] Yet, several pieces of evidence support that this channel does not apply. First, in section 4.3.1, we show that the alliances focusing on the reduction on reducing the probability of conflict between signatories (i.e. the weak alliances) have no impact on bilateral trade. Second, in data, interstate

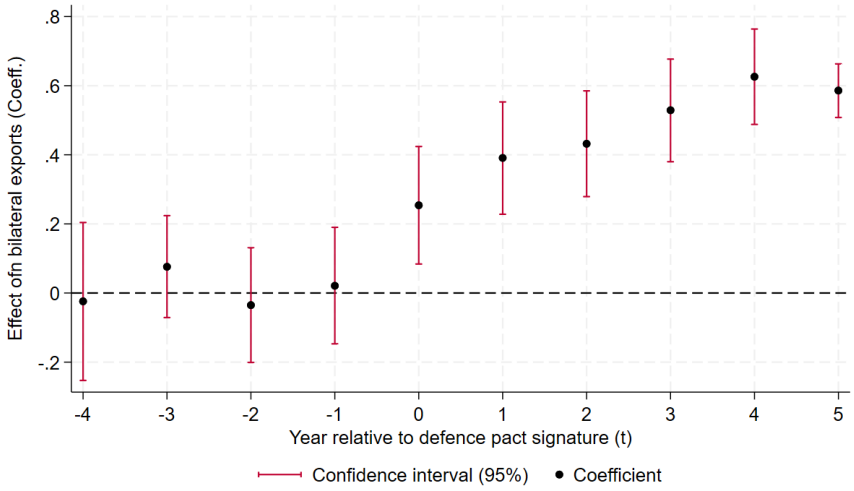
[46] Since the data set is staggered, the DATT estimates only the entry effect (switches from 0 to 1). In previous estimation strategies, both entry and exit are considered.

[47] DATT results are also robust to the cold war. See the full discussion on the cold war in section F.

[48] Most previous empirical papers focusing on the link between military alliances and trade consider that alliances affect exports because signatories are more inclined to reduce tariffs or sign RTAs with their allies (Long, 2003; Long and Leeds, 2006; Mansfield and Bronson, 1997). Yet, our baseline estimation includes RTAs as a control variable, while our analysis shows that our baseline results are barely sensitive to the inclusion of tariffs and RTA depth (see section 4). Therefore, this mechanism is excluded.

[49] See treaties description in appendix section A.

Figure 6: Dynamic effect of defence pacts on bilateral exports (DATT)



Note: Figure plots results of the DATT estimation of the defence pacts' effect on bilateral trade. Every time k is compared to $k' <= t_{def} - 5$. The last period includes $k >= t_{def} + 5$. Estimator is PPML. Standard errors are clustered at the country-pair-year level.

conflicts are extremely rare in our panel.[50] Therefore, we do not observe that interstate conflicts are the counterparts of the absence of an alliance. Extending the risk of conflict in the country pair to geopolitical tensions, we estimate the effect of defence pacts on the common United Nations votes of the country-pair.[51] Results are reported in the appendix table 25. Defence pacts' effect is extremely low (+2%) while the weak alliances have no significant impact.[52] This supports that alliances do not increase trade by reducing the probability of conflict between signatories.

Nevertheless, defence pacts' content is not limited to the reduction of interstate conflicts between members. These alliances are designed to enforce deeper security cooperation aimed at addressing any source of insecurity that concerns both signatories. Indeed, as we can observe in the data, conflict events are, in the extremely large majority, related to fights against non-state organized actors (terrorism, civil wars, piracy, armed factions).[53] Taking into account the complexity of conflicts, we therefore use a broader measure of bilateral insecurity:

$$INS_{ijt} = \sum(conflict_event_{it}) * \sum(conflict_event_{jt}) \tag{7}$$

[50] Using the Military Interstate Dispute database from the Correlate of War project (Palmer et al., 2022) , we find in our sample only 86 observations (exporter-importer-time) with an active war. Following (Martin et al., 2008) by including lower magnitude conflicts (starting at simple display of force), we find only 1578 exporter-importer-time observations with an active interstate conflict – 436 happening while an alliance is active. Performing a linear probability estimation with our full set of fixed effects, we do not observe any significant effect of alliances on the probability of interstate conflict.

[51] For this purpose we use the United Nations General Assembly Voting Data from Voeten (2013).

[52] We estimate the effect of alliances on common UN votes at the country-pair-time level. The dependant variable being a count we use a PPML estimator. Since we want to capture the degree of geopolitical convergence the dependant variable includes only expressed votes while we control for abstention. In column (2) we use our instrumental variable. This does not affect our conclusions.

[53] Using UCDP data – see section 3 – between 1989 and 2012 we observe 120.029 conflict events.

the interacted country-time sums of conflict events between i and j.[54]

We use two-stage estimations to look at the effect of defence pacts on exports by means of the variation of INS_{ijt} they enforce. The set of fixed effects is the same as in the baseline. This implies that the independent level of insecurity of country j or in country j at time t are controlled which ensures that we capture only the country-pair specific variation of INS_{ijt}. For interpretation reasons, we use the inverse hyperbolic sine transformation of INS_{ijt}.[55] Due to data limitations with respect to conflict events, we use a sub-sample starting in 1989. The results are displayed in table 5.[56] Column 1 presents the defence pact dummy variable. To further address possible endogeneity, we replace it in column 2 with common outside defence pacts.[57]

In the first-stage estimations, we observe a strong negative effect of defence pacts on bilateral insecurity. In column 1, we estimate that the enforcement of a defence pact reduces bilateral insecurity by 69%. Then, in the second-stage results, we observe in both specifications that the reduction in bilateral insecurity enforced by defence pacts (or common outside defence pacts) has a significant positive effect.[58] Thus, we estimate that, by reducing bilateral insecurity, defence pacts raise exports by 49.5%. In this sub-sample, this is equivalent to almost 100% of the total defence pact effect.

Alternatively, we test the insecurity mechanism estimating the effect of defence pacts on exports through the variation of $\sum coop.mil.ev._{ijt}$, the sum of the country-pair's cooperative military events. Contrary to INS_{ijt}, this does not directly target insecurity, but the enforcement of the military cooperation that reduces insecurity. Yet, we identify a purely bilateral variation. We report the two-stage estimations in appendix table 26.[59] Results strongly support both the validity and prevalence of the insecurity mechanism: by signing defence pacts, members sharply increase their effective security cooperation which ensures an important reduction in country-pairs insecurity and leads to an increase in trade between signatories.

7.1 Margins of international insecurity

As outlined in the theoretical section 2, alliances can reduce international insecurity through two distinct margins. First, they can decrease the probability of country-pairs facing international insecurity (the extensive margin). Second, they can decrease the intensity of the insecurity that country-pairs

[54] Military cooperation events capture a reduction in insecurity rather than an increase. They therefore need to be excluded for an accurate measurement of bilateral insecurity.

[55] We test different functional forms. This does not affect the robustness of our results. In addition, given that on average $INS_{ijt} = 14622$, we are not exposed to approximation errors using the inverse hyperbolic sine transformation (Bellemare and Wichman, 2020).

[56] As in section 5, we use a two-stage OLS/PPML estimator to prevent log-linearisation under heteroscedasticity from biasing our results (Lin and Wooldridge, 2019; Silva and Tenreyro, 2006). The control-function approach provides similar results.

[57] We construct this variable in the same way as the IV in section 5 but restricting it to defence pacts.

[58] The bilateral insecurity coefficient is negative since it expresses the effect of a *rise* in insecurity.

[59] $\sum coop.mil.ev._{ijt}$ measures the opposite of INS_{ijt}. Therefore, the second-stage coefficient is positive: defence pacts make for a sharp increase in military cooperation, which makes for a sharp increase in trade.

Table 5: The bilateral insecurity reduction

Second stage	(1)	(2)
Estimator:	PPML	
Dependent variable:	Exports	
Bilateral insecurity	-0.346^a	-0.311^a
	(0.049)	(0.045)
Weak alliance	-0.227	-0.286^c
	(0.152)	(0.149)
RTA	0.040	0.041
	(0.036)	(0.033)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	167.304	167.304
First-stage		
Estimator:	OLS	
Dependent variable:	Bilateral insecurity	
Defence pact	-1.162^a	
	(0.148)	
Common out. def. pacts		-0.076^a
		(0.009)
Weak alliances	-0.213	-0.130
	(0.243)	(0.242)
RTA	-0.165^a	-0.168^a
	(0.060)	(0.060)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	167,328	167,328

Note: OLS, Ordinary Least Square; PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects. The panel starts in 1989. Common defence pacts sum all external partners for which country i and j both have a defence pact. Robust standard errors clustered at country-pair level are in parentheses. Second-stage standard errors are bootstrapped. a, b and c denote significantly different from 0 at the 1%, 5% and 10% level, respectively

experience (the intensive margin). To examine the contribution of each margin, we proceed in two distinct estimations. Specifically, we estimate the effect of alliances on a binary variable that takes the value one if our measure of bilateral insecurity (see eq. 7) is positive, thereby capturing the extensive margin. Then, we re-estimate the effect of alliances on bilateral insecurity, as in table 5's first stage, but capture the intensive margin by excluding all exporter-importer-year observations with null bilateral insecurity. We report results in table 6. As previously, we focus on defence pacts. They decrease the yearly probability of bilateral insecurity by 11.5% while they have no impact on the intensity of insecurity when it occurs. Thus, the whole effect of alliances goes through the extensive margin of international insecurity. Furthermore, using an event study approach (see appendix graphs 11), we confirm the significance of the defence pacts' effect over time, the progressiveness observed

in our dynamic analysis (see section 6) and the robustness of the results to negative weights issues (De Chaisemartin and d'Haultfoeuille, 2020; Wooldridge, 2023).

Given that in this sub-sample the elasticity of trade with respect to defence pacts, denoted as $\varepsilon_{Def.}(X_ij)$, is estimated at 0.402 (i.e. 49.5%),[60] we can now derive its components. In our theoretical model, insecurity costs are defined by $\tau_{ij}(s) = 1 + E_{ij}(1/(1 - I_{ij}) - 1)$, where E_{ij} represents the extensive margin of international insecurity and I_{ij} the intensive margin. The elasticity of trade with respect to $\tau_{ij}(s)$ is $\theta = 3.7$,[61] the elasticity of E_{ij} with respect to defence pacts is 0.115 while I_{ij} is held constant. Consequently, the elasticity of trade with respect to defence pacts, and thereby the insecurity mechanism, are defined as follows:

$$\varepsilon_{Def.}(X_{ij}) = \theta \star (\frac{1}{1 - I_{ij}} - 1) \star \varepsilon_{Def.}(E_{ij}) = 3.7 \star (\frac{1}{1 - 0.487} - 1) \star 0.115 = 0.402 \quad (8)$$

This equation underlines two important conclusions. First, the intensity of bilateral insecurity is substantial. With $I_{ij} = 0.487$, this means that, in the event of international conflict, a traded product is 48.7% likely to be expropriated. Second, decreasing the risk that trade partners face such insecurity leads to a substantial reduction in trade costs which explains the significant effect of alliances on exports.

Table 6: Margins of insecurity and defence pacts

Estimator:	OLS	
Dependent variable:	Extensive margin	Intensive margin
Variables	(1)	(2)
Defence pact	-0.115^a	-0.051
	(0.014)	(0.086)
Weak alliance	-0.016	0.062
	(0.024)	(0.129)
RTA	-0.012^b	-0.137^a
	(0.005)	(0.043)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	167,328	11,718

Note: OLS, Ordinary Least Square; FE, Fixed effects; Dependent variables are respectively in column one and two a dummy taking the value one if the country pair faces bilateral insecurity ($INS_{ijt} > 0$) and our bilateral insecurity proxy INS_{ijt}. In column two, the sample excludes country-pair-year observations whose dependent variable (INS_{ijt}) is equal to zero. Standard errors clustered at country-pair level are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

[60] Our baseline analysis begins in 1967, while our estimations utilizing conflict event data commence in 1989. We replicated estimation 1 from appendix table 18 using this sub-sample.

[61] See appendix table 28 for estimation details.

8 General equilibrium and welfare implications

We investigated so far the direct effect of alliances on trade. In this section, we complete our analysis by considering the General Equilibrium (GE) impact – i.e. allowing for changes in aggregated prices, output and expenditures – and derive the welfare gains from alliances.[62] Following the theoretical model presented in section 2 and detailed in section B, we can characterise the GE in four equations:

$$X_{ij} = N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} \tau_{s,ij}^{-\theta} T_{n\neq s,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]} \tag{9}$$

$$\Pi_i^{-\theta} = \sum_j \frac{\tau_{s,ij}^{-\theta} T_{n\neq s,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]}}{\Phi_j^{-\theta}} X_j \tag{10}$$

$$\Phi_j^{-\theta} = \sum_i \frac{\tau_{s,ij}^{-\theta} f_{s,ij}^{-[\frac{\theta}{\sigma-1}-1]} T_{n\neq s,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]}}{\Pi_i^{-\theta}} Y_i \tag{11}$$

$$\overline{\alpha}_i w_i = \left(\frac{Y_i}{\Pi_i^{-\theta} N_i}\right)^{-\frac{1}{\theta}} \tag{12}$$

Equation (9) is the structural gravity relation presented in section 2 above. Π_i and Φ_j are respectively the outward and inward multilateral resistance terms. [63] Y_i is country i's total output and $\overline{\alpha}_i w_i$ the maximum factory gate price – the marginal cost at the lowest productivity to which a firm can draw in country i.[64]

In this frame, in keeping with Arkolakis et al. (2012), we can summarise the welfare effect of a change in insecurity costs due to military alliance enforcement in a few parameters. Welfare is defined as the real revenue ($\frac{Y}{\Phi}$). Thus, any change in welfare follows the equality:

$$dln(W_j) = dln(Y_j) - dln(\Phi_j) \tag{13}$$

Military alliances contend with bilateral and reciprocal shocks on variable and fixed trade costs sensitive to insecurity. Based on such shocks, we can desegregate country j changes in welfare as follows:

[62] Note that in this exercise we focus on the gains from the cooperation induced by alliances. In our baseline estimation, military expenditures were captured by fixed effects, while in the general equilibrium they are hold constant.

[63] Φ_j in eq. 11 is obtained by replacing in eq. 9 $N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} = \frac{Y_i}{\Pi_i^{-\theta}}$, which is derived from the market clearance: $Y_i = \sum_j X_{ij}$.

[64] Equation 12 implicitly assumes that alliances do not affect multilateral insecurity costs ($\tau_{s,i}$). Yet, relaxing this assumption does not impact the GE system. As discussed by Anderson et al. (2018), in an endowment economy the composition of the factory-gate price does not affect the system. In practice, by allowing output-price ratios to adjust to alliances, the GE takes into account any effect that alliances may have on trade or welfare through multilateral insecurity costs. Furthermore, we show bellow that by making bilateral insecurity endogenous we capture a multilateral dimension through the impact of wages on insecurity. Nonetheless, in appendix section D we further discuss the importance of considering multilateral insecurity and show that in partial equilibrium alliances have a pure bilateral effect.

$$dln(W_j) = dln(w_j) - \sum_{i=1}^{n} \psi_{ij} \left[dln(w_i) + dln(\tau_{s,ij}) \right] \tag{14}$$

Therefore, welfare changes induced by military alliances can be derived from a system of a few parameters: initial trade shares (ψ_{ij}), wages (w_j and w_i) and insecurity costs ($\tau_{s,ij}$).[65]

8.1 Endogenous insecurity

In this model, alliances are treated as exogenous. However, changes in the economic conditions may also affect insecurity (Martin et al., 2008; Thoenig, 2023). Given that the observed international insecurity is largely driven by non-state actors (see section 7), we model this interplay using a simplified appropriation game (Couttenier et al., 2023). For each country-pair ij, there exists an armed group G_{ij} of size L_{ij}. In each period, members of the group can either work and earn the local wage w, or fight and expropriate a share of traded products υ.[66] To engage in fighting, groups must combine labor from the exporting country l_i, the importing country l_j and external sources l according to the Cobb-Douglas function: $L_{ij} = l_i^{\eta_1} * l_j^{\eta_2} * l^{\eta_3}$ with $0 < \eta < 1$. Additionally, when fighting, each group faces a country-pair-specific level of security s_{ij} which acts as a marginal cost on expropriation. Alliances affect groups behavior by rising s_{ij}. Finally, groups draw a motivation parameter $1/\zeta_{ij}$ following an inverse pareto distribution $\zeta^{\delta}/\overline{\zeta}^{\delta}$ with $0 < \delta < 1$ and $1/\overline{\zeta}$ the minimum motivation a group can draw. Thus, ζ_{ij} captures that most of groups are driven by exogenous ideological or political motivations and tends to over-evaluate gains from fighting, while δ defines how respond to changes in economic and security variables.

The group G_{ij} attacks the country-pair if its gains from fighting (expropriation) exceed the gains from peace (wages). From this framework, we can derive the intensive and extensive margins of insecurity (see appendix section C) and define how trade and wages endogenously determine $\tau_{s,ij}$ as follows:

$$\tau_{s,ij} = 1 + E_{ij}\left(\frac{1}{1 - I_{ij}} - 1\right) = 1 + (\upsilon X_{ij})^{\delta} s_{ij}^{-\delta} \overline{\zeta}^{-\delta} \left(\frac{w_i}{\eta_1}^{\eta_1} \frac{w_j}{\eta_2}^{\eta_2} \frac{w}{\eta_3}^{\eta_3}\right)^{-\delta} \left(\frac{1}{1 - L_{ij}\upsilon} - 1\right) \tag{15}$$

First, we observe that s_{ij} has a negative elasticity. By increasing s_{ij}, alliances reduce the probability of fighting, thereby decreasing bilateral insecurity. Second, the elasticity of insecurity with respect to trade X_{ij} is positive. Following a rent-seeking mechanism, an increase in trade raises revenues from

[65] Including fixed insecurity costs the welfare equation is: $dln(W_j) = dln(w_j) - \sum_{i=1}^{n} \psi_{ij} \left[dln(w_i) + dln(\tau_{s,ij}) + (\frac{1}{\sigma - 1} - \frac{1}{\theta}) dln(f_{s,ij}) \right]$. Knowing that we have $dln(\tau_{ij}(s)) = \varepsilon_{ln(\tau_{s,ij})}(ALL_{ijt})$ and $dln(f_{ij}(s)) = \varepsilon_{ln(f_{s,ij})}(ALL_{ijt})$, we do not need to identify changes in insecurity costs, but only changes in alliances.

[66] Since alliances do not affect the share of expropriated products when groups fights – i.e. the intensive margin of insecurity (see section 7) – we assume that υ is a constant. Assuming a G_{ij} specific υ does not affect the results.

expropriation, thus increasing the risk of insecurity. Third, wages exhibit negative elasticity. While trade increases the gains from expropriation, higher wages raise the returns from peace, reducing the likelihood of group G_{ij} choosing to fight. However, since groups can substitute members from different origins (i, j and external), this mitigates the effect of changes in wages. Including endogenous insecurity in our general equilibrium induces a significant interplay between economic and security variables. By reducing international insecurity, alliances increase trade, raise wages, and in turn, affect insecurity and economic variables again.

8.2 GE Empirical application

This General Equilibrium system can be solved using the Anderson and Yotov (2016) methodology and its extension in Anderson et al. (2018) which we adapt to bilateral insecurity. We construct a counterfactual global economy in which no alliance exist - i.e. with the level of international insecurity that would apply in the absence of alliance.[67] By comparing the counterfactual level of exports and real revenues with the baseline, we can assess the GE gains (or losses) in trade and welfare of countries from the observed network of alliances.

We first estimate the partial equilibrium (eq. 9)[68] to capture military alliance elasticity and estimates of bilateral trade costs.[69]We develop our analysis for the year 2012 – the last year in our panel. To retrieve baseline multilateral resistance, we estimate the gravity equation for 2012 imposing bilateral trade costs and elasticities from the previous step.[70] We define our counterfactual as the absence of alliance. To obtain the counterfactual multilateral resistance terms, we again estimate the constrained gravity equation setting $ALL_{ijt} = 0$. We then determine the endogenous change in insecurity $\tau_{s,ij}$,[71] as well as in output and expenditures: $\widetilde{X_i^c} = \frac{\tilde{w_i^c}}{\tilde{w_i}} X_i$ and $\widetilde{Y_i^c} = \frac{\tilde{w_i^c}}{\tilde{w_i}} Y_i$. The Change in wage ($\frac{\tilde{w_i^c}}{\tilde{w_i}}$) is

[67] We do not need to specify in this exercise the type of insecurity. Yet, as discussed in section 7, this counterfactual insecurity is mainly interpretable as a rise in conflicts with non-state organized actors.

[68] Given that this is a general equilibrium case, intranational trade flows are included. See section 4.2 for details on this specification and comparison with our baseline. For consistency and data quality reasons, we use in the GE section TradeProd data only for intra-national flows. We performed a robustness check using TradeProd data for all flows. Results are poorly affected.

[69] Time-varying trade costs are derived from controls, while time-invariant trade costs are captured by country-pair fixed effects. Some exporter-importer fixed effects are dropped due to convergence issues. These missing effects are replaced by regressing for 2012 the estimates of exporter-importer fixed effects on gravity variables and country fixed effects.

[70] Using a PPML estimator, we can directly recover empirical expressions of the multilateral resistance terms (Fally, 2015). Yet to solve the system, we need to normalise one of the multilateral resistances. We choose to normalise Germany's importer multilateral resistance term so that $\widetilde{\Phi_0} = 1$. Therefore we can derive country i's and j's multilateral resistance from $\widetilde{\Pi_i} = (\frac{Y_i X_0}{exp(\widetilde{\lambda_i})})^{-\frac{1}{\theta}}$ and $\widetilde{\Phi_j} = (\frac{X_j}{X_0 exp(\widetilde{\lambda_j})})^{-\frac{1}{\theta}}$, with $\widetilde{\lambda}$ the estimated exporter/importer fixed effect.

[71] Using a difference in difference strategy to estimate the alliances effect on trade (cf. section 4) the elasticity already captures the direct interplay between trade and insecurity. However, changes in wages being captured by fixed effects, we need to calibrate their impact on insecurity. Changes in wages are derived from the maximum factory gate price (eq. 12). To calibrate $-\eta_1\delta$ and $-\eta_2\delta$ we estimate the effect of the exporter's and importer's wages on the probability of facing bilateral insecurity. Data on wages are retrieved from International Labour Organisation database. Results are displayed in the appendix table 27. By construction the bilateral insecurity probability is the same for ij and ji which implies that $-\eta_1\delta = -\eta_2\delta$. Thus we estimate $-\eta\delta = -0.033$. We tested the consequences of assuming insecurity is exogenous. The conclusions of our general equilibrium application are robust.

captured directly by changes in maximum factory gate prices (eq. 12).[72] The calibration of trade elasticity θ plays a crucial role in the estimation of both prices and welfare. Including tariffs in the standard structural gravity estimation, we directly estimate $\theta = 3.7$.[73] Finally, we can quantify the General Equilibrium effect of military alliances enforced in 2012 as the percentage difference between the baseline and the counterfactual.[74]

8.3 Results

Results per country are reported in table 7.[75] Military alliances improve signatories' exports and welfare, while non-members experience losses. GE effects highly depend on countries' import penetration. The biggest winners in terms of welfare also see sharp increases in their exports, but not the largest ones. These countries are small, developed countries with military alliances with many partners, such as Belgium (16.28%), the Netherlands (+16.20%) and Iceland (+13.12%). We then find a mix of developed and middle-income countries also intensively involved in military alliance treaties, such as Hungary (+11.03%), Mexico (+10.71%), Venezuela (+9.75%), Denmark (+8.75%), Canada (+8.74%) and Argentina (+6.06%). Military alliances are less impactful for large economies, but still bring non-negligible welfare gains: France (+5.34%), Great Britain (+5.21%), Germany (+4.59%) and the USA (+2.42%). On the other hand, the biggest losers are small countries excluded from alliance treaties whose close partners have signed multiple ones. Here, we can cite Ireland (-3.30%), Nigeria (-2.85%), Malta (-2.44%), Cyprus (-2.35%) and Sweden (-2.21%). These negative effects are not the result of a rise in insecurity for non-signatory countries, which is assumed as constant,[76] but simply the consequence of a general equilibrium trade diversion mechanism.[77] In addition, our results are robust to the inclusion of heterogeneous alliances and trade elasticities.[78]

[72] Given that $\overline{\alpha}$ and N_i are fixed, we have $\frac{\tilde{w_i^c}}{\tilde{w_i}} = (\frac{exp(\tilde{\lambda_i})^c X_0}{exp(\tilde{\lambda_i})\tilde{X_0^c}})^{-\frac{1}{\theta}}$. Variations in expenditures and outputs trigger new changes in multilateral resistance, which impacts outputs and expenditures and so forth. Translating these variations into changes in exports, we iterate the estimation process until maximum prices converge.

[73] The results of the trade elasticity estimation are reported in table 28. For robustness reasons, we also perform the general equilibrium analysis using two alternative calibrations of θ. In keeping with Head et al. (2014) and Melitz and Redding (2013) we calibrated $\theta = 4.25$, and in keeping with Anderson et al. (2018) $\theta = 6$. Mechanically, the higher θ, the smaller the welfare variations. Nonetheless, our conclusions are robust to these alternative calibrations of θ.

[74] Changes in exports and welfare are simply: $\frac{X_j}{\tilde{X_j^c}} = \frac{\sum_j X_{ij} - \sum_j \tilde{X_{ij}^c}}{\sum_j \tilde{X_{ij}^c}}$ and $\frac{W_j}{\tilde{W_j^c}} = \frac{Y_j/\tilde{\Phi_j} - \tilde{Y_j^c}/\tilde{\Phi_j^c}}{\tilde{Y_j^c}/\tilde{\Phi_j^c}}$.

[75] Minor additional sensitivity checks are performed. We replicate the analysis while controlling for globalisation as in table 16 column 8. We also differentiate between defence pacts and weak alliances, removing only defence pacts. In both checks, results are barely affected.

[76] We properly discuss this assumption in section 5.

[77] Note that losers may experience (very small) gains in exports. This is the result of an increase in their inward and outward multilateral resistance terms associated with a drop in their factory gate prices. The increase in expenditure by winners causes non-signatory countries to see trade diverted from their internal market to the winners. This diversion offsets (or overcomes) the decrease in their exports due to the fall in output.

[78] We showed in section 4.3.2 that, given that trade elasticities are not constant, alliances have a country-pair specific effect. We adjust our GE analysis to include bilateral trade elasticities. We allow trade elasticities to be country-pair specific and the price-index elasticity to be country specific. Theoretically, the above-presented GE structure and welfare system still hold. After estimating the average effect on military alliances, we introduce the distortion in coefficients derived from the quantile estimation in section 4.3.2. Then, we determine the price-index elasticities. We calibrate the average elasticity at 3.7 and apply the country-specific distortion. In keeping with our model extension in section B.3, a good proxy can be directly derived from the importer's average trade elasticities. We present the new GE results in

8.4 Scenarios analysis

International tensions have been exacerbated in recent years. The war in Ukraine has brought conflict back to Europe with new threats and strategic interests that are shaking the post-Cold War balance. The future may bring a substantial reshaping of military alliances, especially among European countries. Using our general equilibrium approach, this section analyses the ramifications on countries' welfare of potential major alliance network disruption.[79] We define three scenarios: i) the expansion of NATO to neutral European countries and partner nations, ii) NATO breaking with Eastern countries, and iii) the creation of a new Eastern block.[80] Extending the network of alliances, the first scenario induces a pure reduction in international insecurity. On the contrary, the second scenario captures a pure increase in insecurity, while the third scenario assumes a mix of bilateral insecurity changes.[81]

Results per country are presented in the appendix table 30. Despite the assumed important change in the alliance network, any scenario's GE effect is insufficient to induce a major impact on large or unconcerned economies. For countries like the US, France, UK and Germany, maintaining NATO in the East or expanding the treaty to their closest partners has noticeable, but not major economic outcomes. Furthermore the changes in the GE trade diversion are weak and poorly affect neutral economies. On the other hand, for countries targeted as potential switchers, the choice to switch would have drastic repercussions. Leaving NATO would severely reduce their real revenue, which a new Eastern block could temper but not offset. Moreover, for still-neutral countries – especially in Europe – joining NATO (i.e. the closest and largest alliance network) would bring remarkable welfare gains. For example, Bulgaria would increase its real revenue by 10.27%, Finland by 11.51%, Sweden by 15.73%, Switzerland by 17.13% and Ireland by 24.58%. Additionally, in the appendix section H, we discuss the welfare consequences of a more specific shock with the US withdrawal from alliance treaties.

appendix table 29. On the whole, the introduction of bilateral elasticities tempers the welfare variations. Nonetheless, our conclusions are barely affected.

[79] We do not observe Russia or Ukraine's intranational trade, which excludes them from the analysis. Therefore, we do not aim to study the impact of war on the two belligerents directly, but the ramifications of new military relationships between countries indirectly involved.

[80] We assume that i) Sweden, Finland, Japan, Austria, Australia, Ireland, South Korea, New Zealand, Colombia, Malta, Switzerland, Pakistan and Serbia-Montenegro become full NATO members, ii) Albania, Bulgaria, China, Finland, Sweden, Hungary, Pakistan, Poland, Romania, Serbia-Montenegro and Turkey leave NATO or terminate any military alliance with its members, and iii) that after leaving NATO, they form one common military alliance together.

[81] We argued in the present paper that overall alliances only affect signatory country-pairs. Yet, we also showed that in specific contexts, such as the Cold-War, some change in trade with non-signatory partners may be observed (see appendix section F). Allowing for such indirect changes in the scenarios tempers the positive effects of alliances but does not affect our conclusions.

9 Conclusion

This paper provides a systematic analysis of the impact of military alliances on trade using a panel of 6,972 country pairs from 1967 to 2012. Taking a structural gravity approach, we show that military alliances have a strong positive causal effect on bilateral exports. Namely, our baseline specification shows that the enforcement of a military alliance engenders an increase of 60%. We perform numerous sensitivity tests and show that results are robust to a variety of alternative specifications. However, this average effect is highly heterogeneous across country pairs, depending on the nature of the treaties and the economic size of partners. Furthermore, an instrumental variable approach and a DATT approach confirm the causal interpretation of our results. We confirm the validity and prevalence of the insecurity mechanism: military alliances increase trade by reducing bilateral insecurity. Finally, we perform a general equilibrium analysis to quantify the welfare effect of alliances. Building a counterfactual for 2012, we show that intensive involvement in the signature of military alliances brings significant welfare gains while being neutral induces marked losses. We then analyse different scenarios to demonstrate that reshaping the military alliance network in response to the war in Ukraine could have considerable welfare ramifications on the concerned economies.

Our findings have important scientific and policy implications. First, they point up the need to consider the specific role of security and international military relations to understand trade and globalisation. Second, they show the efficiency of military alliances, particularly defence pacts, at guaranteeing the safety and inter-state cooperation required for economic agents to trade. That opens an interesting research agenda. The important macro-economic effect of alliances calls for a better understanding of the micro-level dynamic. This questions the heterogeneity in the exposure to insecurity among sectors and firms, as well as the capacity of international security cooperation policies to address its complexity. Nonetheless, the unambiguous welfare gains that alliances bring their members should give policymakers strong incentives to promote the signature of such treaties. Although some may fear that they create relations of domination between nations, our findings suggest on the contrary that they bring more favourable welfare gains to small economies.

Table 7: GE exports and welfare gains from alliances (2012)

Country (Iso3)	Exports	Real revenues	Country (Iso3)	Exports	Real revenues
ALB	2.34	-0.38	ISL	29.96	13.12
ARG	21.54	6.06	ISR	-2.66	-1.85
AUS	4.16	0.46	ITA	35.10	3.53
AUT	-1.62	-1.93	JPN	7.37	0.40
BEL	19.95	16.28	KEN	-5.54	-0.34
BGD	-0.36	-0.99	KOR	5.45	0.61
BGR	9.02	1.68	LKA	-2.06	-0.91
BOL	29.58	11.60	MAR	-0.15	-0.52
BRA	20.02	0.74	MEX	28.92	10.71
CAN	44.41	8.74	MLT	1.02	-2.44
CHE	-1.05	-1.89	MYS	0.63	-0.71
CHL	11.76	6.11	NGA	1.44	-2.85
CHN	-1.14	-0.13	NLD	17.80	16.20
CIV	13.14	0.30	NOR	20.31	6.61
CMR	0.20	-1.25	NZL	-0.51	-0.44
COL	38.52	3.32	PAK	25.09	5.47
CYP	-1.04	-2.35	PER	25.07	2.79
DEU	26.66	4.59	PHL	4.21	1.70
DNK	26.85	8.75	POL	61.18	5.11
DZA	-0.45	-1.02	PRT	56.90	6.94
ECU	31.62	6.26	ROM	2.24	-0.19
EGY	-3.64	-0.68	SAU	0.38	-0.96
ESP	45.81	4.14	SER	-5.52	-0.55
FIN	-2.55	-1.28	SGP	-0.39	-0.38
FRA	45.15	5.34	SWE	-2.32	-2.21
GAB	1.38	3.66	THA	0.31	-0.64
GBR	41.19	5.21	TUN	0.22	-0.77
GRC	51.44	4.98	TUR	60.8	2.53
HKG	0.02	-1.36	URY	37.82	3.86
HUN	26.82	11.03	USA	65.90	2.42
IDN	0.14	-0.32	VEN	18.17	9.75
IND	-2.36	-0.20	VNM	0.05	-0.45
IRL	1.25	-3.30			

Note: The real revenue is our measure of welfare. All numbers are percentage variations.

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A Military alliance treaties

A.1 Overview

Military alliances are international treaties designed to develop international security cooperation policies. As defined by Gibler (2008) military alliances can be divided into four categories depending on the degree of restriction and involvement of signatories. First, the *military entente* implies a diplomatic exchange of information among members before taking any military decision. Second, the *neutrality pact* specifies that signatories must stay neutral in the event of a conflict involving one party to the pact. Third, the *non-aggression pact* states that signatories cannot declare war or engage in military action against treaty members. Fourth, the *defence pact* is where signatories agree on collective but centralised military management. It does not deny members' sovereignty, but enforces strong security cooperation in areas that matter to the signatory countries. Therefore, defence pacts reach a highly specific level of cooperation. While the first three categories of alliance mainly describe different international policies to keep peace between members, the defence pacts imply military cooperation to protect signatories from any common threats.

A.2 Defence pacts examples

The most famous defence pact is the *North Atlantic Treaty* (NATO). Signed on the fourth of April 1949 and still in force, it concerns most North American and Western European countries and was later expanded to a number of Eastern European nations. Created to ensure protection against the USSR and its satellites, it implies strong and centralised military cooperation. It was also designed with important economic and institutional objectives in mind such as economic collaboration, free institutions and stable well-being.[82] Yet, to pursue these objectives, the treaty specifies only military cooperation policies. Moreover, the ninth article includes the creation of a central council in charge of compliance with the alliance's constraints, organisation and objectives.

The *Treaty on Collective Security* (TCS) was signed by former USSR states in 1992 and is still in force. It was signed in recognition of the inability of the Commonwealth of Independent States to provide the required economic and commercial prosperity among members despite the tariff liberalisation it includes. The TCS aims to achieve members' trade objectives by enabling lasting stability and security throughout the region due to common and centralised management of military matters. It also specifies the creation of a collective security council in charge of defence decisions, armed forces coordination and the application of the treaty's purposes.

The *Joint Defense and Economic Cooperation Treaty* between the States of the Arab League was created in 1951 by Egypt, Lebanon, Saudi Arabia, Syria, Yemen Arab Republic and Iraq, and joined later by a number of Arab states. Even though the treaty has encountered problems due to internal tensions over members' relations with Israel, it is still in force and was reinvigorated following the USA intervention in Iraq. Once again, it concerns close military cooperation and the creation of a centralised council. It also contains explicit economic and trade objectives and aims to favour the development and trade of signatory countries.[83] Moreover, to assist the first council, a second council in charge of economic issues was created. Yet, this council cannot propose or enforce standard trade liberalisation policies such as tariff reductions.

The *Defense Pact of the African and Malagasy Union* was signed in 1961 by twelve French-speaking sub-Saharan countries to protect themselves from both internal and external interference. Nonetheless, the pact did not last long since it was terminated in 1964. The core of the treaty was the enforcement of peace and stability in the region and military cooperation by members. Yet, it also introduced a

[82] "Article 2. The Parties will contribute toward the further development of peaceful and friendly international relations by strengthening their free institutions, bringing about a better understanding of the principles upon which these institutions are founded, and promoting conditions of stability and well-being. They will seek to eliminate conflict in their international economic policies and will encourage economic collaboration between any or all of them."

[83] "Article 7. In order to fulfil the aims of this Treaty and to bring about security and prosperity in Arab countries and in an effort to raise the standard of life therein, the contracting States undertake to collaborate for the development of their economic conditions, the exploitation of their natural resources, the exchange of their respective agricultural and industrial products, and generally to organise and coordinate their economic activities and to conclude the necessary inter-Arab agreements to realise such aims."

mandatory contribution to the development of free institutions, well-being and economic collaboration. Similarly to the previous example, international security was also considered here as a necessity for economic development. Moreover, the treaty stipulated the creation of a central council to take decisions with a two-thirds majority of pact members regarding the alliance's procedures.

The last example of defence pact is the *Treaty Instituting the Arab-Maghreb Union*. It was signed in 1989 by North African and Arab countries and is still in effect today. The agreement covers common management of defence and stability matters, the creation of a presidential council to centralise decisions and a judicial body to ensure the legal enforcement of decisions. A striking point in our case is the explicit objective of trade liberalisation and free movement of persons, services, capital and goods.[84] The treaty's third article also includes a clear objective of common economic and industrial development for members.

A.3 Weaker alliances examples

A first example is the neutrality pact between Chile and Argentina called the *Treaty of Peace and Friendship between Chile and Argentina*. It was driven by increasing border disputes between the two states since 1970 and negotiations to settle them. It was finally signed in 1984 and is still in force today. It lays down military and economic objectives, especially maritime goals, and the establishment of a commission. Yet, contrary to a defence pact, it does not imply close cooperation between states but merely a frame to avoid armed conflicts and agree on each state's sovereignty.

The *Treaty of Peace, Friendship and Cooperation between India and the Soviet Union*, coded as a non-aggression pact, was signed in 1971 and was in effect until 1991. The treaty provides for respect for members' sovereignty and borders and an absence of interference in any domestic affairs. Moreover, it expresses the importance of economic cooperation and trade. Yet, it provides for no supra-national institution to be created. The agreement provides for a guarantee from participants, but neither centralised military cooperation nor the ambitions of a defence pact.

The *treaty of Friendship and Co-operation between France and Russia*, an entente pact, was signed by Francois Mitterrand and Boris Yeltsin in 1992. It is still in force today without any objection having ever been raised by either state. The main goal of the agreement is to ensure immediate consultation between signatories in the event of security issues or important diplomatic decisions. It also stipulates institutional and economic objectives such as the development of the manufacturing sectors, the promotion of democratic institutions and the facilitation of the movement of capital, persons and goods. Yet, there is no further military cooperation, no guarantee of peace, and no supra-national institution to ensure the application of the treaty.

[84] "Article Two. The Union aims at:(...) - Working gradually towards achieving free movement of persons and transfer of services, goods and capital among them."

B Theoretical model

B.1 Standard model

We start with a constant elasticity of substitution utility function. Consumers in each country maximise their utility by consuming $q(\omega)$ units of each differentiated good ω, noted by the following function:

$$U = [\int_{\Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega]^{\frac{\sigma}{\sigma-1}} \tag{16}$$

where q is the consumed quantity, and σ the elasticity of substitution between two varieties of goods. After maximisation under the revenue constraint, we can define the consumed quantity for a specific variety as:

$$q(\omega) = p(\omega)^{-\sigma} X (\int_{\Omega} p_{\omega''}^{1-\sigma})^{\frac{\sigma-1}{1-\sigma}} \tag{17}$$

and firm ω's revenue:

$$x(\omega) = X_j (\frac{p(\omega)}{P_j^{\frac{1}{1-\sigma}}})^{1-\sigma} \tag{18}$$

where $x(\omega) = q(\omega)p(\omega)$, X_j the total revenue of country j, and $P_j = \int_{\Omega} p_{\omega''}^{1-\sigma}$ the Dixit-Stiglitz price index. Thus, the total consumed value in country j of goods variety ω can be understood as the share of the country's total revenue allocated to the consumption of variety ω.

Next, we consider firm productivity level γ such that marginal cost $\alpha = 1/\gamma$. In keeping with Helpman et al. (2008), we assume that the distribution of firm productivity γ in each country follows a Pareto distribution G with:

$$G_i(\alpha) = (\alpha^{\theta} - \underline{\alpha}^{\theta})/(\overline{\alpha}_i^{\theta} - \underline{\alpha}^{\theta}) = \frac{\alpha^{\theta}}{\overline{\alpha}_i^{\theta}} \tag{19}$$

where θ is the parameter determining the shape of the distribution, $\alpha = \frac{1}{\gamma}$ the firm's marginal cost, $\overline{\alpha}_i$ the maximum marginal cost (or minimum productivity) to produce in country i, and $\underline{\alpha}$ the minimum marginal cost (or maximum productivity). Therefore, naming N the number of firms and considering solely exports from country i to country j we have:

$$x_{ij}(\alpha) = X_j (\frac{p(\alpha)}{(\sum_l N_l \int_0^{\alpha_{lj}^*} p_{lj}(\alpha)^{1-\sigma} dG(\alpha))^{\frac{1}{1-\sigma}}})^{1-\sigma} \tag{20}$$

Firms present monopolistic competition and a CES demand function. Therefore, by introducing insecurity costs – discussed in section 2 – and other sorts of trade costs, we obtain the following price and profit functions for each variety:

$$p_{ij}(\alpha) = \frac{\sigma}{\sigma - 1} w_i T_{n,ij} \alpha \tag{21}$$

$$\pi_{ij} = (\frac{x_{ij}(\alpha)}{\sigma}) - F_{n,ij} \tag{22}$$

where $T_{n,ij} = \Pi^n \tau_{n,ij}$ is a product of variable trade costs with n the n potential source of iceberg costs, including $\tau_{s,ij}$ the insecurity cost, but also all variable trade costs sensitive to other parameters (geography, standard trade policies, institutions, etc.)., and $F_{n \neq s,ij}$ a vector of fixed trade costs insensitive to insecurity that firms have to pay to enter country j from i.

Once all exports from i to j have been aggregated, taking into account equations (22) and (23), and setting $\underline{\alpha} = 0$ for solving issues[85], we can define total exports from i to j:

$$X_{ij} = X_j \frac{N_i w_i^{1-\sigma} V_{ij} T_{n,ij}^{1-\sigma}}{\sum_l N_l w_l^{1-\sigma} V_{lj} T_{n,lj}^{1-\sigma}} \tag{23}$$

where V is defined as in Helpman et al. (2008):

$$V_{ij} = \int_0^{\alpha_{ij}^*} \alpha^{1-\sigma} dG(\alpha) \tag{24}$$

α_{ij}^* is by definition the level of productivity for which the profit from exporting, π_{ij}, is zero:

$$\pi_{ij} = (\frac{x_{ij}(\alpha^*)}{\sigma}) - F_{n \neq s,ij} = 0 \tag{25}$$

where:

$$\alpha^* = (\sigma - 1)\sigma^{\frac{\sigma}{\sigma-1}} (\frac{X_j}{P_l' F_{n \neq s,ij}})^{\frac{1}{\sigma-1}} \frac{1}{w_i T_{n,ij}} \tag{26}$$

with index price

$$P_l' = \sum_l N_l \int_0^{\alpha_{lj}^*} p_{lj}(\alpha)^{1-\sigma} dG(\alpha) \tag{27}$$

Once equation (27) is plugged into equation (25), we can develop V. Combined with equation (24), we obtain the following expression for bilateral exports:

$$X_{ij} = X_j \frac{N_i (\overline{\alpha}_i w_i)^{-\theta} T_{n,ij}^{-\theta} F_{n \neq s,ij}^{-[\frac{\theta}{\sigma-1} - 1]}}{\sum_l N_l (\overline{\alpha}_l w_l)^{-\theta} T_{n,lj}^{-\theta} F_{n,lj}^{-[\frac{\theta}{\sigma-1} - 1]}} \tag{28}$$

[85] This implies that we assume that there is always a firm that is productive enough to export at least a small amount.

Finally, after defining the importer multilateral resistance term:

$$\Phi_j = (\sum_l N_l \overline{\alpha}_l^{-\theta} w_l^{-\theta} T_{n,lj}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]})^{-\frac{1}{\theta}} \tag{29}$$

we obtain the structural gravity equation:

$$X_{ij} = N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} T_{n,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]} \tag{30}$$

Or outlying insecurity costs from trade cost aggregates:

$$X_{ij} = N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} \tau_{s,ij}^{-\theta} T_{n\neq s,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]} \tag{31}$$

with $T_{n\neq s,ij}$ is the variable trade costs sets excluding insecurity costs $\tau_{s,ij}$.

B.2 Extension with fixed insecurity costs.

In the standard model, we assume that insecurity costs are equivalent to an expropriation risk which can be model as a variable trade cost. Yet, insecurity costs may also be related to barriers inducing a fixed cost (controls, procedures and information requirements).

We introduce insecurity barriers in our model. Firms need to address expensive procedures and information requirements to lift these barriers and enter the foreign market. The higher the bilateral insecurity, the higher the barriers and therefore the higher the cost to lift them. This is directly interpretable as a fixed trade cost sensitive to insecurity: to enter the market, firms pay a cost that depends on the degree of bilateral insecurity but does not vary with the exported quantity. So it does not affect the price function, but directly affects profit:

$$\pi_{ij} = (\frac{x_{ij}(\alpha)}{\sigma}) - F_{n,ij} \tag{32}$$

$x_{ij}(\alpha)$ is the firm's revenue function and $F_{n,ij}$ a vector of fixed trade costs that firms have to pay to enter country j from i, including $f_{s,ij}$, the fixed insecurity cost derived from insecurity barriers, but also all fixed trade costs sensitive to other sources n. If the market entry cost decreases, the firm's profit increases. When firms switch from negative profit to positive profit, they start exporting, which increases the number of varieties sold from i to j.

Therefore, we can derive at aggregated level the following structural gravity equation outlying the

insecurity trade costs $\tau_{s,ij}$ and $f_{s,ij}$:

$$X_{ij} = N_i \overline{\alpha}_i^{-\theta} w_i^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} \tau_{s,ij}^{-\theta} f_{s,ij}^{-[\frac{\theta}{\sigma-1}-1]} T_{n\neq s,ij}^{-\theta} F_{n\neq s,ij}^{-[\frac{\theta}{\sigma-1}-1]} \tag{33}$$

X_{ij} is the total exports from country i to country j, N_i, the number of firms in the exporting country, $\overline{\alpha}_i$, the maximum marginal cost of country i's technology, and w_i the wage in country i's economy. X_j is the total revenue of country j, and Φ_j, the importer's multilateral resistance term, while $T_{n\neq s,ij}$ and $F_{n\neq s,ij}$ are respectively the variable and fixed trade costs sets, but excluding the insecurity costs. Again, like other trade costs, insecurity costs ($\tau_{s,ij}$ and $f_{s,ij}$) have negative elasticities.[86] Hence, by reducing both variable and fixed insecurity costs, the enforcement of a military alliance between countries i and j increases bilateral exports X_{ij}. [87]

B.3 Extension with bilateral trade elasticities

A way to deal theoretically with the constant trade elasticity issue is to rule out the CES assumption in favour of other utility functions consistent with the idea of sub-convex gravity (Mrázová and Neary, 2017). Yet, the CES utility function has the advantage of being simple to use, works well with Pareto productivity distributions, and allows for a structural gravity equation with heterogeneous firms (Chaney, 2008). We propose another solution to capture bilateral trade elasticities: relaxing the assumption of constant technology in our standard model.

We start with the same structure as earlier, that is to say, the CES demand function, monopolistic competition and firm heterogeneity with a Pareto distribution of productivity. Yet, we allow the Pareto shape parameter θ to be exporter specific and assume that worldwide technology has been developed to match the sub-variety of dominant markets. Precisely, we apply a distortion ζ_j on the productivity distribution. In keeping with empirical evidences presented in Carrère et al. (2020) and section 4.3.2, we assume $\frac{\delta\theta_i}{\delta\frac{Y_i}{\Pi_i^{-\theta_i}}} < 0$ and $\frac{\delta\zeta_j}{\delta\frac{X_j}{\Phi_j^{-\theta_j}}} < 0$. The larger countries i's and j's share of global revenue, the greater the firm's probability of drawing high productivity. In other words, firms still have a monopoly on their variety, but produce a sub-variety for each destination that has its own productivity level and a greater chance of being more productive in sub-varieties designed for the largest markets. For example, a firm might produce blue T-shirts (its variety) with the highest level of productivity for the sub-variety designed for the US (chemical dyed large blue T-shirts). However, it would have to divert

[86] These elasticities depend both on θ, the Pareto shape parameter of the firms' productivity distribution. Yet, fixed trade cost elasticity also depends on σ, the elasticity of substitution. Here, we assume $\theta > \sigma - 1$. Otherwise, fixed trade costs elasticity is positive.

[87] We do not make any composition assumptions. Military cooperation policies described in appendix A suggest that both variable and fixed insecurity costs are reduced by alliances. In our analysis of the overall effect of alliances and the role of bilateral insecurity, we recognise for interpretation reasons the existence of both variables in fixed insecurity costs, but do not need to disentangle them.

from this optimal production chain when producing the sub-variety for Sweden (naturally dyed long blue T-shirts), where consumer characteristics and preferences are different.

We define the country-pair specific productivity distribution as follows:

$$G_{ij}(\alpha) = (\alpha^{(\theta_i\zeta_j)} - \underline{\alpha}^{(\theta_i\zeta_j)}/\overline{\alpha'}^{(\theta_i\zeta_j)} - \underline{\alpha}^{(\theta_i\zeta_j)} = \frac{\alpha^{(\theta_i\zeta_j)}}{\overline{\alpha'}^{(\theta_i\zeta_j)}} \tag{34}$$

with $\overline{\alpha'} = \frac{X_j}{\Phi_j}\overline{\alpha}$ the maximum marginal cost. Therefore, the firms' probability of drawing sub-variety productivity γ_{ij} and the productivity distribution in the economy are determined by θ_i and ζ_j. Each country-pair presents a specific productivity distribution, while each firm draws different outputs depending on the destination market. Nonetheless, because each country-pair's productivity is Pareto distributed, the observed average productivity of firms in a given origin country is also Pareto distributed.[88] In this extended model, the price and profit equations are unchanged. Yet, because the productivity distribution is different from the standard model, the firms' productivity is affected and their prices too.

Running through the model, we obtain the following expression of the structural gravity equation with bilateral trade cost elasticities:

$$X_{ij} = N_i\overline{\alpha}_i^{-\theta_i\zeta_j}(\frac{\sigma^{\frac{\sigma}{\sigma-1}}}{\sigma-1})^{-\theta_i\zeta_j}w_i^{-\theta_i\zeta_j}\frac{X_j}{\Phi'_j}\tau_{s,ij}^{-\theta_i\zeta_j}f_{s,ij}^{-[\frac{\theta_i\zeta_j}{\sigma-1}-1]}T_{n\neq s,ij}^{-\theta_i\zeta_j}F_{n\neq s,ij}^{-[\frac{\theta_i\zeta_j}{\sigma-1}-1]} \tag{35}$$

with

$$\Phi'_j = \sum_l N_l\overline{\alpha}_l^{-\theta_l\zeta_j}(\frac{\sigma^{\frac{\sigma}{\sigma-1}}}{\sigma-1})^{-\theta_l\zeta_j}w_l^{-\theta_l\zeta_j}T_{n,lj}^{-\theta_l\zeta_j}F_{n,lj}^{-[\frac{\theta_l\zeta_j}{\sigma-1}-1]} \tag{36}$$

This distorted structural gravity equation raises new trade cost elasticities: variable trade cost elasticity $-\theta_i\zeta_j$ and fixed trade cost elasticity $-[\frac{\theta_i\zeta_j}{\sigma-1}-1]$. The lower θ_i and ζ_j, the lower the trade elasticities. Therefore, large economies are less affected by insecurity costs. This explains why we observe alliances elasticities inversely proportional to the value of trade (cf. section 4.3.2).

C Deriving endogenous insecurity

In this appendix section, we detail the derivation of the endogenous insecurity from the framework presented in section 8. Knowing that each fighter expropriates a share υ of traded products X_{ij}, the intensive margin of insecurity I_{ij}, defined as the total share of expropriated product in period of conflict, can be directly expressed as $I_{ij} = L_{ij}\upsilon$.

[88] At country-pair level, many firms draw small productivity while a few firms draw high productivity. Taking the firms' average productivity, we observe the same thing. Many firms draw small productivity for all destinations while a few firms draw only high productivity. Nonetheless, in this framework, some firms that are on average not very productive may have a low level of productivity for the large majority of destinations, but a high level of productivity for a few destinations.

The extensive margin of insecurity E_{ij} captures the probability that group G_{ij} decides to fight. The gains from fighting are the expropriated products and the political motivation at the cost of facing security measures: $R_f = \frac{L\upsilon}{s_{ij}} X_{ij} \frac{1}{\zeta_{ij}}$. The gains from peace are wages. Considering the marginal cost derived from the Cobb-Douglas production function: $L_{ij} = l_i^{\eta_1} * l_j^{\eta_2} * l^{\eta_3}$, the total gains from peace are: $R_p = L_{ij}(\frac{w_i}{\eta_1}^{\eta_1} \frac{w_j}{\eta_2}^{\eta_2} \frac{w}{\eta_3}^{\eta_3})$. G_{ij} decides to fight if $R_f > R_p$. Therefore we have:

$$E_{ij} = P\left[Z < \frac{X_{ij}\upsilon}{s_{ij} \frac{w_i}{\eta_1}^{\eta_1} \frac{w_j}{\eta_2}^{\eta_2} \frac{w}{\eta_3}^{\eta_3}}\right] \tag{37}$$

Knowing that $P(Z < \zeta) = \frac{\zeta^\delta}{\overline{\zeta}^\delta}$ we can rewrite E_{ij} as follows:

$$E_{ij} = (\upsilon X_{ij})^\delta s_{ij}^{-\delta} \overline{\zeta}^{-\delta} (\frac{w_i}{\eta_1}^{\eta_1} \frac{w_j}{\eta_2}^{\eta_2} \frac{w}{\eta_3}^{\eta_3})^{-\delta} \tag{38}$$

Combining the extensive and intensive margins, the endogenous bilateral insecurity cost is therefore defined by:

$$\tau_{s,ij} = 1 + E_{ij}(\frac{1}{1 - I_{ij}} - 1) = 1 + (\upsilon X_{ij})^\delta s_{ij}^{-\delta} \overline{\zeta}^{-\delta} (\frac{w_i}{\eta_1}^{\eta_1} \frac{w_j}{\eta_2}^{\eta_2} \frac{w}{\eta_3}^{\eta_3})^{-\delta} (\frac{1}{1 - L_{ij}\upsilon} - 1) \tag{39}$$

D Multilateral insecurity

In section 7, we showed that alliances strongly increase trade by reducing bilateral insecurity. Yet, in theory, we may expect alliances to also induce multilateral changes in insecurity. In keeping with (Martin et al., 2008), we can define multilateral insecurity as a exporter-specific marginal cost $\tau_{s,i}$ leading to the price function:

$$p_{ij}(\alpha) = \frac{\sigma}{\sigma - 1} w_i \tau_{s,i} \tau_{s,ij} T_{n \neq s,ij} \alpha \tag{40}$$

and, deriving our model,[89] to the gravity equation:

$$X_{ij} = N_i \overline{\alpha_i}^{-\theta} w_i^{-\theta} \tau_{s,i}^{-\theta} \frac{X_j}{\Phi_j^{-\theta}} \tau_{s,ij}^{-\theta} T_{n \neq s,ij}^{-\theta} F_{n \neq s,ij}^{-[\frac{\theta}{\sigma - 1} - 1]} \tag{41}$$

In this framework, alliances could increase bilateral trade X_{ij} by reducing the bilateral insecurity cost $\tau_{s,ij}$ and the multilateral one $\tau_{s,i}$. In our baseline estimation, any change in $\tau_{s,i}$ are captured by the exporter-time fixed effects. Alliances are therefore restricted to affect trade only through bilateral insecurity. Then, in the General Equilibrium approach, we implement a bilateral insecurity shock resulting from alliances, and, under several assumptions,[90] allow multilateral insecurity to adjust.

[89] see the appendix section B for details)

[90] Mainly, we do not need to disentangle multilateral insecurity from other marginal costs, but must assume that multilateral insecurity changes are ether redistributed in revenues or compensated by a proportional change in wage.

These methods consider the existence of multilateral insecurity, but do not permit to observe whether they are affected by alliances.

To address this issue, we estimate below the alliances' effect on trade allowing for changes in both bilateral and multilateral insecurity. In order to allow for a change in multilateral insecurity, we cannot include exporter-time fixed effects.[91] However, this may cause omitted variable bias, since changes in the exporter output or price-index may influence the exporter's willingness to sign alliances. Therefore, we use the instrumental variable detailed in section 5. We present the results in table 8. In column one, we use a two-stage OLS-PPML strategy and in column two a control function (Lin and Wooldridge, 2019). First-stage coefficients are not affected by the absence of exporter-time fixed effect.[92] Furthermore, using the *plausible exogeneity test* proposed by Conley et al. (2012), we confirm that the IV still sufficiently respect the exclusion restriction (see table 9). Finally, in the second stage, alliances' coefficient is very weakly affected, while capturing a reduction in multilateral insecurity should have increased the estimated elasticity. This supports that alliances' impact is purely bilateral.

[91] Changes in bilateral insecurity can also affect the exporter price index. Removing the exporter-time fixed effects we also allow alliances to affect trade through this channel.

[92] See table 3 for comparison.

Table 8: Allowing for bilateral and multilateral insecurity changes

Dependent variable:	exports	exports
Second stage	IV	Ctrl. function
Estimator:	PPML	PPML
Alliance	0.647[a]	0.614[a]
	(0.024)	(0.026)
RTA	0.198[a]	0.193[a]
	(0.017)	(0.017)
First stage residuals		-0.198[a]
		(0.057)
Exporter x Year FE	no	no
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.666	320.666
First-stage		
Estimator:	OLS	OLS
Dependent variable:	Alliance	Alliance
Common out. alliances	0.056[a]	0.056[a]
	(0.007)	(0.007)
RTA	0.013[c]	0.013[c]
	(0.007)	(0.007)
Exporter x Year FE	no	no
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320,712	320,712
KPW F-stat	68	68
KPW LM-stat	11	11

Note: OLS, Ordinary Least Squares; PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects. Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at the exporter and importer levels are in parentheses. Second-stage standard errors are bootstrapped. a, b and c denote significantly different from 0 at the 1%, 5% and 10% level, respectively.

Table 9: Plausible exogeneity test, multilateral insecurity

Dep var: exports	*Union of Confidence Interval estimations*		
Instrumented var.	ν	Min	Max
	-0.030	95% CI	95% CI
Alliance		0.448	1.166

Note: UCI based on the IV's ν coefficient from a regression of exports on interest variables and the IV. We use importer-time and exporter-importer fixed effects. Exporter-time are not included to allow for changes in multilateral insecurity.

E Two-way (robust) fixed effects estimations

As pointed up by De Chaisemartin and d'Haultfoeuille (2020), heterogeneous treatments or treatment effects over time and groups may return false results in the case of two-way fixed effects estimations. Comparing groups (here country-pairs) that are not treated at the same time or that experience different outcomes following the treatment could cause negative weights in the (bias) ATE. The estimator developed by De Chaisemartin and d'Haultfoeuille (2020) is sufficient to deal with this bias. But, because we want to address the effect's dynamic, we use the later estimator developed by De Chaisemartin and d'Haultfoeuille (2024), which provides event study results.

The intuition behind this estimation is that avoiding these negative weights entails a comparison of the first-time switchers' t-1 to t+l outcome evolution with the t-1 to t+l outcome evolution of country-pairs whose treatment has hitherto remained stable; with t the treatment time and l the event time. Our panel is balanced, so we estimate the treatment effect from positive switchers (i.e. alliance signatures):

$$\delta_l = \frac{DID_{+,l}}{DID^D_{+,l}} \tag{42}$$

where:

$$DID_{+,l} = \sum_{g:D_{g,1}=0,t_g<T_u-l} \frac{N_{g,t_g+l}\beta^{t_g+l}}{N^1_l} \left[(Y_{g,t_g+l} - Y_{g,t_g-1}) - \sum_{g:D_{g',1}=0,t_{g'}t_{g'}>t_g+l} \frac{N_{g',t+l}}{N^u_{t_g+l}} (Y_{g',t_g+l} - Y_{g',t_g-1}) \right] \tag{43}$$

and

$$DID^D_{+,l} = \sum_{g:D_{g,1}=0,t_g<T_u-l} \frac{N_{g,t_g+l}\beta^{t_g+l}}{N^1_l} \left[(D_{g,t_g+l} - D_{g,t_g-1}) - \sum_{g:D_{g',1}=0,t_{g'}t_{g'}>t_g+l} \frac{N_{g',t+l}}{N^u_{t_g+l}} (D_{g',t_g+l} - D_{g',t_g-1}) \right] \tag{44}$$

with t_g the time of group g's treatment variation, $\beta \in (0,1]$ the planner's discount rate, D the treatment variation, T_u the last observed period with a group untreated since period 1, $N^1_l = \sum_{g:D_{g,1}=0,t_g<T_u-l} N_{g,t_g+l}\beta^{t_g+l}$ the discounted number of units in groups reaching l periods after their first treatment or before T_u, and Y the outcome – in our case exports. Yet, since ALL_{ijt} is a dummy variable, $DID^D_{+,l} = 1$. Therefore, we have:

$$\delta_l = DID_{+,l} \tag{45}$$

We present the results for military alliances in table 10 and defence pacts in table 11. They show a growing dynamic effect and confirm the robustness of our identification strategy.

However, De Chaisemartin and d'Haultfoeuille (2024) estimator is linear which in a gravity setting

may bias results (Silva and Tenreyro, 2006). Therefore, we perform an alternative two-way (robust) fixed effects approach developed by Nagengast and Yotov (2023); Wooldridge (2023) which allows for ppml estimator. The intuition is similar. By interacting each cohort with the post-treatment periods, it directly addresses the negative weights issue that may results from heterogeneous effects. Furthermore, as in our structural gravity baseline, this estimator allows for exporter-year and importer-year fixed effects. The results, displayed on graph 7, are similar to the linear estimation and support our conclusions.

Table 10: Military alliances: Chaisemartin D'Haultfoeuille (2020) estimator

Dependent variable: Bilateral exports						
Time	t	t+1	t+2	t+3	t+4	t+5
Alliance's coeff	0.339^a	0.457^a	0.500^a	0.581^a	0.661^a	0.682^a
Standard error	(0.085)	(0.086)	(0.090)	(0.093)	(0.093)	(0.094)
RTA control	yes	yes	yes	yes	yes	yes
No. observ.	128.004	127.878	127.788	127.594	121.022	114.458
No. switchers	250	248	248	246	242	238

Note: Dependent variable is the inverse hyperbolic sine transformation of exports from country i to country j at time t in millions of current dollars. t is the year of the pair's alliance signature. Standard errors clustered at country-pair level are in parentheses. a, b and c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 11: Defence pacts: Chaisemartin D'Haultfoeuille (2020) estimator

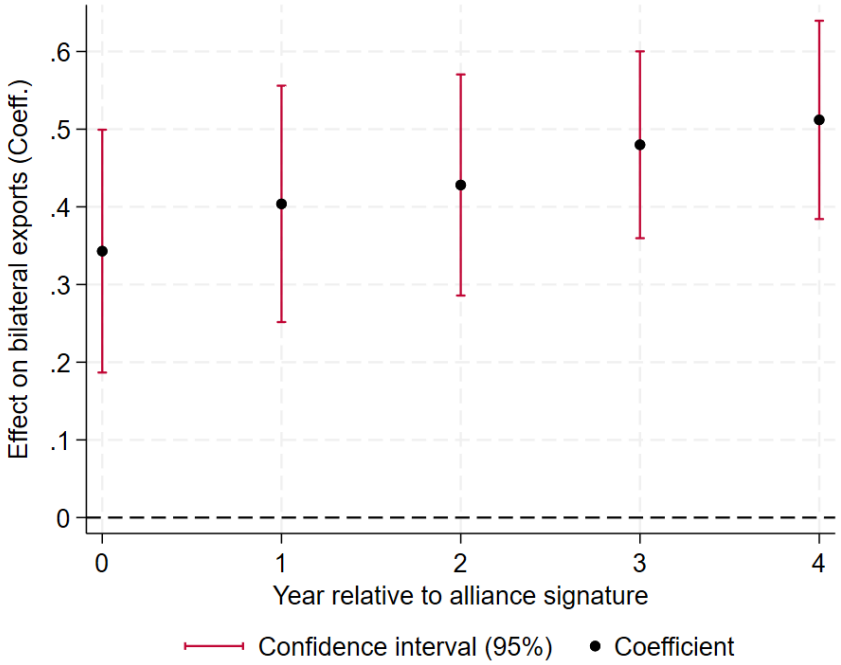
Dependent variable: Bilateral exports						
Time	t	t+1	t+2	t+3	t+4	t+5
Defence pact's coeff	0.434^a	0.561^a	0.568^a	0.656^a	0.714^a	0.748^a
Standard error	(0.118)	(0.119)	(0.118)	(0.123)	(0.127)	(0.128)
RTA control	yes	yes	yes	yes	yes	yes
No. observ.	44.888	44.854	44.844	44.818	38.266	38.262
No. switchers	172	172	172	172	170	170

Note: Dependent variable is the inverse hyperbolic sine transformation of exports from country i to country j at time t in millions of current dollars. t is the year of the pair's alliance signature. Standard errors clustered at country-pair level are in parentheses. a, b and c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

F The Cold War

How to define the Cold War and to what extent it can bias our estimation is not obvious. If we consider that the Cold War is a period structuring global country relationships, it is a time-level variable and is captured by our country-year fixed effects. If we define the Cold War as a period when countries were either capitalist or communist, it comes under the country-year level and once again is captured by our fixed effects. Yet, if we consider the Cold War as a latent conflict between the western block and the eastern block, our fixed effects are not sufficient. Therefore, we include in our estimation a dummy variable taking the value one if country i is a member of one block and country j a member of the

Figure 7: Two-way robust fixed effects estimation, PPML



Note: Figure plots results of the two-way robust fixed effects estimation with PPML estimator and 95% confidence intervals. Dependant variable is exports. Exporter-year and importer-year fixed effects are included. Standard errors are clustered at the country-pair level.

opposite block, conditional on the absence of military alliances between i and j, and zero otherwise.[93]

In this case, we deal with highly specific heterogeneity in alliance effects. The Cold War variable is a particular case of a non-alliance relationship between countries i and j. In section 4.3.1, the defence pact coefficient is estimated compared with the average case of non-alliances. Yet, introducing the Cold War variable would exclude a case of "latent-conflict-non-alliance" from this average. Therefore, the non-alliance average would be closer to a neutral relationship. This could induce overestimated coefficients. estimation should address this issue. Using propensity score matching, the treated and control groups should be comparable in terms of bilateral diplomatic relationships. Controlling for the $Cold.war_{ijt}$ dummy, we estimate the defence pacts effect as in section 4.2 and with a DATT. The results are reported in table 12. In the standard estimation (column 1), controlling for the Cold War reduces the defence pact coefficient. In the DATT estimation (column 2), variables of interest coefficients are not impacted while the Cold War's coefficient is non-significant. In both estimations, the defence pact effect on bilateral exports is estimated at 80% and is highly significant.

[93] $Cold.war_{ijt} = \mathbb{1}_{\{alliance_{ijt}=0\}} * ((alliance_{i,USA,t} + \mathbb{1}_{\{i=USA\}}) * (alliance_{RUS,jt} + \mathbb{1}_{\{j=RUS\}}) + (alliance_{i,RUS,t} + \mathbb{1}_{\{i=RUS\}}) * (alliance_{USA,jt} + \mathbb{1}_{\{j=USA\}})) * \mathbb{1}_{\{alliance_{i,USA,t} * alliance_{USA,jt}=0\}} * \mathbb{1}_{\{alliance_{i,RUS,t} * alliance_{RUS,jt}=0\}}$

Table 12: Defence pacts and the Cold War

Estimator: PPML Dependent variable: Exports Variables	Standard three-way FE	DATT
Defence pact	0.592[a]	
	(0.078)	
t-4		-0.035
		(0.118)
t-3		0.065
		(0.077)
t-2		-0.046
		(0.086)
t-1		0.010
		(0.088)
t		0.243[a]
		(0.088)
t+1		0.380[a]
		(0.085)
t+2		0.421[a]
		(0.079)
t+3		0.518[a]
		(0.078)
t+4		0.615[a]
		(0.072)
>=t+5		0.575[a]
		(0.043)
Weak Alliance	-0.127	-0.453[a]
	(0.159)	(0.105)
Cold War	-0.239[a]	-0.029
	(0.076)	(0.031)
RTA	0.135[a]	0.152[a]
	(0.032)	(0.014)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.666	38.625

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; DATT, Differenced Average Treatment on the Treated; Dependent variable is exports from country i to country j at time t. In DATT, defence pact's signatory effect is estimated in comparison to $k' <= t - 5$. Robust standard errors are in parentheses; column (1) standard errors are clustered at country-pair level; column (2) standard errors are clustered at country-pair-year level. a, b and c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

G Intensive and extensive margins of trade

In this section, we investigate through which margin of trade military alliances affect bilateral exports. We first estimate the effects of military alliances on bilateral exports conditional on positive flows from country i to j at year t and $t-1$ (the intensive margin). Then, using a non-linear probability model (Kitazawa, 2012; Silva and Kemp, 2016), we estimate the effects of alliances on the probability of starting to export to a destination (the extensive margin).[94] Results are reported in appendix table 13. The intensive margin estimation results are reported in panel A of the table, while the extensive margin results are shown in panel B. First, alliances increase by 47% the bilateral exports of country-pairs that were already trade partners. Second, they increase by 35% country i's probability of starting to export to country j. Thus, military alliances affect bilateral exports in terms of both margins. This suggests the presence of heterogeneous effects depending on which margin applies to the country-pair.

Table 13: Extensive and intensive margins of trade

A: Intensive margin	
Dependent variable:	$\{X_{ijt} \vert X_{ijt} > 0, X_{ijt-1} > 0\}$
Estimator:	PPML
Alliance	0.389^a
	(0.094)
Controls	yes
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	289.581

B: Extensive margin	
Dependent variable:	Export dummy
Estimator:	Logit
Alliance	0.403^a
	(0.079)
Controls	yes
Year FE	yes
Dyadic FE	yes
No. observ.	102.442

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t without the zero observations and conditional to a positive value the previous year. Standard errors clustered at country-pair level are in parentheses. Intensive margin estimation's control: RTAs; Extensive margin estimation's controls: RTAs, exporter's GDP, importer's GDP, exporter's population, importer's population. Coefficient of our Logit estimation can be directly interpreted as the elasticity. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

[94] Given that the Logit estimator does not allow for intensive use of fixed effects, we use only country-pair and year fixed effects, which partially capture the multilateral resistance while controlling for importer/exporter GDP and population.

H US withdrawal scenario

Over the past years, the involvement of the United States of America in military alliances may have been questioned, or used to exert diplomatic pressure, particularly on European partners. In this debate, the real-revenue consequences of a US withdrawal could play a significant role. To investigate this, we employ the same scenario analysis method as outlined in section 8. Within our general equilibrium framework, we consider a counterfactual scenario in which the US has terminated all its alliances.

The results are presented in table 14. Under such a withdrawal, US welfare would decrease by 2.51%. The impact on partner countries is diverse. Economies that are strongly integrated with the US would experience major losses, such as Canada (-7.03%) or Mexico (-9.51%). Nevertheless, other US partners would be weakly impacted. Especially when comparing European countries' losses to those of the US, they are largely inferior (approximately 5 times less on average). Furthermore, countries that are not US allies would no longer suffer from trade diversion and would experience slight gains, like Ireland (+0.66%) or Gabon (+1.16%). Thus, if the US chose to withdraw from the alliance network, the most negatively affected countries would be the closest US partners and the US itself.

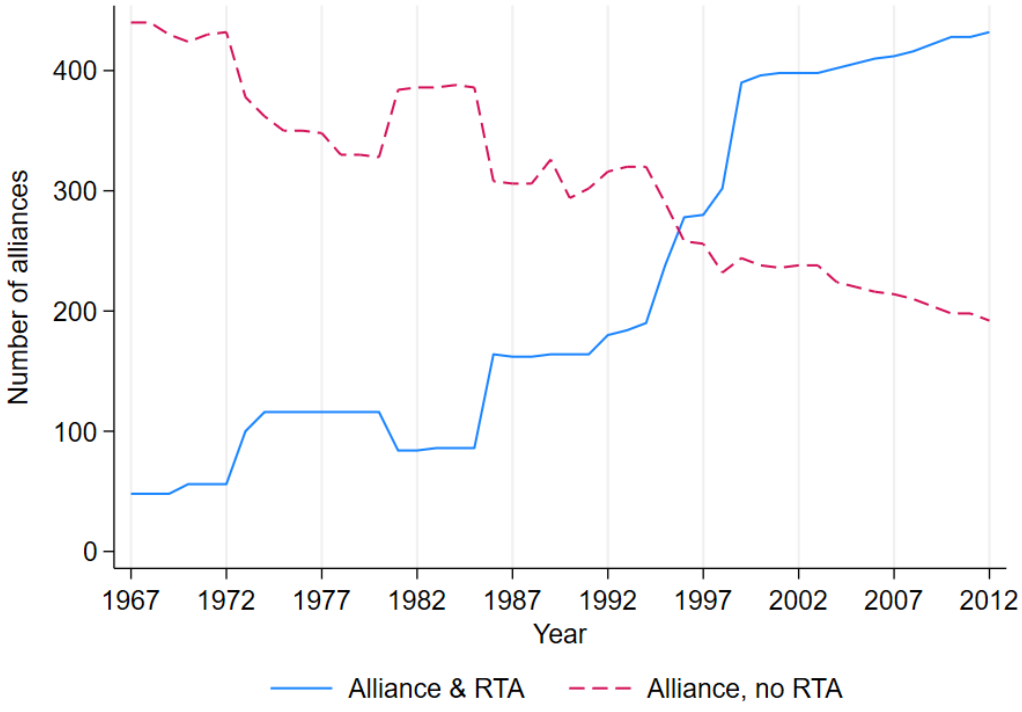
Table 14: Welfare impact of the US withdrawal from alliances

Country (Iso3)	Real revenues	Country (Iso3)	Real revenues	Country (Iso3)	Real revenues
ALB	0.16	ESP	-0.15	NGA	0.90
ARG	-0.71	FIN	0.17	NLD	-0.91
AUS	-0.62	FRA	-0.39	NOR	-0.35
AUT	0.22	GAB	1.16	NZL	0.19
BEL	-0.78	GBR	-0.75	PAK	-1.21
BGD	0.28	GRC	-0.18	PER	-0.39
BGR	0.13	HKG	0.58	PHL	-1.95
BOL	-0.81	HUN	-0.32	POL	-0.09
BRA	-0.34	IDN	0.14	PRT	-0.21
CAN	-7.03	IND	0.07	ROM	0.11
CHE	0.32	IRL	0.66	SAU	0.37
CHL	-2.04	ISL	-0.94	SER	0.03
CHN	0.07	ISR	0.51	SGP	0.19
CIV	0.61	ITA	-0.26	SWE	0.27
CMR	0.04	JPN	-0.48	THA	0.34
COD	-1.74	KEN	0.05	TUN	0.12
COG	-0.51	KOR	-0.79	TUR	-0.23
DEU	-0.45	LKA	0.34	URY	-0.24
DNK	-0.42	MAR	0.12	USA	-2.51
DZA	-0.29	MEX	-9.51	VEN	-5.44
ECU	-2.62	MRT	0.49	VNM	0.20
EGY	0.10	MYS	0.38		

Note: The real revenue is our measure of welfare. All numbers are percentage variations.

I Supplementary tables and figures

Figure 8: Alliances & RTAs, overlap



Note: The number of alliances counts each exporter-importer pair with an active alliance.

Table 15: List of countries

Albania	Denmark	Latvia	Saudi Arabia
Algeria	Ecuador	Kyrgyzstan	Russia
Argentina	Egypt	Libya	Serbia-Montenegro
Australia	Estonia	Lithuania	Singapore
Austria	Finland	Luxembourg	Slovakia
Bangladesh	France	Malaysia	Slovenia
Belarus	Gabon	Malta	South Korea
Belgium	Germany	Mexico	Spain
Bolivia	Greece	Morocco	Sri Lanka
Bosnia and Herzegovina	Hong Kong	Netherlands	Sweden
Brazil	Hungary	New Zealand	Switzerland
Brunei	Iceland	Nigeria	Taiwan
Bulgaria	India	North Macedonia	Thailand
Cameroon	Indonesia	Norway	Tunisia
Canada	Ireland	Pakistan	Turkey
Chile	Israel	Paraguay	Ukraine
China	Italy	Peru	United Kingdom
Columbia	Ivory Coast	Philippines	United States of America
Croatia	Japan	Poland	Uruguay
Cyprus	Kazakhstan	Portugal	Venezuela
Czech Republic	Kenya	Romania	Vietnam

Figure 9: Quantile estimates of RTAs

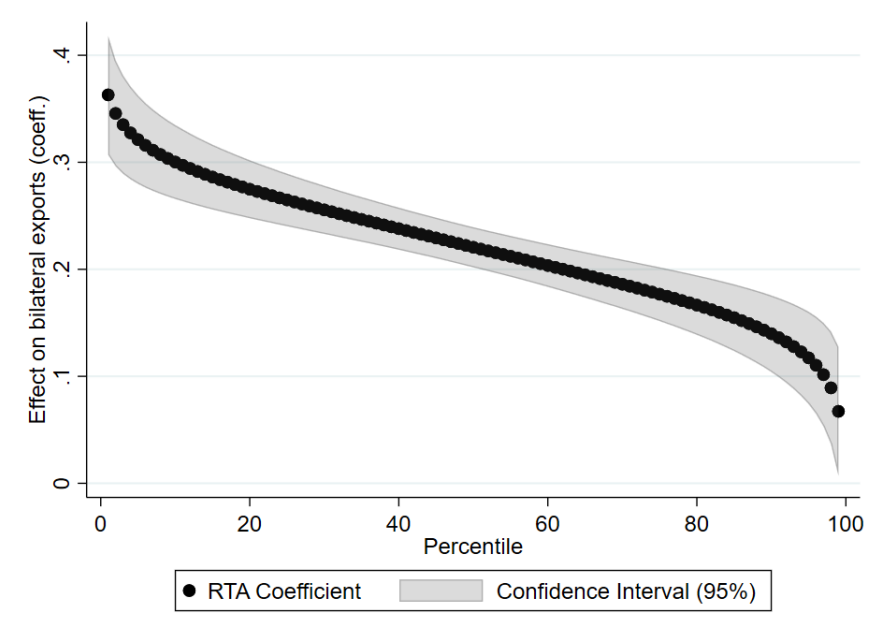


Table 16: Exports and military alliances, robustness checks

Robustness check:	Intra. trade	Tariffs			Tariffs & Intra. trade	RTA depth		EU	Geo. and eco. dist.	Extended panel			Import shares
Period:	1990-2012	1996-2012			1996-2012	1967-2012		1967-2012	1967-2012	1870-2012	1948-2012	1967-2020	1967-2012
Baseline sample:	No	Yes	No	No	No	No		Yes	No	No	No	Yes	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Alliance	0.490^a	0.203^a	0.232^a	0.233^a	0.353^a	0.439^a	0.438^a	0.491^a	0.473^a	0.554^a	0.550^a	0.366^a	0.646^a
	(0.046)	(0.052)	(0.059)	(0.060)	(0.043)	(0.116)	(0.106)	(0.116)	(0.106)	(0.065)	(0.069)	(0.082)	(0.105)
RTA	0.104^a						-0.021	0.134^a	0.157^a		0.165^a	0.107^a	0.374^a
	(0.041)						(0.052)	(0.033)	(0.033)		(0.030)	(0.036)	(0.045)
ln(Tariffs+1)				-1.025^a	-1.330^a								
				(0.288)	(0.390)								
Intra x Year	-0.039^a				-0.033^a								
	(0.003)				(0.004)								
RTA depth						0.010^a	0.011^a						
						(0.001)	(0.002)						
EU								0.253^a					
								(0.037)					
Diff. GDP per cap.								-0.005					
								(0.004)					
ln(Distance) x Year								-0.000					
								(0.001)					
Exporter x Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer x Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Dyadic FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
No. observ.	97.129	118.439	71.456	71.456	47.921	314.128	314.128	320,666	320.666	1.159.418	1.102.828	376.434	320.666

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t. Standard errors clustered at the country-pair level are in parentheses. Because of data limitation, several estimations are performed with a shorter panel or omitted observations/country-pairs. In column 3 we perform the same regression as in column 2 but without observations whose Bilateral average tariff is unknown. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 17: Corrected three-way ppml estimation

Estimator: PPML Dependent variable: exports	
Variables	(1)
Alliance	0.482^a
Corrected bias	-0.010
	(0.118)
RTA	0.166^a
Corrected bias	-0.005
	(0.036)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	320.666

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at country-pair level are in parentheses. Coefficients are corrected from the asymptotic bias. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 18: Exports and defence pacts

Estimator:	PPML	
Dependent variable:	Bilateral exports	
Variables	(1)	(2)
Defence pact	0.693^a	0.694^a
	(0.079)	(0.120)
Weak alliance	-0.107	-0.149
	(0.151)	(0.153)
RTA	0.137^a	0.137^a
	(0.032)	(0.032)
NATO		0.643^a
		(0.080)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.666	320.666

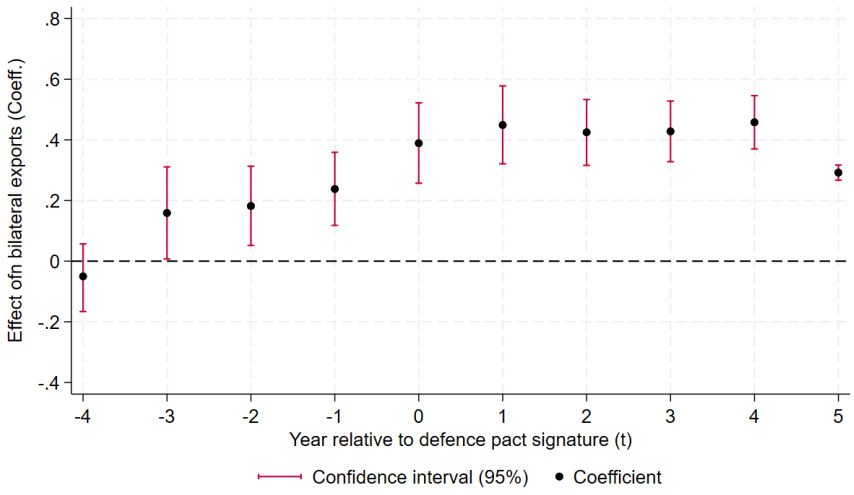
Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at country-pair level are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 19: Alliances and bilateral exports, 2SLS

Dependent variable: exports		
Second stage		
	(1)	(2)
Estimator:	OLS	2SLS
Instrument variable:	None	Common out. alliances
Alliance	0.664[a]	0.452[a]
	(0.088)	(0.165)
RTA	0.562[a]	0.575[a]
	(0.029)	(0.074)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.712	320.712
First-stage		
Instrumented variable:	None	Alliance
Common out. alliances		0.056[a]
		(0.007)
RTA		0.012[a]
		(0.008)
KPW rk F-stat:		67
KPW rk LM-stat:		11

Note: OLS, Ordinary Least Squares; 2SLS, Two-Stage Least Square; FE, Fixed effects; Dependent variable is the inverse hyperbolic sine transformation of exports from country i to country j at time t in millions of current dollars. Standard errors clustered at country-pair levels (column 1) and at the importer and exporter levels (column 2) are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Figure 10: Event study



Note: Figure plots results of the standard event study estimation of the defence pacts' effect on bilateral trade. Every time k is compared to $k' <= t_{def} - 5$. The last period includes $k >= t_{def} + 5$. Standard errors are clustered at the country-pair-year level.

Table 20: Alliances and bilateral exports, IV control function

Dependent variable: exports		
Second stage	(1)	(2)
Estimator:	PPML	PPML
Alliance	0.635^a	
	(0.025)	
Defence pact		0.624^a
		(0.025)
Weak alliance		-0.011^a
		(0.041)
RTA	0.152^a	0.144^a
	(0.012)	(0.011)
First stage residuals	-0.357^a	0.176^a
	(0.049)	(0.057)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.666	320.666
First-stage		
Estimator:	OLS	OLS
Dependent variable:	Alliance	Defence pact
Common out. alliances	0.056^a	0.053^a
	(0.007)	(0.006)
Weak alliance		-0.398^a
		(0.062)
RTA	0.011	0.015^c
	(0.008)	(0.009)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.712	320.712
KPW F-stat	67	78
KPW LM-stat	11	10

Note: OLS, Ordinary Least Squares; FE, Fixed effects. Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at the exporter and importer levels are in parentheses. Second-stage standard errors are bootstrapped. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 21: Outside alliances

Estimator: PPML Dependent variable: Exports Variables	(1)	(2)
Alliance	0.467^a	
	(0.108)	
Outside alliance(exp.)	-0.030	
	(0.174)	
Outside alliance(imp.)	-0.106	
	(0.157)	
Defence pact		0.702^a
		(0.081)
Weak alliance		-0.113
		(0.169)
Outside defence pact(exp.)		0.101
		(0.152)
Outside defence pact(imp.)		0.044
		(0.144)
Outside weak alliance(exp.)		-0.102
		(0.185)
Outside weak alliance(imp.)		0.101
		(0.266)
RTA	0.160^a	0.131^a
	(0.033)	(0.032)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	320.666	320.666

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects. Dependent variable is exports from country i to country j at time t. Standard errors clustered at country-pair level are in parentheses. a, b and c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 22: Dynamic propensity score matching, some details

Estimator: Probit Dependent variable: Defence pact			
Variables	(1)	(2)	(3)
Year:	1967	1990	2012
Exp. ln(GDP)	0.379^a	0.314^a	0.318^a
	(0.031)	(0.025)	(0.027)
Imp. ln(GDP)	0.379^a	0.314^a	0.318^a
	(0.031)	(0.025)	(0.027)
Exp. ln(Pop.)	-0.185^a	-0.117^a	-0.116^a
	(0.035)	(0.029)	(0.028)
Imp. ln(Pop.)	-0.185^a	-0.117^a	-0.116^a
	(0.035)	(0.029)	(0.028)
Common religion	1.231^a	1.616^a	1.378^a
	(0.098)	(0.098)	(0.091)
ln(Distance)	-0.435^a	-0.331^a	-0.503^a
	(0.031)	(0.033)	(0.030)
Common official language	1.169^a	1.023^a	0.817^a
	(0.078)	(0.082)	(0.079)
Colonial past	-0.479^a	-0.641^a	-0.366^a
	(0.140)	(0.154)	(0.134)
No. observ.	6.970	6.870	6.866

Note: OLS, Ordinary Least Square; Dependent variable is the presence of a military alliance between countries i and j at time t. Standard errors are in parentheses. The PSM is made for each year from 1967 to 2012, respectively. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 23: Propensity score matching, variables' mean

Variable	Psm base	Standard base
GDP exp. (ln)	11.633	10.608
GDP imp. (ln)	11.629	10.608
Population exp. (ln)	2.816	2.575
Population imp. (ln)	2.812	2.575
Distance (ln)	7.762	8.511

Table 24: DATT

Estimator: PPML Dependent variable: Bilateral exports	
Variables	(1)
t-4	0.024
	(0.117)
t-3	0.076
	(0.075)
t-2	-0.035
	(0.085)
t-1	0.021
	(0.086)
t	0.254^a
	(0.087)
t+1	0.391^a
	(0.083)
t+2	0.431^a
	(0.078)
t+3	0.529^a
	(0.076)
t+4	0.626^a
	(0.070)
>=t+5	0.585^a
	(0.040)
Weak Alliance	-0.445^a
	(0.108)
RTA	0.152^a
	(0.014)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	yes
No. observ.	38.625

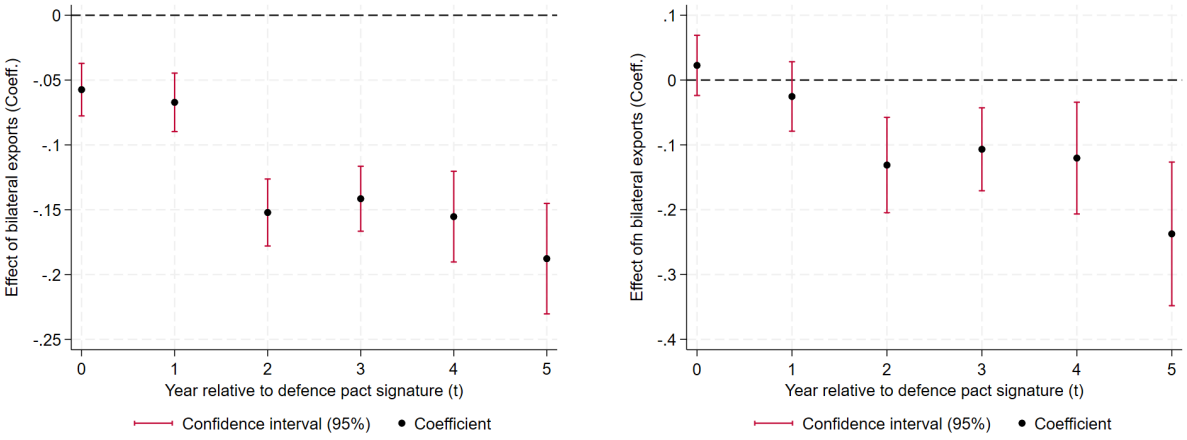
Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects. Dependent variable is exports from country i to country j at time t in millions of current dollars. t is the date of the signatory of the alliance between country i and j. Defence pact's signatory effect is estimated in comparison to $k' <= t-5$. Standard errors clustered at country-pair-year level are in parentheses. Observations are weighted in function of our Propensity Score Matching. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 25: Defence pacts and UN votes

Estimator:	PPML	
Dependent variable:	Common votes (sum)	
Variables	(1)	(2)
Defence pact	0.020[a]	
	(0.004)	
Common out. def. pacts		0.001[a]
		(0.000)
Weak alliance	0.009	0.007
	(0.006)	(0.006)
RTA	0.033[a]	0.033[a]
	(0.002)	(0.002)
Abstention	0.168[a]	0.168[a]
	(0.003)	(0.003)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	251.806	251.806

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is the sum of common UN votes between country i and j. Abstention is the sum of the common abstention between country i and j. We use the inverse hyperbolic sine transformation of Abstention. For reasons of consistency with the baseline estimation, in structural gravity, each country-pair is counted twice (ij and ji). Standard errors clustered at country-pair level are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Figure 11: Defence pacts and extensive margin of international insecurity, event study



(a) Full sample

(b) Constrained sample

Note: Figure plots the effect of defence pact signature on the probability of facing bilateral insecurity (extensive margin) with 95% confidence intervals. We use Wooldridge (2023) estimator. Dependent variable is a dummy taking the value 1 if the country pair faces bilateral insecurity ($INS_{ijt} > 0$). Exporter-year, importer-year and exporter-importer fixed effects are included. Standard errors are clustered at the country-pair level. Results are robust to negative weights issue. Graph two limits our sample to country pairs which switch from positive bilateral insecurity to none (and inversely) over the period.

Table 26: The military cooperation channel

Second stage	(1)	(2)
Estimator:	PPML	
Dependent variable:	Bilateral exports	
Military cooperation	0.401^a	0.294^a
	(0.069)	(0.044)
Weak alliance	-0.227	-0.286
	(0.157)	(0.178)
RTA	0.040	0.041
	(0.036)	(0.040)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	167.304	167.304
First-stage		
Estimator:	OLS	
Dependent variable:	Military cooperation	
Defence pact	1.004^a	
	(0.100)	
Common out. def. pacts		0.081^a
		(0.005)
Weak alliances	0.241^b	0.178^c
	(0.097)	(0.096)
RTA	0.128^a	0.125^a
	(0.035)	(0.035)
Exporter x Year FE	yes	yes
Importer x Year FE	yes	yes
Dyadic FE	yes	yes
No. observ.	167.328	167.328

Note: OLS, Ordinary Least Square; PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects. The panel starts in 1989. Common defence pacts sum all external partners for which country i and j both have a defence pact. Military cooperation is the inverse hyperbolic sine transformation of $\sum coop.mil.ev._{ijt}$. Robust standard errors clustered at country-pair level are in parentheses. Second-stage standard errors are bootstrapped. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 27: Estimating the wage elasticiy of insecurity

Estimator: OLS	
Dependent variable:	Bilateral insecurity probability
Variables	(1)
ln(wage$_i$)	-0.034^a
	(0.006)
ln(wage$_j$)	-0.034^a
	(0.006)
Dyadic FE	yes
Year FE	yes
No. observ.	25,298

Note: OLS, Ordinary Least Square; FE, Fixed effects; Dependent variable is a dummy variable taking the value one if country-pair ij's bilateral insecurity is positive. Due to wages data restrictions, the panel goes from 2011 to 2020 while several country-pairs are not observed. Standard errors clustered at country-pair level are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 28: Estimating the trade elasticity

Estimator: PPML	
Dependent variable:	Bilateral exports
Variables	(1)
ln(1+Tariffs)	-3.754^a
	(1.102)
ln(Distance)	-0.781^a
	(0.044)
Common religion	-0.157
	(0.160)
Contiguity	0.579^a
	(0.111)
Common language	0.131
	(0.101)
Exporter x Year FE	yes
Importer x Year FE	yes
Dyadic FE	no
No. observ.	54,479

Note: PPML, Poisson Pseudo Maximum Likelihood; FE, Fixed effects; Dependent variable is exports from country i to country j at time t in millions of current dollars. Standard errors clustered at country-pair level are in parentheses. a, b, c denote significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 29: GE exports and welfare gains from alliances (2012) with heterogeneous elasticities

Country (Iso3)	Exports	Real revenues	Country (Iso3)	Exports	Real revenues
ALB	2.53	0.20	ISL	26.34	9.52
ARG	13.55	4.07	ISR	-1.21	-1.04
AUS	2.64	0.26	ITA	20.32	2.85
AUT	-0.41	-1.25	JPN	5.10	0.32
BEL	11.47	11.80	KEN	-2.90	-0.17
BGD	0.32	-0.55	KOR	3.34	0.40
BGR	7.45	1.25	LKA	-0.77	-0.48
BOL	22.29	6.68	MAR	1.19	-0.15
BRA	12.81	0.57	MEX	16.47	7.03
CAN	24.08	6.14	MLT	1.01	-1.30
CHE	-0.16	-1.30	MYS	0.65	-0.49
CHL	8.99	3.93	NGA	1.30	-1.68
CHN	-0.33	-0.11	NLD	10.41	12.05
CIV	10.91	0.21	NOR	12.95	4.32
CMR	0.77	-0.54	NZL	-0.07	-0.26
COL	23.47	1.89	PAK	16.31	3.20
CYP	-0.33	-1.20	PER	17.16	1.70
DEU	15.54	3.87	PHL	3.21	1.07
DNK	17.04	6.10	POL	34.14	3.22
DZA	0.40	-0.50	PRT	33.81	4.53
ECU	21.34	3.90	ROM	2.66	0.04
EGY	-1.85	-0.38	SAU	0.58	-0.60
ESP	25.75	3.11	SER	-3.29	-0.27
FIN	-1.11	-0.78	SGP	-0.04	-0.24
FRA	24.91	4.31	SWE	-0.97	-1.47
GAB	1.31	3.06	THA	0.42	-0.44
GBR	22.94	4.09	TUN	1.56	-0.22
GRC	36.39	3.59	TUR	35.42	1.75
HKG	0.28	-0.71	URY	29.96	2.76
HUN	17.40	7.04	USA	34.09	2.02
IDN	0.32	-0.21	VEN	11.75	5.72
IND	-1.13	-0.15	VNM	0.36	-0.29
IRL	1.35	-2.07			

Note: The real revenue is our measure of welfare. All numbers are variations in percentage.

Table 30: Alliances scenarios and welfare changes

Scenarios:	NATO expansion	NATO East-rupture	New East-block	Scenarios:	NATO expansion	NATO rupture	New East block
Country (Iso3)	Real revenues	Real revenues	Real revenues	Country (Iso3)	Real revenues	Real revenues	Real revenues
ALB	23.82	-1.24	6.24	ISL	1.60	-0.37	-0.45
ARG	-0.20	0.04	0.01	ISR	-0.69	0.12	0.12
AUS	3.29	0.02	0.02	ITA	1.08	-0.27	-0.33
AUT	17.46	0.40	0.20	JPN	1.61	0.01	-0.00
BEL	1.80	-0.38	-0.46	KEN	-0.17	0.01	-0.02
BGD	-0.49	0.07	-0.08	KOR	3.07	0.03	0.01
BGR	10.27	-2.67	2.52	LKA	-0.39	0.03	-0.03
BOL	-0.15	0.00	-0.02	MAR	-0.39	0.09	0.05
BRA	-0.07	0.01	0.01	MEX	-0.25	0.04	-0.01
CAN	1.28	-0.02	-0.03	MLT	23.44	0.25	0.20
CHE	17.13	0.19	0.15	MYS	-0.54	0.04	0.00
CHL	-0.46	0.06	0.02	NGA	-1.03	0.12	0.06
CHN	-0.07	0.01	0.09	NLD	2.27	-0.50	-0.65
CIV	-0.06	0.02	0.01	NOR	2.63	-0.23	-0.42
CMR	-0.38	0.06	0.03	NZL	6.47	0.02	0.00
COL	2.05	0.02	0.00	PAK	6.83	0.07	0.81
CYP	-1.24	0.32	0.25	PER	-0.24	0.01	-0.00
DEU	1.88	-0.59	-0.67	PHL	-0.46	0.03	0.02
DNK	3.40	-0.46	-0.72	POL	0.73	-5.60	-3.50
DZA	-0.38	0.09	0.07	PRT	0.57	-0.10	-0.12
ECU	-0.26	0.03	-0.01	ROM	11.20	-0.65	3.98
EGY	-0.33	0.07	0.02	SAU	-0.71	0.08	0.09
ESP	0.68	-0.19	-0.22	SER	6.52	0.24	3.25
FIN	11.51	0.13	4.43	SGP	-0.27	0.01	0.02
FRA	1.00	-0.22	-0.25	SWE	15.73	0.19	3.38
GAB	-0.82	0.16	0.29	THA	-0.54	0.04	0.01
GBR	1.71	-0.22	-0.26	TUN	-0.53	0.12	0.09
GRC	0.96	-1.04	-1.25	TUR	0.40	-2.73	-1.64
HKG	-1.14	0.07	0.18	URY	-0.15	0.03	0.01
HUN	2.93	-12.05	-5.57	USA	0.03	-0.03	-0.04
IDN	-0.32	0.02	-0.00	VEN	-0.31	0.03	0.03
IND	-0.13	0.02	0.00	VNM	-0.33	0.03	-0.03
IRL	24.58	0.18	0.11				

Note: The real revenue is our measure of welfare. All numbers are variations in percentage.