Trade policy in the shadow of war: A quantitative toolkit for geoeconomics *

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January 5, 2024

Abstract

This paper presents a quantitative toolkit for investigating the interplay between international trade and interstate war. A generic modeling framework is first constructed based on two core elements: (i) a structural gravity model of trade and (ii) a game of diplomatic negotiation that aims to deescalate geopolitical tensions and prevent armed conflicts. Methodologically, the setup extends the conventional quantitative procedures of trade policy evaluation to incorporate endogenous conflict risk. A series of empirically relevant scenarios is then simulated to assess the welfare gains of trade in a context of heightened conflict risk. Finally, the framework is used to structure a survey of the existing literature on trade and war.

Keywords: international trade, interstate conflict, opportunity cost of war, geography of import sourcing, economic interdependence, geoeconomic welfare gains

JEL Codes: F1, F5

*I thank Mateo Moglia for excellent research assistance and Thierry Mayer for providing me with the trade data. Helpful comments from Marius Brülhart, Aurélien Eyquem, Marco Fugazza, Thierry Mayer and Dominic Rohner are also gratefully acknowledged. I warmly thank Oxford University for its hospitality during the work on the first draft.

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1 Introduction

The war in Ukraine and tensions in the Pacific region force economists to move beyond the purely mercantile view of globalization that has prevailed since the 1990s. The vulnerability of global value chains to local disruptions and the intricate consequences of economic sanctions in an interconnected world show that, in the shadow of high-intensity warfare, the design and objectives of trade policy must be reconsidered. In this regard, globalization is gradually shifting from a liberal paradigm to a realist one. Yet, many questions remain open regarding the management of conflict risk in international trade: What is the best strategy for sourcing imports? Is it worth engaging in trade relations that could be disrupted by war, or should risk diversification be favored? Can trading with geopolitical rivals have a pacifying effect?

Montesquieu's view of *Doux Commerce* is arguably a seminal and influential perspective on the trade and war question (Montesquieu, 1748). It is based on the mechanism that trade, by increasing the opportunity cost of war (OCW), contributes to deescalating geopolitical tensions and avoiding military conflicts. In essence, the mechanism is natural, if not obvious. However, the question of its empirical relevance is less clear. Can trade losses associated with war-induced disruption, even if they amount to billions of dollars, truly be equated with the casualties and destruction that occur in war? Can economic calculations really counterbalance the political calculus of big powers? The answer is not trivial and primarily hinges on quantitative analysis.

This paper adopts the perspective of geoeconomics, which can be defined as the study of the interaction between trade, diplomacy and geopolitics. It brings together and organizes insights from a fragmented literature that intersects two fields: international trade and the economics of conflict. A challenge arises from the need to assemble theoretical elements and modeling blocks that come from two different traditions in a way that is tractable and flexible enough to accommodate the various situations faced by policy makers.[1] Ultimately, the goal is to provide a set of quantitative tools to inform the conduct of trade policy in a conflict-prone world. This approach is motivated by the observation that trade is just one factor among many in the dynamics of escalating or containing armed conflict. However, it is also one of the few levers on which diplomats and policy makers can directly act.

A generic model of trade and war is first built. To this purpose, diplomatic negotiation is modeled as the exchange of concessions and compensations between countries in order to settle their (exogenous) geopolitical disputes. Disputes may escalate into armed conflict when negotiation fails due to pervasive informational asymmetries and non-credible threats. To capture these ideas, I opt for a framework that is not sensitive to the specifics of the modeling assumptions: I rely on the class of negotiation protocols that was proposed in a classic contribution of the mechanism design literature by Myerson and Satterthwaite (1983). In spite of its inherent richness, this bargaining game under asymmetric information admits a surprisingly simple characterization of the equilibrium, which provides a closed-form mapping between the OCW and the (endogenous) probability

[1] The trade literature has evolved towards structural approaches using data-fed models. The economics of conflict literature still faces a disconnect between theoretical models and empirical analysis that is mostly based on reduced-form econometric specifications. Given this methodological gap, one secondary objective of this paper is to transpose numerical techniques associated with quantitative trade models to a war context.

of escalation to armed conflict.

In a second step, the workhorse quantitative trade model, called structural gravity in the literature, is used to estimate the OCW, conflict risk and welfare. This class of models has been developed in the past 15 years and is extremely economical in terms of data requirement: only trade shares observed in peace and a parsimonious set of calibrated structural parameters are needed for quantification. Furthermore, solving for the trade equilibrium enables to revisit and qualify one of the central theoretical predictions from the literature related to the geography of import sourcing: bilateral import dependence pacifies while, for plausible parameter values, multilateral import dependence tends to destabilize. To illustrate the numerical procedure, I apply it to prominent country-pairs such as Russia-Ukraine or China-USA. While the resulting estimates should not be considered definitive, they provide insights into the extent to which the historical evolution of their trade dependencies has contributed to the deterioration of their geopolitical relationships.

The theoretical and empirical literature exploring the links between interstate conflicts and international trade is then surveyed through the lens of this conceptual framework. Quantitative research on this topic truly began with the seminal contribution of Polachek (1980). However, the first generation of papers faced severe estimation biases due to the complexity of the causal mechanisms relating trade and war. More recent advances have provided modeling tools that integrate the trade and war margins within a unified framework and allow for the derivation of theory-consistent econometric specifications that can be tested against the data. Moreover, in line with the trend in all fields of economics, the practice of empirical causal analysis has greatly improved. The survey starts from the chapter by Polachek and Seiglie (2007) in the Handbook of Defense Economics and reviews the literature that followed.

A final objective of the paper is to evaluate the welfare gains of trade conducted in a world marked by pervasive geopolitical tensions which have the potential to escalate into armed conflicts. Surprisingly, this question has been largely overlooked, as existing methods for measuring trade gains are designed for peaceful periods. The framework developed in this paper serves the purpose of addressing this gap in the literature by providing a means to integrate conflict risk.

The welfare gains of trade in the shadow of war consist of two components. The first one corresponds to the standard trade gains realized during peacetime. The second component, termed "geoeconomic welfare gains," is made of (i) the probability of war; (ii) the economic costs associated with war when it occurs; and (iii) the diplomatic concessions that countries must make to maintain peace. The geoeconomic gains can be positive or negative depending on the direction and extent to which *conflict risk endogenously reacts to policy-induced redirection of trade flows*. A method for estimating these gains is provided and applied to evaluate several policies of empirical relevance, including the China-US trade war, EU enlargement to Ukraine and trade sanctions against Russia. The estimation results show that in the presence of latent geopolitical disputes, the welfare implications of trade policy may differ significantly from what is predicted by models calibrated solely for peacetime conditions.

Overall, the analysis highlights the existence of a fundamental "security dilemma". On one hand, increasing import dependencies with geopolitical rivals can raise the OCW, potentially deterring the escalation of geopolitical disputes into armed conflicts by exerting discipline during negotiations. However, if negotiations fail, the opportunity cost transforms into the actual cost of war, creating a fundamental tension. On the other hand, countries may be inclined to diversify their import sources and secure supply chains to mitigate the risk of war-induced disruptions. Paradoxically, such diversification reduces economic interdependencies with rivals and can further elevate the risk of conflict. At the global level, this logic can lead to a positive feedback loop between deglobalization and geopolitical risk. The question of which strategy policy makers should pursue remains complex and contingent upon the context. Nonetheless, the quantitative tools presented in this paper prove to be valuable in formulating an answer.

The paper is structured as follows. Section 2 presents some facts on trade and war in the historical perspective. Section 3 builds and solves the model; the numerical procedure is presented. Section 4 surveys the literature. In section 5, the formula of welfare gains of trade in the shadow of war is derived and several empirically relevant policies are simulated. Section 6 covers areas of unsettled research questions and concludes.

2 Historical Perspective

According to the "liberal" view in international relations, globalization and the spread of free markets should reduce the use of military force among states. By contrast, the "realist" view argues that increased economic rivalry between nations tends to heighten political tension.[2] To see whether those two views receive some support in the data, it is useful to take first a historical perspective.

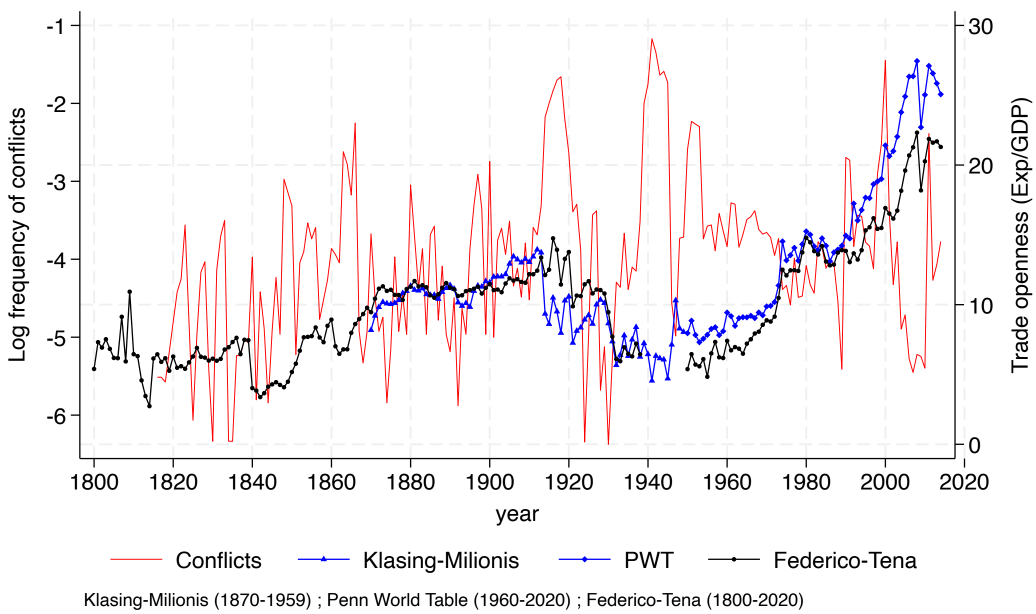
There is little doubt that, in the long-run, trade and conflict have co-evolved. Findlay and O'Rourke (2009) show how fighting for resources and growing global commerce were closely connected throughout Eurasia's economic history in the past millennium. Likewise, in the Mediterranean Sea's history, trade involved expensive security issues (Abulafia, 2012). However, the nature of this co-evolution is complex. In some instances, commerce is associated with pacification, while in others, it is associated with exacerbating tensions. In line with the liberal view, the rise in Atlantic trade is concomitant with Europe's pacification between 1640 and 1896 (Ahsan et al., 2022). The 1860 Anglo-French commercial treaty was signed to diffuse tensions between the two countries. Mercosur was created in 1991, in part, to curtail the military power in Argentina and Brazil, two recent and fragile democracies with potential conflicts over natural resources. In line with the realist view, one can draw parallels between the current China-US trade war and earlier historical episodes: for instance, the commercial confrontation between Germany and Great Britain around the turn of the twentieth century or the so-called Thucydides Trap that involved Athens and Sparta (Allison, 2012).

Beyond these anecdotes, what does long-run time-series evidence look like? In the data, the correlation between trade openness and military disputes may be driven by: (i) the impact of trade on war; (ii) the reverse causation from war to trade policies (e.g. economic sanctions); (iii) the presence of omitted (gravity-related) variables. For instance, it is well-known that having a common

[2]See Morelli and Sonno (2017) for an insightful discussion of the different schools of thought in international relations.

border significantly increases trade flows (Head and Mayer, 2014) and, at the same time, can be a source of political disputes between neighbors. Therefore, the evidence presented below should be interpreted as correlational rather than causal.

Figure 1: Global Trade and Interstate Conflicts



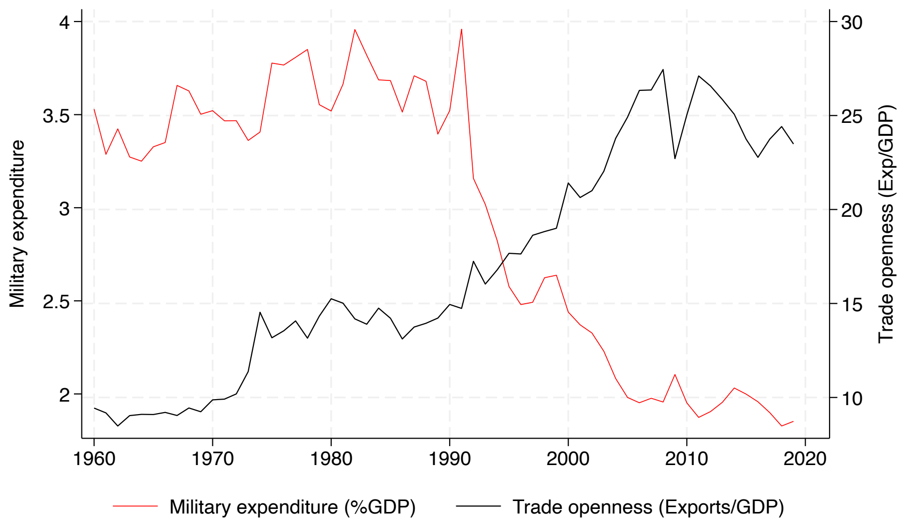
Source: Trade data come from Klasing and Milionis (2014), Federico and Tena-Junguito (2019) and Penn World Table (2023). Conflicts correspond to the Militarized Interstate Disputes (hostility levels 4 and 5) in the COW dataset.

Figure 1 illustrates the relationship between trade openness and military conflicts over the past two centuries. It reveals that this relationship is not straightforward. During the first wave of globalization in the late 19th century, characterized by increased trade openness, there were numerous military conflicts, including World War I.[3] During the interwar period, there was a simultaneous decline in both world trade and conflict. However, following World War II, there was a rapid increase in world trade accompanied by a decrease in the number of conflicts, despite the high risk of a global confrontation between the Eastern and Western blocks. Finally, the post 1990 period was marked by a dramatic increase in trade flows and a rise in the number of sovereign states; yet, there is no clear evidence indicating that this period had a lower prevalence of military conflict.

While wars are infrequently observed, the *threat* of war is a powerful driver of geopolitical relations. In line with this "out-of-equilibrium" view, an insightful approach involves examining the relationship between trade and the costs associated with deterring wars. Figure 2 displays the long-run evolution of world trade and military expenditure in the spirit of Seitz et al. (2015). Here, the evidence is more clear cut: the co-evolution of global trade and military spending in the long

[3] Figure 1 displays the (log) ratio between the yearly amount of militarized interstate disputes (MID, from the COW dataset) summed across all country-pairs divided by the total number of country-pairs in a given year. I retain MIDs characterized by use of force (hostility level 4) and military conflicts with at least 1000 deaths of military personnel (hostility level 5). Trade data come from three different sources (Klasing and Milionis, 2014; Penn World Table, 2023; Federico and Tena-Junguito, 2019) for the sake of having robust measures of historical trade openness, measured as the sum of world exports divided by world GDP.

Figure 2: Global Trade and Military Spending



Source: Military expenditures are measured in % of GDP and come from the Stockholm International Peace Research Institute; trade data come from Penn World Table (2023).

run is negative, a fact that was first documented in Acemoglu and Yared (2010). This correlational evidence is more clearly supportive of the liberal view.

3 Trade and War: Theory

In this section, a quantitative model of international trade and interstate war is built and simulated. The framework encompasses the different aspects of the existing theoretical literature and provides an overarching approach for reviewing the empirical literature in Section 4.

3.1 The standard argument on trade dependence and its pitfall

The logic of *Doux Commerce* is founded on the premise that increased trade openness promotes extensive economic interdependence, consequently raising the opportunity cost of engaging in warfare. A crucial aspect of this argument is that conflicts have the potential to disrupt trade and value chains: in the subsequent discussion, the available evidence that supports this hypothesis is analyzed.

Evidence on aggregate trade. A substantial body of empirical literature examines the impact of armed conflict on trade, with a focus on aggregate trade flows. Early studies conducted in both economics and political science have brought contrasting results. While the majority of studies find that war significantly disrupts trade flows (Keshk, Pollins, and Reuveny, 2004; Mansfield and Bronson, 1997; Pollins, 1989; Reuveny and Kang, 1998), others fail to observe any significant effect (Mansfield and Pevehouse, 2000; Morrow, Siverson, and Tabares, 1998; Morrow, 1999) . However, it is important to note that these studies have certain methodological issues that may compromise the accuracy of their findings. One of the limitations is their focus on politically significant cases involving major powers or neighboring nations. This exclusion of country-pairs with a low likelihood of conflict leads to sample selection biases. Moreover, these studies often fail to consider both the contemporaneous and lagged effects of war on trade or the third-party impacts of bilateral conflict. Additionally, most of these early studies use pooled estimators without pair-specific fixed effects and thus fail to account for the panel dimension of the data.

Empirical studies that use modern techniques from the gravity literature in international trade, such as those conducted by Blomberg and Hess (2006); Martin et al. (2008a,b) and Glick and Taylor (2010), provide precise estimates of the disruptive impact of war on trade. Among them, Glick and Taylor's study covers a particularly long period, spanning from 1870 to 1997, including the two major wars of the twentieth century. Their Figure 1 summarizes the key findings: during a conflict, trade is substantially reduced not only between belligerent nations (85% drop) but also with nations that are not directly involved in the conflict (12% drop). In both cases, trade gradually returns to its normal level, as predicted by gravity models, within approximately 10 years after the end of hostilities. The analysis conducted by Martin et al. (2008a), presented in Figures 4 and 5 of their study, reveals similar patterns with smaller quantitative effects. The contemporary decline in trade between belligerent nations is approximately 38%, while third-party trade remains unaffected. These somewhat weaker effects can be attributed to two reasons: first, their sample begins after 1950, excluding the world wars, and second, their analysis considers not only full-scale war events but also low-intensity disputes (coded as level 3 in the MID dataset). In the same vein, Fuchs and Klann (2013) confirm that even mild diplomatic incidents can disrupt trade. Their gravity estimates show that hosting high-level meetings with the Dalai Lama imposes costs on the host country, as it leads to a statistically significant reduction in bilateral trade with China in the subsequent year.

Firm-level data. More recent studies use firm-level data to examine war-induced trade disruption; their findings align with the literature based on aggregate data. Using granular data has allowed researchers to address potential reverse causation from trade to conflict and to identify the underlying mechanisms that contribute to trade disruption.

Korovkin and Makarin (2023) analyze the impact of the 2014 conflict between Russia and Ukraine on their bilateral trade. They find that the conflict reduced Ukraine's export shares to Russia by 62% (from 25.7% in 2012 to 9.9% in 2016) and Ukraine's import shares from Russia by 60% (from 32.4% to 13.1%). However, despite the conflict, Russia has remained Ukraine's largest trading partner, indicating that trade was not completely disrupted. By examining firm-level data, their study reveals an interesting finding: firms located in districts of Ukraine with a lower proportion of ethnic Russian residents experienced a greater decline in trade with Russia. This decline was associated with an erosion of trust and the emergence of local nationalism. This result supports theoretical research suggesting that wars can reduce trade by not only destroying physical capital but also increasing hostility between different groups and eroding intergroup trust (Rohner et al., 2013). With the objective of investigating the impact of low-intensity disputes, Michaels and Zhi (2010) examine how firm-level trade was affected by the deterioration of France-US relations following the French government's opposition to the US government's request for a UN Security Council mandate to use military force against Iraq in 2002-2003. Despite the absence of risk of bilateral war, economic sanctions, or formal trade barriers, the authors estimate that the change in attitudes led to a reduction in France-US bilateral trade of approximately 9 percent. Similar empirical patterns are documented in the other papers that use disaggregated data to analyze trade disruption caused by violence (Pandya and Venkatesan, 2016; Amodio and Di Maio, 2018; Ksoll et al., 2021).

A quantitative puzzle: the contribution of trade disruption to OCW. The second premise of the *Doux Commerce* argument is that war-induced trade disruption significantly contributes to increasing the opportunity cost of war. Upon initial examination, one might assume that trade losses due to war are insignificant compared to the vast economic and human costs of conflict. Existing research suggests that the welfare costs of interstate conflict are massive (Auray and Eyquem, 2019; Rohner and Thoenig, 2021). In contrast, the typical estimates of the welfare gains from trade are significantly smaller (Costinot and Rodríguez-Clare, 2014; Head and Mayer, 2014).

Surprisingly, there have been few attempts in the literature to assess the contribution of trade disruption to the OCW. To my knowledge, such an exercise has only been conducted by Glick and Taylor (2010). Their analysis shows that trade disruption substantially increased the cost of World War I and II. For example, averaging across all belligerents, they found that the cost of WWII amounted to 6.6% of their permanent flow GDP, while lost trade represented an average of 2.5% of their permanent GDP. This means that for those countries, foregone trade raised the cost of World War II by roughly one-third (2.5/6.6). It is worth noting that their estimates have been obtained with a methodology that predates the general equilibrium framework of structural gravity presented in the next section. Importantly, structural gravity is well suited for quantifying the contribution of trade flows to the OCW, thus filling a gap in the literature.

3.2 A quantitative model of trade and war

In this section, I build a generic model of international trade and interstate war that combines a structural gravity model of trade with a diplomatic game of escalation to conflict. The former provides a robust data-fed method to quantitatively assess the economic impact of war and policy shocks, while the latter addresses a conceptual challenge known as the paradox of war. This paradox captures why rational leaders, given the substantial costs of war, are not always able to deescalate tensions and prevent conflicts. Overall, this generic model streamlines and generalizes the approach of Martin et al. (2008a), which will be referred to as MMT henceforth. In particular, the results on the geoeconomic factors are not covered in their paper.

In the model, the escalation from geopolitical disputes to military conflict is conceptualized as a breakdown in diplomatic negotiations. Out of the many causes for interstate wars, I focus specifically on bargaining failure, for three reasons. First, according to Powell (2006), unresolved informational issues during negotiation (alongside commitment problems) constitute first-order factors leading to conflict. These informational problems stem from the well-known "fog of war", which encompasses the widespread uncertainty surrounding tactical military operations, their economic and human costs, the strategic development of the conflict, and its future political resolution. Second, the consideration of commercial interests is an essential component of any negotiation between states, even when the primary objective of the negotiation relates to geopolitical matter. Therefore, diplomacy is a natural margin through which trade acts on conflict. Third, the existing theoretical literature on the interaction between trade and the other causes of interstate wars is limited, with the notable exception of the paper by Bonfatti and O'Rourke (2018) on commitment.

3.2.1 Setup

There are N countries engaged in international trade, which is subject to spatial frictions that hamper the ability of workers to ship their production to non-local markets. These frictions give rise to a gravity equation of trade, which is essential for quantifying the opportunity cost of war. The specific details of the trade model are discussed in Section 3.2.3.

The occurrence of a geopolitical dispute between two potential belligerent countries, labeled i and j, is assumed. The dispute escalates into a war if diplomatic negotiations between their leaders fail. The remaining third countries, denoted as $n \neq i, j$, are considered neutral and do not interfere with the negotiation process to avoid the complexity of modeling third-party intervention. In the model, disputes are treated as exogenous factors, while the likelihood of escalation is endogenous.

The timing of the model is composed of the following stages: (0) dispute arises; (1) leaders of countries i and j choose an optimal negotiation protocol; (2) private information is revealed; (3) depending on the negotiation outcome, either peace or war between countries i and j occurs; (4) production, trade, and consumption are realized for all countries.

Preferences. Leaders care about welfare of the population and balance economic interests against geopolitical considerations when deciding to engage in war. Their utility criterion encompasses the (log of) real consumption C of a representative agent, supplemented by v that represents a state-controlled public good referred to as *geopolitical valence*. There are two mutually non-exclusive interpretations of geopolitical valence, both derived from the civil war literature (Esteban and Ray, 2011). First, it can be understood as an immaterial good—intangible incentives in the words of Blattman (2022)—that includes factors such as the geopolitical status or prestige of the country, moral values associated with maintaining peace (e.g. pacifism) or defending the country (e.g. nationalism), leaders' ego rents, etc. Alternatively, a purely economic interpretation of v is as a divisible material public good that can be transferred between countries. For instance, it can represent control over, or access to, a territory, a natural resource, a water body, etc. Technically, v serves as an "external" good (similar to the numeraire good in Grossman and Helpman, 1994) that is equally valued by all leaders. This assumption ensures that utility is transferable between countries in the diplomatic game.

Specifically, consider one of the two potential belligerent countries $k \in \{i, j\}$. At stage 2 (after information is revealed but before diplomatic negotiations start), utilities in peace and war are given by

$$U_k(\text{peace}) = \log C_k(\text{peace}) + v_k(\text{peace}), \tag{1}$$

$$\tilde{U}_k(\text{war}) = \log C_k(\text{war}) + v_k(\text{war}) + \tilde{u}_k, \tag{2}$$

where real consumption C_k is determined endogenously by the trade equilibrium, as described in Section 3.2.3. The terms $v_k(\text{peace})$ and $v_k(\text{war})$ represent the exogenous endowments of geopolitical valence in peace and war, respectively. To simplify notation, and without loss of generality, I set $v_k(\text{war}) = 0$ and $v_k(\text{peace}) = v_k \in \mathbb{R}$ for the remainder of the analysis. The term v_k captures the intrinsic attractiveness (positive valence, $v_k > 0$) or aversion (negative valence, $v_k < 0$) towards peace relative to war by the population and the leader. I refer to the random variable $\tilde{u}_k$ as the war shock, which can take positive or negative values. It captures the uncertainty surrounding both the economic and immaterial costs of war, reflecting the inherent fog of war that characterizes military operations. The war shock $\tilde{u}_k$ is privately observed by the leader of country k. Given that real consumption is represented in logarithmic form and utility is additively separable, the metrics of geopolitical valence v_k and war shock $\tilde{u}_k$ are expressed in percentage points of real consumption. Intuitively, this means that, holding everything else constant, agents are ready to sacrifice v_k percentage points of consumption to maintain peace (if $v_k > 0$) or to engage in war (if $v_k < 0$).

Most of the analysis focuses on the belligerent countries i and j due to their active role in the negotiation process. Nevertheless, for completeness, I specify the utility of third countries n as well. In their case, a war shock is not modeled, and their utility is contingent upon the occurrence of peace or war between countries i and j

$$U_n(\text{peace}) = \log C_n(\text{peace}) + v_n \qquad \text{and} \qquad U_n(\text{war}) = \log C_n(\text{war}). \tag{3}$$

Note that war directly impacts the belligerent countries, but it also has the potential to indirectly affect the consumption of all countries, including neutral ones, through the reconfiguration of the global trade matrix.

Finally, it is assumed that peace Pareto dominates war in the sense that belligerents' joint surplus in peace is larger that their joint surplus in war

$$\tilde{U}_i(\text{war}) + \tilde{U}_j(\text{war}) < U_i(\text{peace}) + U_j(\text{peace}). \tag{4}$$

This condition is not essential for the overall validity of the approach, but it is included for the sake of realism, as war leads to destruction. Intuitively, it states that (i) both countries are worse off in war compared to peace, or (ii) while one country may be better off in war than in peace, the gains of this "winning" country are strictly lower than the losses of the defeated country. It is worth noting that the setup allows for such a possibility, but it does not impose a requirement for a clear winner or loser in a war. This flexibility aligns well with many military conflicts.

A key factor influencing the belligerents' decision to settle disputes peacefully is the opportunity cost of war. This object is typically interpreted as an economic cost by scholars in the literature. In line with this tradition, I disregard geopolitical valence and define the opportunity cost of war for country i (and symmetrically for country j) as the logarithmic difference in its aggregate consumption between peace and war:

$$\texttt{OCW}_i \equiv \log C_i(\text{peace}) - \log C_i(\text{war}). \tag{5}$$

Quantitatively, $\texttt{OCW}_i$ can be interpreted as the war-induced drop in aggregate consumption expressed in percentage-points. I also define the utility cost of war as $\widetilde{\texttt{UCW}}_i \equiv U_i(\text{peace}) - \tilde{U}_i(\text{war})$. This random variable adds the geopolitical valence and the war shock to the OCW. Combining (1), (2) and (5) yields

$$\widetilde{\texttt{UCW}}_i = \texttt{OCW}_i + v_i - \tilde{u}_i. \tag{6}$$

3.2.2 A game of diplomatic negotiation

The avoidance of war hinges on a diplomatic agreement. The leaders of countries i and j must reach a consensus on a sharing rule for their joint surplus under peace (right-hand side of Equation 4), which they implement through a bilateral transfer of geopolitical valence denoted as T.

To understand the logic of the negotiations, let's start by discussing their functioning under perfect information, assuming that war shocks are publicly observed by both leaders. In this case, the dispute is peacefully resolved when leaders agree on a transfer T that improves the welfare of both countries compared to war

$$U_i(\text{peace}) - T > \tilde{U}_i(\text{war}) \qquad \text{and} \qquad U_j(\text{peace}) + T > \tilde{U}_j(\text{war}), \tag{7}$$

where $T > 0$ implies that i transfers utility to j (and vice versa for $T < 0$). By combining these two participation constraints, I obtain the condition that characterizes the set of transfers T^* which maintain peace

$$-\widetilde{\texttt{UCW}}_j < T^* < \widetilde{\texttt{UCW}}_i. \tag{8}$$

It follows from condition (4) that this set is non-empty. In other words, because peace Pareto-dominates war, there always exists a peace-maintaining transfer. Under perfect information, geopolitical disputes should never escalate to war, which is in line with the paradox of war mentioned previously.

In presence of asymmetric information regarding the war shock and the true cost of war, negotiations may fail despite peace Pareto dominating war. Indeed, since leaders privately observe $\widetilde{\texttt{UCW}}$, they have a strong incentive to strategically misreport it during negotiations. Intuitively, they should report a value that is lower than their true cost in order to extract more concessions from the other leader. To understand this, let's consider Equation (8): by announcing a small $\widetilde{\texttt{UCW}}_i$, the leader of country i intends to lower the peace-compatible transfer that should be conceded to the other leader. Conversely, by announcing a small $\widetilde{\texttt{UCW}}_j$, the leader of j signals that she expects to receive a larger transfer. This strategic behavior reduces the range of peace-compatible transfers. In the extreme case, both leaders may deflate their reported utility cost of war to such an extent that the set of peace-compatible transfers becomes empty.

Modeling diplomacy. A key insight in MMT is the modeling of diplomacy in a manner that is both general and tractable, allowing for easy integration with a trade model. They build upon one of the most influential frameworks in the mechanism design literature, namely the bargaining game under asymmetric information developed by Myerson and Satterthwaite (1983). To align the framework with the reality of diplomatic interstate negotiations, they introduce a few additional features:

- Diplomacy is unconstrained. This means that countries' leaders have the freedom to choose *any type* of diplomatic protocol for conducting the negotiation, without any restrictions. This includes options such as an ultimatum (i.e. a unilateral take-or-leave offer), a one-shot conference to settle peace, or a pre-determined sequence of meetings with offers and counter-offers. Ultimately, rational leaders will select the protocol that is most efficient in maximizing their utility before observing their private information. This assumption of unconstrained diplomacy adds realism to the model, and methodologically, it allows for theoretical results that are robust to specific modeling choices regarding the diplomatic institutional setting.

- Disagreement payoffs, which represent the utilities in war, are negatively correlated. This is reasonable because losses experienced by one country may partially correspond to gains for the other. Therefore, when leaders observe their own private information, it allows them to update their beliefs regarding the disagreement payoff of the other country. To capture this idea, MMT assume that $\tilde{u}_i$ and $\tilde{u}_j$ are jointly uniformly distributed over a triangle in $\mathbb{R}^2$ with a shape that implies a negative correlation between the two variables (the triangle MM_AM_B in Figure 3 of MMT). I follow the same approach and specify in addition that $\tilde{u}_i$ and $\tilde{u}_j$ vary within the domain $[0, 3\eta/4]$ where η is a positive parameter that captures the extent of informational asymmetry.[4]

- Leaders can always choose to unilaterally quit the negotiation table and enter into conflict, regardless of any attempts to prevent them. This feature implies weaker commitment mechanisms compared to the original model proposed by Myerson and Satherwaite.

Solving the game. A conceptual appeal of this diplomatic negotiation game is that, in spite of its inherent richness, the equilibrium of the game remains simple. I report below only the main equilibrium relationships and relegate all the computational details to Appendix A. Specifically, MMT show that the second-best protocol—the one that is optimally adopted by the two countries under imperfect information—is a Nash bargaining that takes the following form:

1. Leader of country $k \in \{i, j\}$ announces a utility cost of war $\widetilde{\texttt{UCW}}_k^a$. Note that in Equation (6), only the war shock is privately observed while the other two components are public information. Therefore, leaders can and will strategically misreport their true $\widetilde{\texttt{UCW}}_k$. This is why their

[4]Setting the bounds of the domain of variations of the war shocks is a matter of normalization in all formulas and has no consequence on the analysis. Assuming a zero lower bound implies $\max U\tilde{C}W_i(\text{war}) = OCW_i + v_i - \min \tilde{u}_i = OCW_i + v_i$.

announcements depend on the realization of the underlying war shocks.[5]

2. Country leaders check whether the two announcements are compatible with the aggregate resource constraint given by (4). This compatibility condition can be expressed as:

$$0 < \widetilde{\texttt{UCW}}_i^a + \widetilde{\texttt{UCW}}_j^a.$$

3. In the case of incompatible announcements, diplomatic negotiations are halted, and war is initiated, with each country receiving its true utility in war.

4. In the case of compatible announcements, peace is maintained, and the following (positive or negative) utility transfer $\widetilde{T}_{ij}$ from country i to country j is implemented

$$\widetilde{T}_{ij} = \frac{\widetilde{\texttt{UCW}}_i^a - \widetilde{\texttt{UCW}}_j^a}{2}. \tag{9}$$

Country i concedes a positive transfer to country j when the utility cost of war announced by its leader is larger than the one announced by the other leader. Conversely, if the announcement of i is smaller, i receives a positive transfer. Hence, the preceding equation highlights the incentive for each leader to announce the smallest possible utility cost of war. This allows them to extract more concessions and receive a larger transfer. However, there is a trade-off because this increases the risk of violating the compatibility condition and breaking the negotiations. Denoting s_{ij} as the probability of a successful negotiation, it is equal to the minimum value between 1 and

$$\texttt{Pr}(\text{de-escalation}) = s_{ij} = \frac{9}{16} \frac{\left[\max \widetilde{\texttt{UCW}}_i + \max \widetilde{\texttt{UCW}}_j\right]^2}{\left[\max \widetilde{\texttt{UCW}}_i - \min \widetilde{\texttt{UCW}}_i\right] \times \left[\max \widetilde{\texttt{UCW}}_j - \min \widetilde{\texttt{UCW}}_j\right]}. \tag{10}$$

The numerator captures the maximal loss in term of joint surplus of i and j when war occurs. The denominator is a measure of the (uniform) dispersion of private information. Hence, negotiations tend to fail more (with probability $1 - s_{ij}$) when uncertainty is high and the realization of $\widetilde{\texttt{UCW}}$ is low: in this configuration, leaders are indeed unable to distinguish between strategic misreporting and truthful reporting, leading to a breakdown in negotiations and an escalation into war.

Replacing utility cost with its functional form (6) and using the fact that $\tilde{u}_i$ and $\tilde{u}_j$ vary in the range $[0, 3\eta/4]$, I obtain

$$\begin{aligned} s_{ij} &= \frac{1}{\eta^2} \times \left[\texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j\right]^2 \quad \text{for} \quad \texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j < \eta \\ &= 1 \quad \text{for} \quad \texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j \geq \eta. \end{aligned} \tag{11}$$

Under the retained distributional assumptions, the variance of $\widetilde{\texttt{UCW}}$ is equal to $\eta^2/32$. Hence, the exogenous parameter η^2 measures the extent of asymmetric information. It is worth noting that all

[5]It is optimal for each leader to announce

$$\widetilde{\texttt{UCW}}_i^a = \frac{2}{3}\widetilde{\texttt{UCW}}_i + \frac{1}{12} \max \widetilde{\texttt{UCW}}_i - \frac{1}{4} \max \widetilde{\texttt{UCW}}_j.$$

variables are scaled in percentage-points of real consumption. Therefore, the probability of peace is a-dimensional and corresponds to a ratio of squared percentage-points. The interpretation is straightforward. Any increase in the OCW or geopolitical valence for one of the countries translates into better chances to settle the dispute and avoid war. By contrast, more dispersed private information harms the odds of a successful negotiation and makes peace less likely. Conversely, for a low enough dispersion of private information, negotiation always succeeds and peace is maintained with certainty.

Geoeconomic factors. The computations of the geoeconomic factors are detailed in Appendix A. The discussion above shows that a peaceful settlement is reached whenever the realization of $\widetilde{\texttt{UCW}}$ is large. It is only for the bottom of the distribution that disputes escalate into war. In other words, even when they fail to settle peace, diplomatic negotiations have the virtue of avoiding the most destructive forms of wars. This translates into the property that the average utility cost of war, conditional on escalation to war, is smaller than its unconditional average:[6]

$$\mathbb{E}\left[\widetilde{\texttt{UCW}}_i|\text{war}\right] = \mathbb{E}\left[\widetilde{\texttt{UCW}}_i\right] - \texttt{WIM}_i, \tag{12}$$

where $\texttt{WIM}_i \geq 0$ stands for the *War Intensity Mitigation* effect of diplomacy

$$\texttt{WIM}_i = \frac{1}{4}\frac{\left[\texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j\right]^2}{\eta + \texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j}. \tag{13}$$

Note that $\texttt{WIM}_i$ is defined only when war has a non-zero probability of occurence, namely for $s_{ij} < 1$ in Equation (11).

Whenever diplomacy is successful, one country has to concede some utility transfer to the other. Using (9), one obtains the expected value of the transfer from i to j conditional on peace—a variable that is denoted hereafter *Peace-Keeping Cost*:

$$\mathbb{E}\left[\widetilde{T}_{ij}|\text{peace}\right] \equiv \texttt{PKC}_i = \frac{\texttt{OCW}_i + v_i - \texttt{OCW}_j - v_j}{2}. \tag{14}$$

In expectation, country i has to concede a positive transfer whenever the differential between $\widetilde{\texttt{UCW}}_i$ and $\widetilde{\texttt{UCW}}_j$ is positive. Indeed, such a positive differential tends to lower i's negotiation power in the diplomatic game. The logic is reversed in the case of a negative differential.

I now compute the ex-ante expected welfare, at stage (1) of the game, namely just after the geopolitical dispute arises but before diplomatic negotiations are settled. By construction, expected utility conditional on war is equal to $\left(U_i(\text{peace}) - \mathbb{E}\left[\widetilde{\texttt{UCW}}_i|\text{war}\right]\right)$ and expected (post-transfer) utility conditional on peace is equal to $\left(U_i(\text{peace}) - \mathbb{E}\left[\widetilde{T}_{ij}|\text{peace}\right]\right)$. Combining these two relations

[6] Given the retained distributional assumption, one gets $\mathbb{E}\tilde{u} = \frac{\eta}{4}$. Using Equation (6) leads to

$$\mathbb{E}\left[\widetilde{\texttt{UCW}}_i\right] = \texttt{OCW}_i + v_i - \frac{\eta}{4}.$$

with Equation (12), one obtains:

$$\mathbb{E}\tilde{U}_i = U_i(\text{peace}) - s_{ij} \times \texttt{PKC}_i - (1 - s_{ij}) \times \left(\texttt{OCW}_i + v_i - \frac{\eta}{4} - \texttt{WIM}_i \right). \tag{15}$$

In the preceding relation, the variables $\{s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$ can be all derived from $\texttt{OCW}_i$ through the relations (11), (13) and (14). In the rest of the paper, these four variables are referred to as the vector of *geoeconomic factors*, and most of the quantitative analysis aims to quantify their relative strength. The relation also highlights the multi-faceted welfare impact for country i of increasing $\texttt{OCW}_i$, namely its opportunity cost of war with j. First, it reduces welfare simply because the costs are larger in wartime.[7] Second, it diminishes country i's diplomatic negotiation power, and the country is compelled to make more concessions to maintain peace. This peace-keeping channel also reduces welfare. Third, it raises the probability of a peaceful settlement, thereby enhancing welfare.

3.2.3 Trade Equilibrium

The model is closed by plugging the diplomatic game into a general equilibrium model of trade, drawing upon the extensive literature on structural gravity surveyed by Costinot and Rodríguez-Clare (2014) and Head and Mayer (2014). Despite variations in their micro-foundations, this broad class of models shares two key features: (i) they model trade flows in general equilibrium within a multi-country world, which is crucial for our purposes as it allows countries to diversify their import sources and reduce dependence on a single partner; (ii) a central component of these models is the gravity equation, which is used to derive the aggregate gains of trade and the OCWs.

With the aim of streamlining the exposition, I employ one of the simplest quantitative trade models, namely the one originally derived by Anderson (1979). However, it is important to note that the tools introduced in this section can be refined and applied to a variety of economic environments.

Each country i, populated by L_i workers, produces a single variety of a tradable good, and is the sole source of this variety. Consumers in country n have a CES utility over all available varieties, given by

$$U_n = \left(\sum_i (q_{in})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{16}$$

with $\sigma > 1$. I further assume perfect competition and iceberg trade costs τ_{in}, the market price being

$$p_{in} = \frac{\tau_{in} w_i}{A_i}, \tag{17}$$

with w_i and A_i representing wage and productivity, respectively. The consumer price index asso-

[7] Computations show that the term $(\texttt{OCW}_i - \texttt{WIM}_i)$ is an increasing function of $\texttt{OCW}_i$.

ciated to the CES utility is then given by

$$P_n \equiv \left(\sum_{i=1}^{N} p_{in}^{1-\sigma} \right)^{1/(1-\sigma)} = \left(\sum_{i=1}^{N} \left(\frac{\tau_{in} w_i}{A_i} \right)^{1-\sigma} \right)^{1/(1-\sigma)}. \tag{18}$$

Let Y_{in} denote the value of country n's imports from country i. Given CES utility, it is equal to $Y_{in} = (\frac{p_{in}}{P_n})^{1-\sigma} \times E_n$ where E_n stands for aggregate expenditure. Combined with Equation (18), one obtains the bilateral trade flow

$$Y_{in} = \frac{(\tau_{in} w_i / A_i)^{1-\sigma}}{\sum_k (\tau_{kn} w_k / A_k)^{1-\sigma}} \times E_n, \tag{19}$$

which yields the classical formulation of the gravity equation of trade for goods.[8] The gravity equation can be expressed in terms of share of aggregate expenditure E_n that consumers in country n spend on the variety imported from i:

$$\pi_{in} \equiv \frac{Y_{in}}{E_n} = \frac{(\tau_{in} w_i / A_i)^{1-\sigma}}{\sum_k (\tau_{kn} w_k / A_k)^{1-\sigma}}. \tag{20}$$

As explained below, the matrix of import shares $\{\pi_{in}\}$ will play a crucial role in the determination of the OCWs.

In a competitive equilibrium, goods market clearing implies that the aggregate trade revenues of producing country i are the sum of trade revenues from all destination countries n (including internal trade): $w_i \times L_i = \sum_n \pi_{in} E_n$. And the budget constraint implies that trade revenues are equal to expenditures: $w_n \times L_n = E_n$. Combining these two equations with the gravity equation (expressed in shares) leads to

$$w_i L_i = \sum_{n=1}^{N} \frac{(\tau_{in} w_i / A_i)^{1-\sigma}}{\sum_k (\tau_{kn} w_k / A_k)^{1-\sigma}} w_n L_n. \tag{21}$$

This system of N equations has N unknowns, represented by the wage vector $\{w_i\}$. According to Walras's Law, one of these equations is redundant, meaning that wage levels are only determined up to a constant. Once wage levels are known, the matrix of bilateral trade shares, $\{\pi_{in}\}$, can be computed using the gravity equation. Expenditure levels are then obtained from the budget constraint. This fully describes the model.

3.3 Computing OCWs

The objective of this section is to compute the OCWs, which serve as the basis for determining other geoeconomic factors. Equation (5) indicates that OCWs can be derived by comparing the real consumption of each country during wartime and peacetime. Therefore, the analysis involves comparing the economic equilibrium in peace (factual) with the hypothetical state of war between

[8] Many other microfoundations lead to the same gravity equation, including Armington (1969); Anderson and van Wincoop (2004); Krugman (1980); Eaton and Kortum (2002); Chaney (2008) models.

countries i and j (counterfactual). Methodologically, techniques introduced by the trade literature are used for conducting this counterfactual analysis, commonly known as exact hat algebra. This approach, popularized by Dekle et al. (2008), leverages the CES structure of the model to express proportional changes (indicated by the hat notation) in import shares and real consumption resulting from war as a function of the *import shares observed in peacetime*, along with a concise set of structural parameters. An appealing aspect of this approach is that it does not necessitate solving the model in levels, thereby reducing data requirements significantly.

War damages. Essential to the analysis is the modeling of how war affects the economy, and there are various degrees of freedom in doing so. To strike a balance between simplicity and realism, I adopt the following parameterization for war damages:

- Human losses: belligerents have casualties. The wartime over peacetime population ratio is equal to $\hat{L}_i < 1$ and $\hat{L}_j < 1$.
- Economic damages: belligerents experience a drop in productivity. Wartime over peacetime ratio of productivity is equal to $\hat{A}_i < 1$ and $\hat{A}_j < 1$.
- Trade logistics disruption: In line with empirical evidence surveyed in section 3.1, trade frictions increase between belligerents and with the rest of the world. Wartime over peacetime ratios of frictions are equal to: $\hat{\tau}_{ij} = \hat{\tau}_{ji} = \hat{\tau}_{\text{bil}} > 1$ and $\hat{\tau}_{ni} = \hat{\tau}_{nj} = \hat{\tau}_{\text{mul}} > 1$. Frictions between third countries are assumed to be unaffected: $\hat{\tau}_{nm} = 1$ for $n, m \neq i, j$. Because war increases spatial frictions, it induces a partial move back to autarky. Therefore, the foregone trade gains become a significant component of the costs associated with war.

These assumptions are natural and general, but it is important to note that the model can be extended to accommodate more complex scenarios.

Exact Hat Algebra. Below I outline the computation of $\texttt{OCW}_i$, noting that the same procedure applies to $\texttt{OCW}_j$. The core of the procedure is dedicated to computing the consumption change between peace (factual) and war (counterfactual scenario). This change is then plugged into Equation (5) to determine $\texttt{OCW}_i$ which, in turn, is used in Equations (11), (13), and (14) to obtain the other geoeconomic factors. Despite the complexity of the spatial structure in the trade model, the overall procedure remains simple due to the CES form of the gravity equation.

I start from the gravity equation expressed in shares (Equation 20) and focus on internal trade (or "self imports"), defined as the consumption of goods produced locally. Because internal spatial frictions are normalized $\tau_{ii} = 1$, the share of internal trade in expenditure of i is equal to

$$\pi_{ii} = \frac{(w_i / A_i)^{1-\sigma}}{P_i^{1-\sigma}}, \tag{22}$$

where the price index is given by Equation (18). Simple manipulation of the previous equation yields real consumption

$$C_i \equiv \frac{w_i}{P_i} = A_i \pi_{ii}^{1/(1-\sigma)} \tag{23}$$

By applying this formula to the factual and counterfactual scenarios under consideration, one can calculate the war-induced loss in real consumption

$$\frac{C_i(\text{war})}{C_i(\text{peace})} = \frac{\hat{A}_i}{\hat{\pi}_{ii}^{1/(\sigma-1)}} \tag{24}$$

where $\sigma - 1 > 0$ is often referred to in the literature as the trade elasticity and $\hat{\pi}_{ii}$ represents the wartime over peacetime ratio of internal trade. The previous relation essentially translates the well-known welfare formula discovered by Arkolakis et al. (2012) to a conflict context. The interpretation is straightforward. The numerator indicates that the exogenous war-induced productivity loss leads to a decrease in consumption, as $\hat{A}_i < 1$. On the other hand, the denominator states that any increase in internal trade, represented by $\hat{\pi}_{ii} > 1$, which can be seen as a move towards autarky, results in a loss in consumption. Conversely, a war-induced decrease in internal trade, denoted by $\hat{\pi}_{ii} < 1$, would increase consumption.

Whether the endogenous variable $\hat{\pi}_{ii}$ is larger or lower than 1 is key for understanding the change in real consumption. Yet, at this stage of the procedure, it is still unknown. To characterize it, I apply the hat-algebra to (18) and (22) using the parameters retained for the war damages (see Appendix B)

$$\hat{\pi}_{ii} = \left[\pi_{ii} + \pi_{ji}\left(\frac{\hat{\tau}_{\text{bil}}\hat{A}_i\hat{w}_j}{\hat{A}_j\hat{w}_i}\right)^{1-\sigma} + \sum_{n\neq i,j}\pi_{ni}\left(\frac{\hat{\tau}_{\text{mul}}\hat{A}_i\hat{w}_n}{\hat{w}_i}\right)^{1-\sigma}\right]^{-1}, \tag{25}$$

where $\hat{w}$ represents the wartime over peacetime ratio of wages. I explain now how the previous equation links the change in internal trade to the changes in price competition between firms operating on the domestic market of i :

i/ The first term captures the competition among domestic firms; this margin is unaffected by war.

ii/ The second term captures $\widehat{\frac{p_{ji}}{p_{ii}}}$, namely the war-induced change in the relative price of imports from j compared to domestic goods (see Equation 17). Three factors contribute to it: the rise in bilateral trade frictions ($\hat{\tau}_{\text{bil}} > 1$); differential in economic damages ($\hat{A}_i/\hat{A}_j$) and relative changes in wages between belligerents ($\hat{w}_j/\hat{w}_i$).
An increase in this relative price ($\widehat{\frac{p_{ji}}{p_{ii}}} > 1$) translates into a decrease in country j's market share ($\widehat{\frac{p_{ji}}{p_{ii}}}^{1-\sigma} < 1$) and an increase in internal trade (i.e. $\hat{\pi}_{ii} > 1$). The logic is symmetrical when the price decreases.

iii/ In the same spirit, the third term captures the change in the relative price of imports from third countries ($\widehat{\frac{p_{ni}}{p_{ii}}}$). Any increase in this price translates into an increase in internal trade. Consequently, the war-induced rise in multilateral trade frictions ($\hat{\tau}_{\text{mul}} > 1$) contributes to increasing internal trade. By contrast, the economic damages that are experienced by i but not by the third countries ($\hat{A}_i < 1$) contribute to decreasing internal trade.

In Equation (25), wage changes are still unknown at this stage of the procedure. They are obtained as a solution to the general equilibrium system of equations (21) expressed in hat-algebra

$$\hat{w}_i = \frac{1}{w_i L_i \hat{L}_i} \sum_{n=1}^{N} \frac{\pi_{in} \left(\frac{\hat{\tau}_{in} \hat{w}_i}{\hat{A}_i}\right)^{1-\sigma}}{\sum_k \pi_{kn} \left(\frac{\hat{\tau}_{kn} \hat{w}_k}{\hat{A}_k}\right)^{1-\sigma}} \hat{w}_n \hat{L}_n w_n L_n. \tag{26}$$

This provides a system of N equations with N unknowns corresponding to the vector of wage changes $\hat{\mathbf{W}} \equiv \hat{w}_i$. The damage parameters $\left(\hat{\tau}, \hat{L}, \hat{A}\right)$ and the trade elasticity $\sigma - 1$ are given; peacetime import shares (the πs) are observed, as is peacetime aggregate income wL.

Quantification of geoeconomic factors: Full procedure

The method for calculating the geoeconomic factors involves the following steps:

1. Retrieve the war damages parameters and trade elasticity from external calibration or gravity estimates (see Section 3.5). These values may vary depending on the type of war under consideration (e.g., high- vs low-intensity, symmetrical or asymmetrical, etc.).

2. Along with the value of aggregate income ($w_i L_i$), the trade share matrix observed in peacetime (π_{in}), plug the damage parameters of step 1 into Equation (26). Using an iterated fixed point procedure with a dampening factor, find the vector of wage changes $\hat{\mathbf{W}} \equiv \hat{w}_i$ that solves Equation (26).

3. Substitute the wage changes into Equation (25) to recover the change in internal trade $\hat{\pi}_{ii}$.

4. Combine Equations (5) and (24) to obtain $\texttt{OCW}_i = -\log \hat{A}_i + \frac{1}{\sigma - 1} \log \left(\hat{\pi}_{ii}\right)$.

5. Use Equations (11), (13) and (14) to compute $\{s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$.

It is important to acknowledge that this analytical framework has certain limitations and omissions. One notable omission is the lack of sector-level heterogeneity and input-output linkages in the model. Specifically, sectors such as weapons, electronics, and energy play a critical role in the conduct of warfare, and disruptions in trade involving these sectors can have a significant impact on the OCW. Another limitation is the assumption that trade costs between third countries are unaffected by the bilateral conflict.

3.4 Geography of Import Sourcing

I now examine the impact of external trade dependence on the OCW and other geoeconomic factors of the countries i and j. The analysis will reveal that the relevant dimension for geopolitics is not the overall level of trade openness, but rather the geography of import sourcing (GIS) of the country-pair.[9] GIS is defined as the relative shares of bilateral and multilateral imports in aggregate expenditure observed during peacetime. Equation (25) highlights the role of GIS by connecting the war-induced change in i's internal trade to the shares of bilateral imports (π_{ji}) and multilateral imports ($\sum_{n\neq i,j}\pi_{ni}$). Interpreting this connection is challenging as it involves changes in relative prices, which are influenced by the endogenous wage changes $\hat{w}$. And wage changes are themselves determined through the system of non-linear equations in (21).

First-order approximation. To make progress, it is useful to rely on an approximated version of Equation (25). The approach is based on the consistent observation by previous quantitative trade models based on a structural gravity framework, similar to ours, that the endogenous changes in incomes or wages tend to have a marginal impact on the results of counterfactual simulations. This observation holds for various empirically relevant trade shocks and policies, such as regional trade agreements (RTAs), the European Union (EU), the North American Free Trade Agreement (NAFTA), and the adoption of a common currency, among others. The point was first highlighted in the seminal paper by Anderson and van Wincoop (2004), where the counterfactual scenario involved a significant shock, namely the removal of the Canada-US border. Subsequent studies, such as Head and Mayer (2014) in their Table 3.6, provide further systematic evidence supporting this finding by considering a wide range of trade shocks and policies. Based on these considerations, Head and Mayer demonstrate that incorporating price index changes along with the trade shocks, is sufficient for obtaining precise enough quantification. Their Modular Trade Impact (MTI) approach is basically a first-order approximation of the counterfactual equilibrium where the price index is endogenously adjusted but all the changes in wages $\hat{w}$ are neglected. Many papers simulate counterfactuals using MTI and Glick and Taylor (2010) have applied this methodology to quantify the costs of military conflicts (see the discussion on page 8). Applying the MTI approach to Equation (25) and combining with (24), one obtains the following first-order approximation of OCW (see Appendix C):

<u>Quantification of geoeconomic factors: Approximated procedure</u>

Along with the trade share matrix observed in peacetime (π), plug the damage parameters into the following equation:

$$\texttt{OCW}_i = \alpha_i + \pi_{ji}\left(\tau_{\text{bil}} - \alpha_i + \alpha_j\right) + \sum_{n\neq i,j} \pi_{ni}\left(\tau_{\text{mul}} - \alpha_i\right), \tag{27}$$

where, for notational convenience, all war damage parameters (now without the hat notation) are scaled in % change: $1-\alpha_i \equiv \hat{A}_i$, $1-\alpha_j \equiv \hat{A}_j$, $1+\tau_{\text{bil}} \equiv \hat{\tau}_{\text{bil}}$ and $1+\tau_{\text{mul}} \equiv \hat{\tau}_{\text{mul}}$.

Use Equations (11), (13) and (14) to compute $\{s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$.

[9] A recent line of research, initiated by Antras et al. (2017), examines supply chain diversification in response to global disruptions caused by epidemics, conflicts, political or social unrest (Bonadio et al., 2021; Grossman et al., 2021). However, in these studies, the endogenous decision of firms regarding foreign sourcing does not feedback on the exogenous risk of trade disruption, which is precisely the mechanism addressed in this section.

Equation (27) highlights the first-order channels through which trade openness affects OCW. This equation also has a straightforward quantitative interpretation, with all variables scaled in percentage-points:

- Trade logistics disruption: Because bilateral and multilateral imports are all disrupted during war, larger shares of both types of imports increase the opportunity cost of war (OCW). For instance, a 1 percentage-point increase in the share of bilateral (resp. multilateral) imports in country i's consumption basket results in a τ_{bil} (resp. τ_{mul}) percentage-point drop in consumption during wartime, which is equivalent to an increase in the OCW.

- Consumption Insurance: The decrease in wartime productivity leads to an increase in the relative price of goods produced by the belligerents compared to those produced in third countries. As a result, multilateral import sourcing serves as a form of insurance for the consumption basket, reducing OCW by the amount $-\pi_{ni}\alpha_i$. On the other hand, for bilateral import sourcing, this insurance effect comes into play only if destruction affects the domestic economy more than the enemy's economy, that is, when $-\alpha_i + \alpha_j < 0$.

- It is important to note that the parameters representing human losses do not appear in Equation (27). However, in the full computational procedure of OCW, population losses do affect income changes (the term $\hat{L}$ in Equation 26), which in turn impact internal trade and OCW ($\hat{w}$ in Equation 25). The wage channel being neglected in the approximation procedure, human losses are not included in the equation.

GIS and high-intensity symmetrical warfare. To further refine the analysis, I now focus on *symmetrical warfare*, which refers to conflicts where the belligerents possess comparable military capabilities. This type of war is commonly observed in interstate conflicts involving major powers and is often characterized by high-intensity violence.[10] In line with this view, the analysis is restricted to the following regime of war damage parameters: $\alpha_i = \alpha_j = \alpha$ and $\alpha > \tau_{\text{mul}}$. The first condition captures the requirement for symmetry in military power; the second condition assumes that high-intensity warfare results in significant economic damages that overturn the disruption of multilateral trade. It is worth noting that the latter condition is often met based on the parameter values commonly observed in the literature (see Table 1). Plugging these parameter restrictions into (27) and combining with (11), one gets the probability that diplomatic negotiations manage to successfully prevent a high-intensity symmetrical war:

$$s_{ij} = \frac{1}{\eta^2} \times \left[2\alpha + \tau_{\text{bil}} \times \left(\pi_{ji} + \pi_{ij} \right) - (\alpha - \tau_{\text{mul}}) \times \sum_{n \neq i,j} \left(\pi_{ni} + \pi_{nj} \right) + v_i + v_j \right]^2, \tag{28}$$

and $s_{ij} = 1$ when the RHS is larger than 1.

[10] Conceptually, many theoretical papers that model the intensity of violence rely on the contest success function. According to this framework, a key theoretical prediction is that symmetry in the balance of military power leads to higher levels of violence. In contrast, an asymmetric balance of power tends to result in low-intensity conflicts (see Rohner and Thoenig (2021) for a demonstration).

The preceding relation highlights how the GIS influences peace: bilateral sourcing facilitates diplomacy (positive impact of $(\pi_{ji} + \pi_{ij})$), while multilateral openness goes against it (negative impact of $\sum_{n \neq i,j} (\pi_{ni} + \pi_{nj})$). MMT originally derived this theoretical prediction in a less general modeling setup. The current analysis shows that their finding can be extended to the broad class of structural gravity models. Empirical tests of the prediction have been performed in several papers, which are surveyed in Section 4.

One direct implication of this result is that the impact of regional and multilateral trade liberalization on the prevalence of war can differ significantly. While RTAs between a group of countries may lower the incidence of regional conflicts, they may increase conflicts with other regions. On the other hand, multilateral trade liberalization may lead to an increase in the occurrence of bilateral conflicts. These findings have important policy implications and highlight the need for careful quantification of the potential unintended consequences of trade liberalization initiatives in a conflict-prone context. I refer to these consequences as the *geoeconomic welfare gains* attached to trade policy. Their analysis and quantification are presented in Section 5.

The case of low-intensity asymmetrical warfare. The case of asymmetric warfare is less relevant for our purpose of studying interstate war as it typically involves a standing, professional army against an insurgency or resistance movement militias. It is often associated to low-intensity violence (for the reasons discussed in footnote 10). To model this type of warfare, I set the parameters such that all the economic costs are incurred by i instead of being equally split: $\alpha_i = \alpha$ and $\alpha_j = 0$ and $\alpha - \tau_{\text{mul}} > 0$. The probability of a successful deescalation of disputes in the shadow of asymmetrical warfare is given by:

$$s_{ij} = \frac{1}{\eta^2} \times \left[\alpha + (\tau_{\text{bil}} - \alpha) \times \pi_{ji} + \tau_{\text{bil}} \times \pi_{ij} - (\alpha - \tau_{\text{mul}}) \times \sum_{n \neq i,j} \pi_{ni} + \tau_{\text{mul}} \times \sum_{n \neq i,j} \pi_{nj} + V_{ij} \right]^2 . \quad (29)$$

The relationship between GIS and peacekeeping is more nuanced in the context of asymmetric warfare. There is an ambiguity regarding the sign of $(\tau_{\text{bil}} - \alpha)$. However, the calibrated parameters in Table 1 suggest that this difference is indeed positive. Therefore, the conclusion regarding bilateral sourcing remains unchanged: bilateral sourcing facilitates diplomacy. However, in the case of multilateral sourcing, the effect differs depending on whether it is the "weak" side (country i) or the "strong" side (country j). Multilateral sourcing of the weak side hinders diplomacy, while multilateral sourcing of the strong side facilitates it.

3.5 Quantification of geoeconomic factors.

In this section, the preceding numerical procedure is applied to quantify the geoeconomic factors related to prominent country-pairs. The objective is to illustrate the method and document empirically how the GIS impacts geopolitics. For simplicity, I make use of the approximated formula (27) in the numerical analysis. However, it is recommended that future studies aiming to compute precise estimates of OCWs use the full (non-approximated) procedure as described on page 19.

Calibration of the parameters. Table 1 presents the calibrated parameters that are essential for the numerical procedure. For the sake of brevity, I focus solely on the case of high-intensity symmetrical warfare. Below, a summary of how these parameters are recovered is provided.

The trade disruption parameters are retrieved from Glick and Taylor (2010) who analyze a sample covering the two world wars. Their gravity estimates indicate that trade between belligerent countries declines by 85% compared to gravity-predicted trade, and by 12% with neutral countries. To match these numbers, I set τ_{bil} and τ_{mul} such that $0.15 = (1 + \tau_{\text{bil}})^{1-\sigma}$ and $0.88 = (1 + \tau_{\text{mul}})^{1-\sigma}$. From the meta-analysis in Head and Mayer (2014) the trade elasticity is set to $1 - \sigma = -5$.

Economic damages are obtained from Chupilkin and Kóczán (2022). Their estimates of war-induced loss in Total Factor Productivity (TFP) are based on a synthetic control method applied to a comprehensive database of nearly 400 wars spanning the past two centuries. They provide estimates for both symmetrical and asymmetrical wars, referred to as "off" and "on" territory in their study, but our focus is on the former case. From their Figure 3, I set $\alpha = \alpha_i = \alpha_j = 8\%$, which represents the average TFP loss one year after the end of an interstate war.

The calibration of the human loss parameters is based on the total military casualties incurred by Germany during the period of 1939-1945. I rely on the estimate provided by Overmans (2004), which indicates 5.3 million dead soldiers out of a population of 69.3 million according to the official 1939 German census. As a result, I set $\lambda_{\text{pop}} \equiv \hat{L}_i - 1 = \hat{L}_j - 1 = 1 - 5.3/69 = 8\%$.

This set of parameters is sufficient for estimating OCWs. However, in order to calculate the other geoeconomic factors, one needs to calibrate two additional parameters, η and v. The parameter representing informational noise in diplomatic negotiations, η, is internally calibrated. To accomplish this, I first estimate the distribution of OCWs (see below) for which knowledge of this parameter is not required. Then I set $\eta = 16.3\%$ such that the support of the theoretical (uniform) distribution of war shocks closely aligns with the empirical distribution of OCWs. Specifically, I choose a value of η such that the empirical distribution of OCWs spans approximately 6 standard deviations, which corresponds to capturing 99.7% of the total mass in the case of a Gaussian distribution.

There is no systematic way of observing, estimating, or calibrating the geopolitical valence of peace v. This highly context-dependent variable varies across country-pairs and disputes. In the analysis, I opt for setting all valence terms to zero: $v_i = v_j = 0$. Hence, the quantification of geoeconomic factors is performed under the assumption that there is no intrinsic preference for peace or war and only economic considerations are taken into account in the decision to wage war. Although this hypothesis does not capture the complexity of real-world negotiations, it serves as a useful benchmark that informs us on the state of affairs when political, cultural and moral factors do not interfere with diplomacy.

Results. Trade shares used for the simulations come from the dataset assembled by Head and Mayer (2021) that reports self-trade and bilateral trade for a panel of 153 countries over 1970-2018. The calculation of the vector of geoeconomic factors $\{\texttt{OCW}_i, s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$ is based on equations (27), (11), (13) and (14) respectively. On top of these variables, I also compute the *Pivotal*

Table 1: Calibration of war damages

parameter	$1-\sigma$	τ_{bil}	τ_{mul}	α	λ_{pop}	η	v
value	-5	0.461	0.026	0.08	0.08	0.16	0

Note: see the text for the informational sources and the calibration procedure.

Valence of Peace that is equal to $\texttt{PVP}_{ij} \equiv \eta - (\texttt{OCW}_i + \texttt{OCW}_j)$. In Equation (11), this corresponds to the cutoff value of geopolitical valence above which diplomacy always manages to secure peace. Mathematically, for all valences such that $v_i + v_j \geq \texttt{PVP}_{ij}$, the probability of diplomatic success is $s_{ij} = 1$. Intuitively, when $\texttt{PVP}_{ij} > 0$, peace can be enforced with certainty only if the two countries have an intrinsic preference for peace (positive valence): in this case, *economic incentives alone (i.e. the OCWs) are not strong enough to guarantee peace*. Conversely, when $\texttt{PVP}_{ij} < 0$, OCWs are large enough to ensure peace with certainty even in the presence of intrinsic preferences for war (negative valence).

Table 2 presents the results, taking 2018 as the reference year, for some prominent country-pairs with an intense history of bilateral violence (displayed in Table 3) and located in various continents. Each row reports the geoeconomic factors attached to a geopolitical dispute susceptible to escalate into a symmetrical high-intensity armed conflict between the two countries under consideration. The last row provides the estimates averaged across all pairs of countries located within a 1000km distance from each other, as these pairs are particularly prone to experiencing geopolitical disputes. Columns 3 and 4 display bilateral and multilateral import sourcing of the country-pair; Columns 5-10 report the vector of geoeconomic factors and the PVP (see the table's note for the details).

Visual inspection of the results reveals substantial OCWs, particularly in cases where bilateral dependence between country-pairs is high, such as France and Germany. With an average 6.1 ppt loss of real consumption for proximate pairs, OCWs are in the range of the war-induced GDP loss estimated by Chupilkin and Kóczán (2022) with a theory-free methodology. Among country-pairs with unbalanced OCWs, the average level of concessions made during diplomatic negotiations to maintain peace (i.e. PKC) can be significant. For instance, Ukraine would have to concede the equivalent of 1ppt of its consumption in 2018 to avoid escalation to a high-intensity war with Russia, while Egypt's concession vis-a-vis Israel would amount to 0.5ppt. Clearly, these cases are in the upper tail of the distribution of PKCs. Indeed, for proximate country-pairs, the average concession amounts to 0.1ppt. This is not negligible though and confirms that, even in peacetime, the prevention of war incurs significant costs.

The estimates of WIM indicate the effectiveness of diplomacy in averting escalation to the most destructive form of war. For proximate country-pairs, consumption in wartime is predicted to be 1.2 percentage points higher than it would have been in the absence of diplomacy. The penultimate column reports the probability of deescalation *conditional* on a geopolitical dispute, which should

Table 2: Estimates of geoeconomic factors in 2018

		Import Shares		OCW		PKC	WIM	s_{ij}	PVP
		Bilateral	Multilateral	Ctry 1	Ctry 2				
IND	PAK	.8	45.2	6.8	7.1	.1	1.6	73.1	2.4
ISR	EGY	.5	100	4.9	5.9	.5	1.1	44.1	5.5
ZAF	AGO	2.4	80.9	6.2	6.5	.2	1.4	60.8	3.6
ECU	PER	2.7	65.7	6.6	7.1	.2	1.6	70.4	2.6
GRC	TUR	2.3	93.3	6	6.1	0	1.3	54.4	4.3
CHN	USA	8.6	37.8	7.9	10	1.1		100	-1.6
RUS	UKR	7.3	65.5	6.9	8.9	1	1.9	94	.5
FRA	DEU	27.3	105.4	13.9	9	-2.4		100	-6.6
Prox.	Pairs	3.6	105	6.1	5.9	-.1	1.1	53.4	4.3

Note: Each row reports the geoeconomic factors attached to a dispute (susceptible to escalate into an armed conflict) between the two countries of the pair under consideration. Numbers represent percentage points. Bilateral and multilateral import sourcing are obtained by summing within the country-pair bilateral import shares in expenditures and total import shares net of bilateral imports (2018 trade data from Head and Mayer (2021). Col. 5 and 6 display the Opportunity Costs of War for countries 1 and 2. Col. 7 reports the Peace Keeping Costs for country 2. Col. 8, 9 and 10 respectively display the War Intensity Mitigation effect of diplomacy, the conditional probability of deescalation and the Pivotal Valence of Peace for the country-pair. The bottom row reports averaged values across the 443 pairs of countries in the sample distant less than 1000km from each other.

Table 3: MIDs of prominent country-pairs

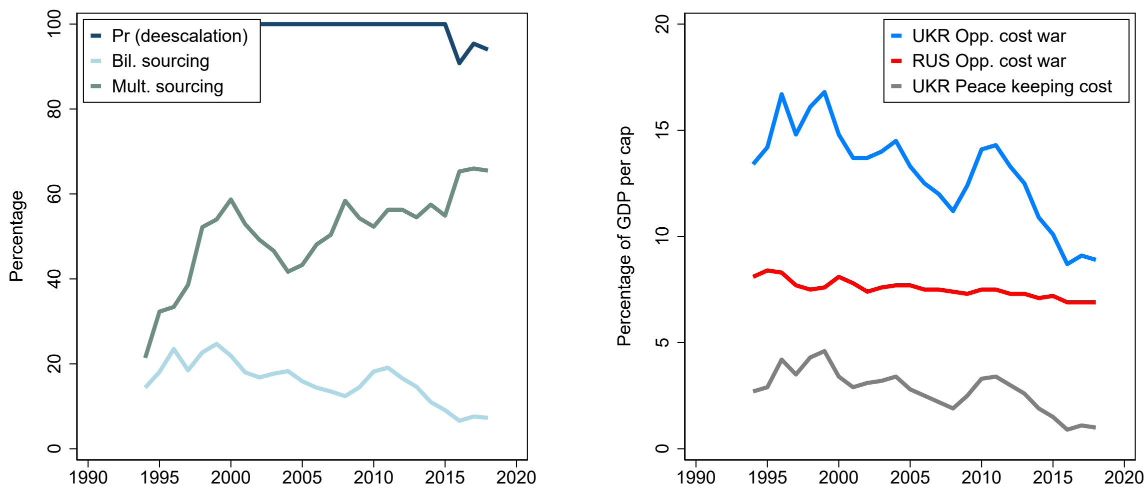
		Host. level 4	Host. level 5	Total
IND	PAK	31	7	38
ISR	EGY	18	10	28
ZAF	AGO	14	0	14
ECU	PER	27	0	27
GRC	TUR	15	8	23
CHN	USA	6	5	11
RUS	UKR	1	0	1
FRA	DEU	0	7	7

Note: Data are from COW and cover 1816-2014. Cells report the number of MIDs of a given hostility-level experienced by the country-pair.

not be interpreted as the unconditional probability of being at peace (see the discussion on page 31). In the cases of France-Germany and China-USA, the probability of deescalation is equal to 1, indicating that these country-pairs consistently settle their disputes peacefully. The last column displays the Pivotal Valence of Peace which is negative and amounts to -6.6ppt for France and Germany, indicating a robust and solid peaceful diplomatic relationship. For war to occur between them with a non-zero probability, the consumption-equivalent of their intrinsic preference *for war* (negative valence) should represent at least 6.6% of their total consumption. By contrast, some country-pairs (e.g. Greece and Turkey) have a positive and large PVP suggesting in their case that economic incentives alone are far from being sufficient to secure peace with certainty.

Time-evolution of geoeconomic factors. The previous analysis is now extended to the entire period covered in the Head and Mayer (2021) dataset for Russia and Ukraine on the one hand, and China and USA on the other hand—two emblematic country-pairs that experienced contrasting evolutions in their bilateral trade dependence.

Figure 3: Evolution of geoeconomic factors for the pair Russia-Ukraine



(a) Geography of Import Sourcing

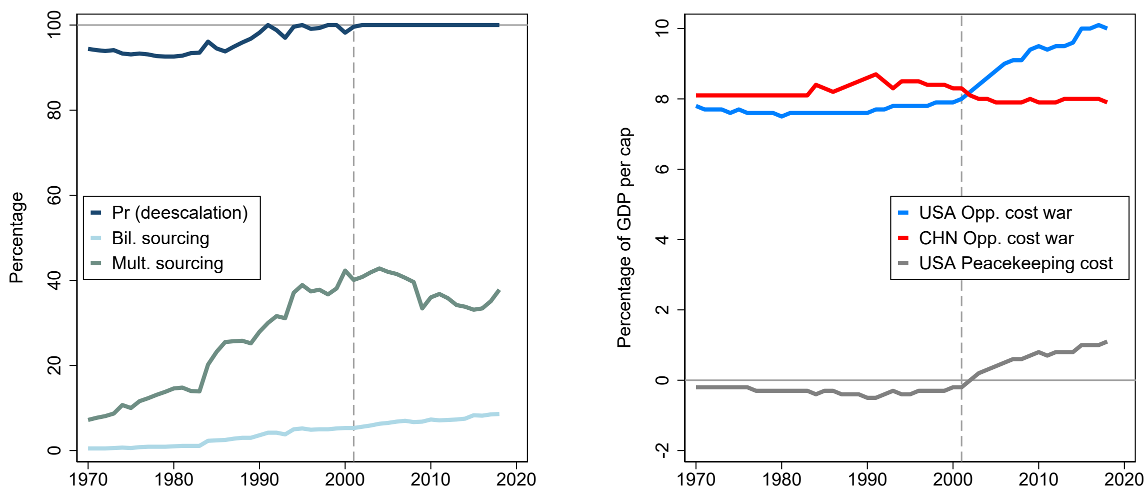
(b) OCW and PKC

Figure 3 illustrates the time-series evolution of geoeconomic factors for the RUS-UKR country-pair from 1994 to 2018. In the left panel, it can be observed that bilateral dependence between the two countries was initially high following the collapse of the Soviet Union but steadily decreased over time, primarily driven by a significant increase in multilateral sourcing. As a result of this substantial bilateral disengagement, the right panel shows that the opportunity cost for Ukraine of a high-intensity war with Russia has decreased from 18ppt (of consumption) in the mid-1990s to less than 9ppt in 2018. A similar pattern, albeit less pronounced, can be observed for Russia. Consequently, the costs and concessions made by Ukraine to maintain peace with Russia, which were historically significant due to the stark asymmetry in OCWs within the country-pair, have decreased from 4.6 percentage points in 1999 to 1 percentage point in 2018. As a consequence, their diplomatic relationship gradually deteriorated and the probability of deescalation of disputes (left panel) which had remained consistently equal to 1 until 2014, declined thereafter.

The case of the CHN-USA pair is presented in Figure 4, covering a longer period from 1970 to 2018. Their geoeconomic factors followed a path that was the reverse of the one observed for the RUS-UKR pair. The reason is the significant increase in their bilateral dependence, particularly after China's accession to the WTO in 2001 (dashed line on both panels). This trend was driven by the threefold increase in the share of Chinese imports in US expenditure, reaching 7.5% in 2018. On the other hand, US imports as a share of Chinese expenditure declined, although not strongly enough to offset the previous trend, decreasing from 2.9% to 1.1% over the period. Consequently, the OCW for the USA increased while it remained relatively stable for China (right panel). Overall, the probability of deescalation increased and remained consistently equal to 1 after 2001. However, maintaining peace came at a cost. The asymmetrical evolution of import sourcing dependency resulted in a substantial increase in US Peace Keeping Costs. These costs were negative until 2000, indicating that, on average, China had to make concessions to maintain peace. However, they turned positive after 2001 and continued to increase, suggesting that the diplomatic bargaining game is now disadvantageous for the USA.

Let conclude this section by emphasizing that the results presented in Table 2 and Figures 3 and 4 are intended to illustrate the method rather than provide definitive calculations. Further research is needed to refine the calibration of the parameter set and use the non-approximated method for all OCW computations.

Figure 4: Evolution of geoeconomic factors for the pair China-USA



(a) Geography of Import Sourcing

(b) OCW and PKC

3.6 Additional mechanisms

In this section, I survey additional theoretical arguments that have been put forward in the literature on how international trade impacts the likelihood of interstate conflict.

3.6.1 Trade Diplomacy

Governments engage in trade agreements not only for economic reasons, but also for political motivations. Scholars in the field of international relations have developed the argument of issue linkage, which sheds light on the implications of linking security policies, not only with trade agreements but also with sanctions and foreign aid (Maggi, 2016, for a recent survey). There are two main channels through which trade agreements can potentially influence global security. Firstly, agreements reshuffle economic interdependencies and alter the OCWs. Through fostering trade among member countries and redirecting trade away from non-member ones, Preferential Trade Agreements (PTAs) prompt a reshaping of the geography of import sourcing. Secondly, supranational bodies established in conjunction with trade agreements serve as diplomatic platforms that aid in mitigating information asymmetry during interstate negotiations, thereby helping to diffuse geopolitical strain. Regular meetings of heads of states and high-level officials can create habits of negotiation and build trust among political leaders. Moreover, actions such as trade concessions or retaliation play a role in conveying the state of diplomatic relationships between countries, thus aiding in the further reduction of information asymmetries. From a conceptual standpoint, this trade diplomacy mechanism can be modeled as a decrease in the variance of the informational noise η in Equations (11) and (13). Through this channel, international institutions help decrease the likelihood that a dispute escalates into war. It is important to note that this mechanism is active, even when the envisioned welfare gains from trade are small.

3.6.2 Globalization, values and tolerance

A well established fact in international relations is that democracies rarely engage in conflicts with one another (Oneal et al., 2003). In line with this so-called "democratic peace" phenomenon, globalization may promote pacification by encouraging democratic values, institutions and tolerance as countries become more interconnected through trade and investment. At the same time, this view seems at odds with some recent macro-trends, as the past two decades have seen both an increase in global trade and a democratic backlash. Unfortunately, the quantitative literature on this topic is scarce. A few empirical papers show how globalization meaningfully affects cultural traits and values (Guiso et al., 2006; Maystre et al., 2014). Particularly relevant is the paper by Lan and Li (2015): in the context of Chinese regions before and after China's accession to the WTO in 2001, they show theoretically and empirically how increasing foreign trade in a region weakens nationalism by reducing economic interests tied to domestic markets. They also provide evidence that their main result is supported in the cross-country dimension. One important question that remains unanswered in Lan and Li (2015) is whether any reduction in nationalism induced by trade can lead to a decrease in conflicts. Such a reduction in nationalism can be modeled as an increase in geopolitical valence in the peacetime welfare criterion of the leader (the term $v(\text{peace})$ in Equation (1)). This change takes place under the condition that leaders accurately reflect the changing preferences of their population. In turn, it reduces the probability of conflict as shown by Equation (11).

3.6.3 Vested interests

One overlooked aspect of the relationship between trade and conflict pertains to the role of conflict-induced trade disruption in shaping the interests of various groups within and across countries. On the one hand, such disruption may serve the protectionist interests of domestic industries that face less foreign competition as a result of trade barriers. On the other hand, it may harm the interests of exporters who face rising non-tariff barriers and other forms of trade restrictions in foreign markets. This suggests that the interests of pro-trade lobbies may be relatively more aligned with a peaceful resolution of disputes than the interests of protectionist lobbies. As a consequence, one should expect that the risk of disputes escalating into conflicts is influenced by the relative capacity of pro- and anti-trade lobbies to mobilize in order to influence political outcomes.[11] A future research direction is to model how trade lobbying interacts with armed conflicts and their resolution.

3.7 Trade and the intensity of conflict

A strand of the theoretical literature pioneered by Skaperdas and Syropoulos (2001) takes the state of war as given and is interested in modeling how international trade affects the *intensity* of war efforts. These so-called "Guns and Butter" models typically assume that inter-state conflict is about contesting a productive resource, the mapping between war efforts and successful appropriation being modeled with a Contest Success Function.

Within this framework, Garfinkel et al. (2015) and Garfinkel et al. (2020) compare the effects of autarky and free trade on the intensity of competition between countries (through arming) over the contested resource as well as on their welfare. In their analyses, the effects are channeled by the world relative price of the contested resource—a terms of trade effect—that makes war efforts trade-regime dependent. One theoretical prediction common to all these papers is that expanded trade opportunities with a third country can, under certain parameters regime, intensify conflict between two adversaries. This result is similar in essence to some of the theoretical conclusions drawn from the discussion of the geopolitical impact of GIS in Section 3.4.

By assuming a world of anarchy and appropriation, the guns-and-butter framework does not attempt to model the reasons why countries fail to negotiate Pareto-dominant peace. Therefore, it is not suitable for explaining the fundamental out-of-equilibrium nature of war, namely why, in reality, countries allocate significant funds towards military expenditures but often refrain from engaging in actual interstate conflict. While most of these papers provide theoretical contributions, I will review in the next section a few empirical papers that apply the guns-and-butter framework to real-world data.

4 Survey of the Empirical Literature

The impact of trade on war is a controversial and longstanding topic in international relations and political scientists have produced a voluminous body of empirical research on this question. Polachek's pioneering paper on "Conflict and Trade" (1980) is the first to perform a quantitative analysis based on a reasonably large dataset (841 country-pairs over 10 years for 15 categories of conflict). He provides evidence supporting the hypothesis that mutual dependence between trading partners reduces the probability of conflict. Many of the subsequent empirical studies con-

[11] The vast literature on protection for sale argues that firms seeking for protection are more likely to select into lobbying than exporting firms (Grossman and Helpman, 1994). However, this argument is typically made in the context of unilateral sector-specific trade policies. By contrast, conflict-induced trade disruption affects all sectors, making lobbying for peace equivalent to lobbying for reciprocal trade facilitation covering all sectors. Recent evidence from Blanga-Gubbay et al. (2020) suggests that pro-trade lobbies are, in fact, more effective in shaping multi-sector trade policies than anti-trade lobbies.

firmed this initial finding, lending further support to the hypothesis that trade promotes peace.[12] Yet, in this early empirical literature, some studies fail to find evidence of a pacifying effect of economic interdependence (Kim and Rousseau, 2005; Keshk et al., 2004) while others even suggest that trade increases conflict, such as Barbieri (1996, 2002).

The majority of this first generation of empirical papers tests the impact of bilateral trade, in different forms, on the frequency of wars between country-pairs. However, as highlighted by two influential contributions from Oneal and Russett (2001) and Green et al. (2001), these papers suffer from methodological flaws. They typically do not account for the fact that trade and war are both endogenous. In particular, country-pair $\times$ year empirical designs are estimated like pooled cross-sectional regression, ignoring time-invariant unobserved heterogeneity (i.e. country-pair fixed effects). Starting with Blomberg and Hess (2006), a second generation of quantitative papers on the trade and conflict question makes use of more sophisticated econometric techniques to run estimations on country-pair panel datasets. The rest of the section focuses on this second generation of papers.[13]

4.1 Bringing the model to the data

Data. The main sources of information on interstate conflicts that are used in the literature come from the Correlates of War (COW) project. In their flagship dataset, wars between country-pairs observed in the past two centuries are coded with the variable *militarized interstate disputes* (MID). Each MID is coded with a hostility level ranging from 3 to 5 (3 = Display of force, 4 = Use of force, and 5 = War). War is defined as a conflict resulting in at least 1000 military deaths. According to this criterion, there have been fewer than 150 interstate wars fought since 1815 (see Table 4). Consequently, it is common in the empirical literature to use a broader definition of conflict that encompasses displays of force, use of force, and actual war itself. Alternatively, some studies have also explored forms of conflicts that are more frequent but of lower intensity, such as analyzing vote correlation in the United Nations General Assembly to reveal the bilateral similarity of countries' foreign policies (e.g., Redding, 2020; Vicard, 2012), contemporary perceptions by political decision makers of whether countries regard one another enemies (measures of strategic rivalries as classified by Thompson (2001) and Colaresi et al. (2008)) or examining military assistance to capture geopolitical alignments (Bove et al., 2014).

Econometric equation. In order to build an econometric model that predicts the probability of conflict as a function of import sourcing, the approach involves combining Equations (11), (21), (24), and (25). This results in a nonlinear model that can be challenging to fit to the data. Martin et al. (2008a) show how imposing a limited set of additional parametric assumptions leads to a manageable closed-form econometric equation. Essentially, these restrictions ensure the validity of the first-order approximation of the OCW formula (27). They consequently estimate the following econometric model:

[12] Mansfield (1995); Polachek et al. (1999); Oneal and Russett (1999); Mansfield and Pevehouse (2000); Hegre et al. (2010); Kim and Rousseau (2005); Dorussen (2006); Oneal and Russett (2001); Gartzke (2007)

[13] For reviews of the early literature, see, e.g., Mansfield and Pollins (2003) or Polachek and Seiglie (2007).

Table 4: Militarized Interstate Disputes (MID) in the data

Sample	All country-pairs		Proximate pairs	
MID Hostility level	Nb pairs	Avg Freq. (%)	Nb pairs	Avg Freq. (%)
level 3: Display of force	128	.018	39	.261
level 4: Use of force	307	.104	83	1.462
level 5: War	90	.02	23	.163
All hostility levels	525	.142	145	1.886
Sample size	18336		526	

Note: In columns (2) and (3), the sample is made of all country-pairs observed in 2014 (i.e. 192 different countries); it is restricted to proximate countries only (below 1000km) in columns (4) and (5). Columns (2) and (4) display the number of country-pairs involved in at least one MID of a given hostility level after 1816; columns (3) and (5) report the sample average of the country-pair yearly frequency of MIDs of a given hostility level observed after 1816. For instance, over 1816-2014, the average yearly frequency of level-4 MID among proximate country-pairs amounts to 1.46%. These disputes have involved 83 different country-pairs. *Source*: COW data (1816-2014).

$$\mathbb{P}(MID_{ijt}) = \alpha \ln(\frac{m_{ijt}}{E_{it}} + \frac{m_{jit}}{E_{jt}}) + \beta \ln\left(\sum_{n \neq i,j} \frac{m_{nit}}{E_{it}} + \frac{m_{njt}}{E_{jt}}\right) + \text{controls}_{ijt} + FE_{ij}. \tag{30}$$

In the preceding equation, the dependent variable represents the probability of a militarized interstate dispute between countries i and j in year t. The measurement of bilateral and multilateral import sourcing is obtained by summing, respectively, the countries' bilateral import shares in expenditures and total import shares net of bilateral imports. Based on the discussion on GIS in section 3.4, the theoretical model predicts $\alpha \leq 0$ and $\beta \geq 0$, indicating a pacifying impact of bilateral import sourcing and a destabilizing impact of multilateral sourcing.

Estimation Challenges. When estimating Equation (30), one encounters two main challenges: the observability of disputes and the endogeneity of trade variables.

1. Cross-sectional variation of disputes: Equation (28) links the GIS to the probability of peace *conditional* on a geopolitical dispute. However, directly testing this equation is challenging because the process of escalation from dispute to actual conflict (MID) is not observed in isolation. The available datasets only provide information on the final outcome, whether MIDs occur. In this respect, the probability of a MID occurrence is the product of the probability of a dispute between countries i and j and the conditional probability of escalation:

$$\mathbb{P}(MID_{ijt}) = \mathbb{P}(\text{dispute}_{ijt}) \times s_{ij}. \tag{31}$$

The probability of disputes varies across different country-pairs and over time, and it is crucial to consider such panel variation when conducting regressions. The estimates would be significantly biased if identical coefficients are imposed across all country-pairs, regardless of whether they have a low or high probability of disputes. The literature has proposed various solutions to address this issue. For instance, Vicard (2012), in the context of regionalism, uses a bivariate probit model with censoring. This approach involves jointly estimating two equations: one explaining the initiation of the dispute and the other explaining the escalation of the dispute into war. Martin et al. (2008a) take a simpler approach by emphasizing bilateral distance as a powerful predictor of disputes. This view is supported by the data: Table 4 shows that the frequency of MIDs is much larger for pairs of countries with a bilateral distance below 1000 km. However, this probability drops nearly to zero for countries separated by more than 1000 km. Therefore, they restrict the sample to country-pairs with a border or with a bilateral distance below 1000 km. This strategy has two drawbacks: First, the sample size is significantly reduced. Second, it assumes that within the restricted sample, the coefficients of interest remain constant. An alternative strategy is to retain the full sample of countries and introduce interaction terms between distance and the import sourcing variables. This approach is a natural choice considering the multiplicative form in Equation (31).

2. Endogeneity: Serious endogeneity issue pertains to the relationship between military conflicts and import sourcing. To address this concern, several approaches have been considered in the literature: (i) lagging bilateral and multilateral import sourcing to mitigate contemporaneous reverse causality; (ii) controlling for potential co-determinants of conflicts and trade patterns (see model 4 in Table 3 of Martin et al. (2008a) for the full list); (iii) adding country-pair fixed effects in a panel setting; (iv) instrumenting import sourcing.

4.2 GIS and war: estimation results

Combining the COW dataset with DOTS trade data, Martin et al. (2008a) estimate the model (30) over the 1950–2000 period across a large set of specifications and robustness tests. Overall, their empirical results support the theoretical prediction: bilateral import sourcing tends to decrease the probability of MID while multilateral sourcing raises it. Quantitatively, the effects are sizeable for proximate countries —the ones for which disputes are presumably more frequent. Since this initial contribution, several empirical papers, looking at alternative types of conflicts and/or trade data, have confirmed these findings. I now briefly review them.

Hegre et al. (2010) convincingly address the endogeneity of trade and conflict (point 2 above) using a system of simultaneous equations that include a gravity equation of trade and a conflict regression that factor in the dual effect of distance on both trade and conflict. Their results confirm that bilateral trade reduces the likelihood of bilateral disputes. Examining low-level disputes instead of conflicts, Kleinman et al. (2020) also find evidence in support of the prediction that bilateral economic interdependence appeases geopolitical relationship.

Morelli and Sonno (2017) revisit the model (30) by suggesting that the crucial factor to consider is bilateral dependence, which they define as the ratio of bilateral over multilateral import sourcing

$$BD_{ijt} = \frac{m_{ijt} + m_{jit}}{\sum_{n \neq i,j} m_{nit} + m_{njt}}. \tag{32}$$

They observe that bilateral and multilateral sourcing have opposite signs in Equation (30) (i.e. $\alpha < 0$ and $\beta > 0$) and consequently push in the same direction when one is in the numerator and the other is in the denominator. Hence, a larger BD_{ijt} is expected to reduce the likelihood of war, particularly for contiguous countries. Morelli and Sonno (2017) also employ different trade data compared to Martin et al. (2008a), using national and bilateral trade data from Barbieri et al. (2009) and Barbieri and Keshk (2016). In their Table 1, they repeat the non-instrumented analysis conducted by Martin et al. (2008a) after replacing bilateral and multilateral imports with their measure of bilateral dependence. Across various specifications, they consistently find that bilateral dependence has a negative impact on the probability of a MID. They also observe that the effect of bilateral dependence declines with distance, a pattern which is in line with Equation (31).

Vicard (2012) makes an important methodological contribution by addressing the issue of heterogeneity in dispute occurrence across country-pairs in a compelling manner (point 1 above). He employs a bivariate probit model that accounts for selection and exploits event data from Kinsella and Russett (2002) to measure the occurrence of interstate disputes exceeding a threshold characterized by strong verbal hostility. It is important to note that Vicard's analysis does not instrument trade flows (point 2 above). Using the COW data from 1950 to 1991, he finds that multilateral import sourcing increases the probability of a dispute escalating into war, while bilateral sourcing does not exhibit a significant effect.

Hadjiyiannis et al. (2016) shift the focus from trade flows to trade agreements. Using COW data spanning the years 1958 to 2000, they address endogeneity concerns by incorporating an extensive set of controls, country-pair fixed effects, simultaneous equations modeling, and instrumental variables. Their findings indicate that PTAs reduce the likelihood of conflicts among member countries, contributing to peace creation within the agreement. However, they also observe that PTAs make it more likely for conflicts to arise between member countries and non-member countries, thus leading to peace diversion. These contrasted patterns align well with the theoretical predictions on the geoeconomic impact of GIS exposed in Section 3.4.

4.3 GIS and the costs of conflict containment

Seitz et al. (2015) and Garfinkel et al. (2020) applies the logic of liberal peace to the containment of violence. Instead of focusing on the likelihood of militarized disputes between specific country-pairs, their research investigates how trade openness influences defense spending at the country level. Thus, in contrast to the rest of the literature, the unit of observation in these studies is the country itself rather than country-pairs.

Both papers rely on the Stockholm International Peace Research Institute (SIPRI) as the primary source for information on defense spending. SIPRI reports defense expenditures as a percentage of GDP for various countries and years. While military conflicts are relatively rare in the modern world, countries still allocate substantial resources to defense spending. Therefore, this additional impact of trade openness on defense spending carries significant welfare implications by potentially reducing the cost of conflict containment.

Seitz et al. (2015) construct and estimate a structural model of trade, military conflicts, and defense expenditure on a sample of 181 countries between 1993 and 2001. Additionally, they conduct counterfactual experiments focusing on some of the most adversarial country-pairs. This well-designed quantitative model encompasses many aspects of the trade and war relationship. Their findings indicate that reducing trade costs between two countries prompts both countries to reduce defense spending. This reduction in defense spending subsequently has a domino effect on the defense expenditures of other countries. Their quantification exercise reveals that the additional welfare effects resulting from cuts in defense spending globally are comparable in magnitude to the direct welfare effects of increased trade, particularly when the two trading partners have a history of hostility. Using an unbalanced panel dataset comprising 67 countries from 1986 to 1999 and incorporating data on historical rivalries from Thompson (2001), Garfinkel et al. (2020) complement the findings of Seitz et al. (2015) by demonstrating that the impact of trade openness on a country's military spending is contingent upon whether trade is conducted with a rival or a friend.

4.4 Evidence on trade diplomacy

Another aspect of Vicard (2012) relates to the empirical study of the influence of RTAs on the likelihood of conflict. His aim is to investigate the trade diplomacy channel (as discussed in section 3.6.1) while accounting for the changes in economic interdependence induced by RTAs. Vicard (2012) distinguishes between two categories of RTAs: deep RTAs, which include customs unions and common markets, and shallow RTAs, encompassing partial scope and free trade agreements. The underlying premise is that the trade diplomacy channel operates primarily for deep RTAs because these agreements necessitate a substantial shared institutional framework that can facilitate the resolution of conflicts through negotiation and foster peace among member countries.

Using the COW dataset spanning the period from 1950 to 1991, Vicard estimates a modified version of the bilateral conflict regression (30) where the main explanatory variable is a binary variable indicating the presence of a trade agreement in force within the country-pair. His estimation results reveal that deep RTAs have a significant effect in reducing the likelihood of war between member countries. In contrast, shallow RTAs do not exhibit the same impact. Importantly, these results hold even after controlling for trade dependency—bilateral and multilateral import sourcing as defined in Equation (30)—suggesting that they are driven by the trade diplomacy channel. He conducts an extensive set of robustness checks, which includes the implementation of an instrumental variable approach to address endogeneity concerns on RTA formation. Quantitatively, the magnitude of the trade diplomacy effect is substantial, deep RTAs leading to a reduction of about two-thirds in the probability of a dispute escalating into war.

4.5 Micro-level evidence on trade and war

A promising and recent research avenue involves exploring the impact of trade on violence using micro-level data. Jha (2013) uncovers that a prolonged history of inter-ethnic trade has a restraining effect on conflict in the present. Based on a rich dataset collected at the town level, which encompasses South Asia's medieval and colonial eras, his research reveals that medieval ports, despite their higher ethnic diversity, exhibited a significantly lower likelihood of Hindu-Muslim riots. Specifically, between 1850-1950, these ports were five times less prone to such conflict, even after two centuries had passed since Europeans disrupted Muslim dominance in overseas trade. Furthermore, between 1950-1995, the incidence of riots in these ports remained only half as likely compared to other areas.

Amodio et al. (2021) conduct a study on the impact of security-motivated trade restrictions on economic activity and political violence. They leverage the quasi-experiment provided by the restrictions imposed by Israel on imports of selected goods to the West Bank in 2008. Following the implementation of the restrictions, they observe that localities experiencing the most severe negative economic effects are more prone to episodes of political violence. The differential effect observed accounts for approximately 16% of the violent events that took place in the West Bank between 2008 and 2012.

Amodio et al. (2023) look at the impact on violence of reduced tariffs on imports from South countries to North countries. The authors combine variations in agricultural tariffs over time with disparities in crop suitability across a wide grid of 9km $\times$ 9km cells covering 27 South countries and all PTAs they signed with major North countries between 1995 and 2014. The empirical strategy is based on the observation that variations in agro-climatic conditions within a country create exogenous differences in the suitability for cultivating different crops. The findings show that in cells where crop suitability is higher for the liberalized crops, the implementation of PTAs leads to an increase in economic output as well as political violence. Looking at global trade rather than PTAs, Gallea and Rohner (2021) perform the same type of spatial analysis and find that while instances of conflict are more prevalent in strategic areas situated near maritime choke points like straits or capes, the expansion of global trade openness actually diminishes the likelihood of conflicts breaking out in these critical locations.

5 Trade Policy in the Shadow of War

Conducting trade policy in the shadow of conflict is characterized by a complex interplay between economics and geopolitics, giving rise to a multitude of open questions. The academic literature on the subject remains limited, making it challenging to distill evidence-based insights. For example, as geopolitical climate deteriorates, the existing literature does not provide quantitative guidance on whether (i) countries should increase bilateral dependence with their geopolitical rivals as a means of reducing the risk of escalation; (ii) countries should diversify their sources of imports to act as insurance in the event of a bilateral crisis that disrupts trade exchanges. I illustrate below how the framework presented in the previous sections allows to gain some insights into these questions.

5.1 Geoeconomic welfare gains: theory

The existing quantitative methods for computing the welfare impact of trade policy have been designed for peacetime. My objective is to revisit them in a context of rising geopolitical tensions and non-negligible conflict risk.[14] To this purpose, I revert to the multi-country setup described in Section 3.2.1. A new decision margin is added to the sequence described on page 9: at stage (0), just after the geopolitical dispute occurs, country i evaluates the merits of implementing a "trade policy". The expected welfare gains attached to this policy are denoted $\mathcal{W}_i$.

The theoretical analysis in Section 3.2.2 shows that, alongside real consumption, the welfare function includes a vector of geoeconomic factors. Specifically, under the status-quo (no policy implemented), the expected utility of i, $\mathbb{E}U_i$, is given by Equation (15). When the policy is in force, I follow common practice in the trade literature and denote all variables with a prime. In this scenario, expected utility $\mathbb{E}U_i'$ is given by the same equation with all variables adjusted for the policy-induced changes. As a consequence: $\mathcal{W}_i \equiv \mathbb{E}U_i' - \mathbb{E}U_i$. Combining these equations together, one obtains

$$\mathcal{W}_i = \log\left(\frac{C_i'(\text{peace})}{C_i(\text{peace})}\right) + \mathcal{G}_i. \tag{33}$$

This relation displays the two components of the welfare gains of trade conducted in the shadow of war. The first one corresponds to the standard trade gains realized under peace; an object that is now routinely quantified in the literature. It is worth noting that existing numerical methods make the (implicit) assumption that world is peaceful when simulating their policy scenarios. I refer to the second component as the *geoeconomic welfare gains* of the policy. It is equal to:

$$\mathcal{G}_i \equiv -(1-s_{ij}) \times (\Delta\texttt{OCW}_i - \Delta\texttt{WIM}_i) - s_{ij} \times \Delta\texttt{PKC}_i + \left(\texttt{OCW}_i + v_i - \texttt{PKC}_i - \frac{\eta}{4} - \texttt{WIM}_i\right) \times \Delta s_{ij}, \tag{34}$$

where the Δ operator represents policy-induced changes: $\Delta x \equiv x' - x$. By redirecting trade flows, the policy affects the GIS of the country-pair ij. This leads to a change $\Delta\texttt{OCW}_i$ which in turn impacts the rest of the geoeconomic factors $\{\Delta s_{ij}, \Delta\texttt{WIM}_i, \Delta\texttt{PKC}_i\}$ as captured by Equations (11), (13) and (14). Depending on the relative contribution of each factor, the geoeconomics gains $\mathcal{G}_i$ can be positive or negative.

Equation (34) captures a *fundamental security dilemma* of geoeconomics that relates to the objective of using policy to either strengthen or reduce bilateral import dependence with geopolitical rivals. While a quantitative analysis is ultimately necessary to inform such decisions, I outline the main intuitions below.

Let consider a policy that deliberately strengthens the bilateral import dependence of country i with its rival j, thereby increasing i's opportunity cost of war: $\Delta\texttt{OCW}_i > 0$

- This policy is detrimental to i's welfare for two reasons. Firstly, in the event that negotiations fail and war breaks out, the actual costs of war increase; this is the case even after accounting

[14] Hadjiyiannis et al. (2016) and Mayer and Thoenig (2016) are the sole quantitative studies that perform this type of approach, albeit with different objectives and methods. Both papers estimate how PTAs impact the probability of conflict, in the context of EU membership for the first paper and Eastern Africa Community for the second paper.

for changes in War Intensity Mitigation (see footnote 7). This channel is captured by the positive term ($\Delta\texttt{OCW}_i - \Delta\texttt{WIM}_i > 0$) on the RHS of Equation (34). Secondly, it undermines country i's diplomatic bargaining power, forcing i to make greater concessions in order to maintain peace ($\Delta\texttt{PKC}_i > 0$).

- This is welfare improving because a larger OCW disciplines leaders during diplomatic negotiations and increases the probability of deescalation ($\Delta s_{ij} > 0$).

These countervailing forces generate a fundamental tension in the design of trade policy. When the net effect is positive, $\mathcal{G}_i/\Delta\texttt{OCW}_i > 0$, increasing import sourcing from rival nations is desirable. When negative, $\mathcal{G}_i/\Delta\texttt{OCW}_i < 0$, dependence should be reduced. I come back to the details of this chain of adjustments in the quantification exercise in the next section.

5.2 Estimation of geoeconomic welfare gains: numerical procedure

The numerical procedure to estimate the geoeconomic gains $\mathcal{G}_i$ is now described. The approach hinges on a well-established literature interested in quantifying the welfare gains of trade. This field has been very active in the recent years and has reached a certain consensus on the modeling procedures (Costinot and Rodríguez-Clare, 2014; Head and Mayer, 2014). The so-called GETI procedure allows researchers to assess trade creation, trade diversion and welfare effects of trade policies: it combines gravity regressions with general-equilibrium simulation. The procedure exposed in Section 3.3 for computing OCW is an example of this type of method. Very importantly for our purpose, GETI quantifications provide an estimate of the changes in trade shares, the relevant metric for computing the changes in the vector of geoeconomic factors.

Quantification of geoeconomic welfare gains: procedure

The method for calculating $\mathcal{G}_i$ involves the following steps:

1. Recover the trade share matrix *observed* in peace time (π_{in}) and compute the vector of geoeconomic factors $\{\texttt{OCW}_i, s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$ in the no-policy equilibrium (*factual*) using the full procedure (page 19) or its approximated version (page 20).

2. Use a off-the-shelf procedure to estimate the trade share matrix in peace time (π'_{in}) in the policy-in-force equilibrium (*counterfactual*).

3. Repeat step 1 with counterfactual trade shares π'_{in} (in place of the observed ones) to compute the vector of counterfactual geoeconomic factors $\{\texttt{OCW}'_i, s'_{ij}, \texttt{WIM}'_i, \texttt{PKC}'_i\}$.

4. Take all geoeconomic factors in first-differences (i.e. $\Delta x \equiv x' - x$) and plug them into equation (34) to estimate $\mathcal{G}_i$.

This procedure does not consider two theoretical channels discussed in Section 3.6, namely trade diplomacy and moral values. In order to incorporate them, one would need to use policy-induced values of informational noise (η') and geopolitical valence (v_i') in Step 3, which would differ from their factual values used in Step 1. These parameters enter into Equations (11), (13), and (14) that are involved in both Steps 1 and 3. However, since there is no straightforward method in the empirical literature for calibrating these parameters, I keep these two margins fixed in the quantitative application.

5.3 Estimation of geoeconomic welfare gains: application

The method outlined in the preceding section is now used to conduct a range of policy experiments. While certain scenarios, such as a complete return to autarky, may be unrealistic, they serve the purpose of enhancing our understanding of the underlying mechanisms. Other scenarios hold greater policy relevance.

Furthermore, it is important to emphasize that the findings presented in this section are intended to illustrate the methods employed, rather than provide policy prescriptions. First, I use the approximated version of the OCW procedure. Second, I do not explore the sensitivity of the estimates to alternative calibrations of the parameters reported in Table 1. Third, the evaluation of the policy impact on trade shares is operated within a minimalist trade framework, similar to the one employed by Head and Mayer (2014). Specifically, the framework does not include an intermediate goods sector or a "roundabout" production function (Eaton and Kortum, 2002; Dhyne et al., 2021). It is well-known, as demonstrated by Costinot and Rodríguez-Clare (2014), that these omissions tend to generate conservative estimates of the welfare gains of trade.

Back to Autarky. I begin with an extreme scenario of de-globalization, in the spirit of Arkolakis et al. (2012), assuming that country-pairs involved in geopolitical disputes revert to full autarky in 2018.

Table 5 presents the results for the same set of country-pairs as in Table 2. Each row presents the changes in the geoeconomic factors associated with a geopolitical dispute that has the potential to escalate into a symmetrical high-intensity armed conflict between the two countries under consideration. Unsurprisingly one observes a substantial decrease in consumption during peacetime, with an average reduction of 16ppt for proximate countries (columns 4 and 10). This welfare loss is partly offset by positive geoeconomic welfare gains that are equal on average to 1ppt for proximate countries (columns 5 and 11). The rationale for these geoeconomic gains is as follows: de-globalization leads to significant reduction in both bilateral and multilateral sourcing, which have opposing effects on OCW (Equation 27).[15] The estimation reveals that the net effect is positive, resulting in an average increase in OCW of 2ppt for proximate countries (columns 3 and 9). Consequently, with larger OCWs, the probability of de-escalation conditional on having a geopolitical dispute rises by 43 ppt for proximate countries (Equation 11).[16] Hence, these simulation results suggest that diplomatic negotiations would be facilitated in a fully de-globalized world. Regarding the two remaining geopolitical factors (columns 7 and 8), they do not have, on aver-

[15] Table 2 conveys useful information on the observed levels of these variables in 2018.

[16] As discussed on page 31, this probability must not be interpreted as the unconditional probability of peace.

Table 5: Eliminating bilateral & multilateral import sourcing in 2018 (full autarky)

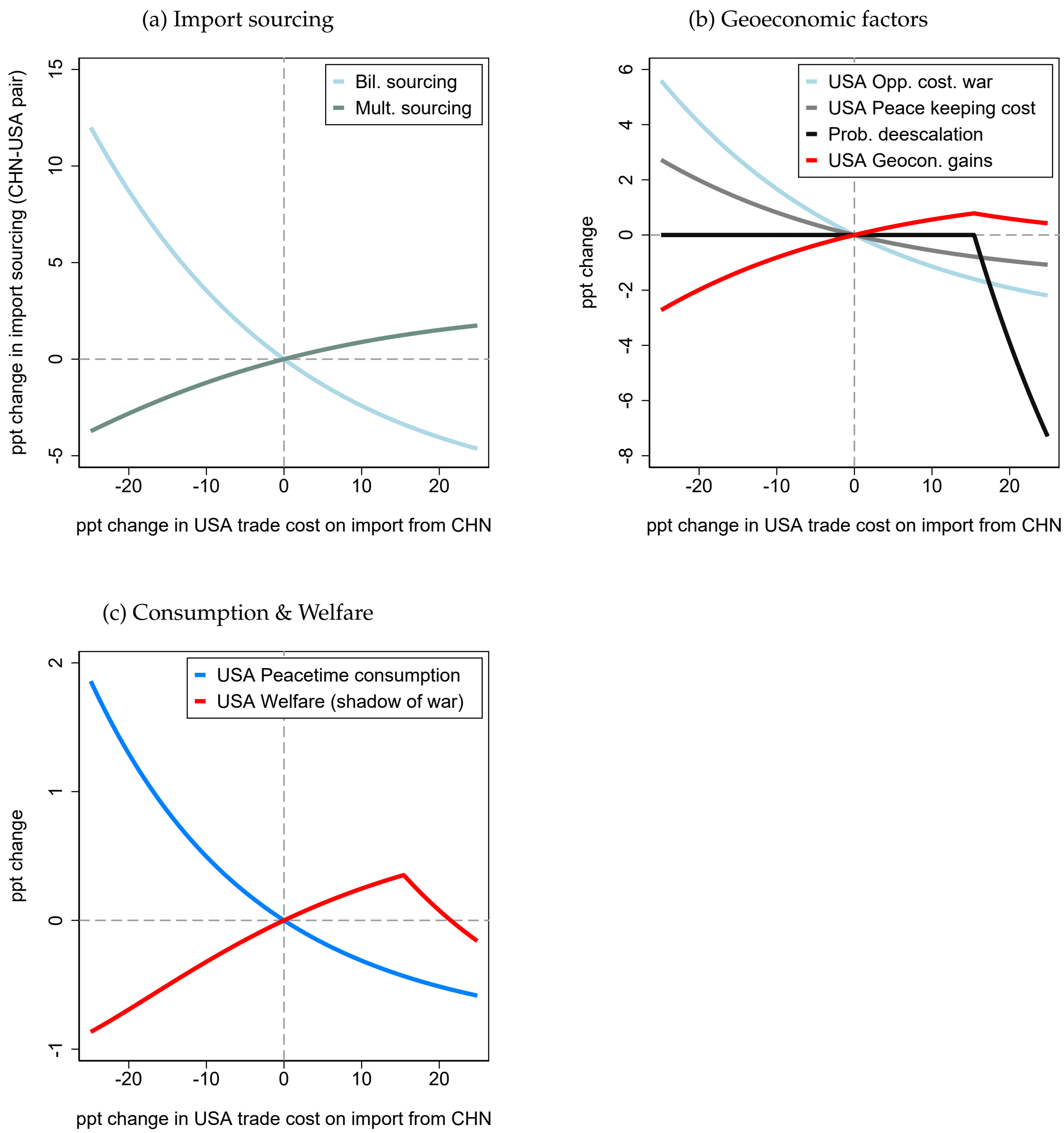
		Country 1						Country 2		
		ΔOCW	Δ log C(peace)	$\mathcal{G}$	Δs_{ij}	ΔWIM	ΔPKC	ΔOCW	Δ log C(peace)	$\mathcal{G}$
IND	PAK	1.2	-4.7	.9	23.2	.4	-.1	.9	-5.4	1.2
ISR	EGY	3.1	-17.3	.8	52.2	.9	-.5	2.1	-9.4	1.8
ZAF	AGO	1.8	-9.3	1.2	35.5	.6	-.2	1.5	-11.2	1.5
ECU	PER	1.4	-9.3	.9	25.9	.4	-.2	.9	-6.9	1.4
GRC	TUR	2	-15.1	1.4	41.9	.7	0	1.9	-9.6	1.4
CHN	USA	.1	-2.7	-1.4	-3.7	2	-1.1	-2	-7.8	.7
RUS	UKR	1.1	-5.9	-.9	2.2	0	-1	-.9	-11.8	1.1
FRA	DEU	-5.9	-19.7	2	-3.7	2	2.4	-1	-19.5	-2.9
Prox.	Pairs	1.9	-16	1.1	42.9	.9	.1	2.1	-15.6	.9

Note: Each row reports changes in the geoeconomic factors attached to a dispute (susceptible to escalate into an armed conflict) between the two countries of the pair under consideration. Numbers represent percentage-points. The trade data come from Head and Mayer (2021). For countries 1 and 2 respectively, are reported the change in the opportunity costs of war (col. 3 and 9), the change in peacetime consumption (col. 4 and 10), the geoeconomic welfare gains (col. 5 and 11). Col. 6-8 report the changes successively in the probability of deescalation *conditional* on a geopolitical dispute, the war intensity mitigation effect of diplomacy and the peace keeping costs from the perspective of country 2. The bottom row reports averaged values across the 443 pairs of countries in the sample distant less than 1000km from each other.

age, a significant quantitative impact. Clearly, all these averages conceal significant heterogeneity across country-pairs. For example, the France-Germany or China-USA dyads actually experience a decrease in OCW and probability of deescalation.

Optimal import dependence with geopolitical rivals: the case of China-USA. I now investigate the security dilemma in the context of a concrete and empirically-relevant policy, namely the China-US trade war that was initiated in January 2018. In this scenario, set in year 2018, I assume that the US manipulates its bilateral iceberg trade cost with China (τ_{in} in Equation (20) with i = CHN and n = USA) with the effect of altering its bilateral import dependence. The objective is to uncover the level of dependence that maximizes US aggregate welfare: is this optimal level below or above the factual level of dependence observed in 2018 (col. 3 and 4, Table 2)? The simulations are performed with changes in trade costs (with respect to their factual level) that span the $(-25\%, +25\%)$ range. For each possible value of the trade cost, I apply the procedure presented on page 37 and compute the counterfactual changes in trade shares, geoeconomic factors, real consumption and welfare gains of trade in the shadow of war.

Figure 5: Optimal import dependence China-USA



The results are illustrated in Figure 5. As expected, increasing trade costs redirects trade flows: the share of bilateral imports in joint expenditures is reduced while the share of multilateral imports increases (panel a). As a consequence of this bilateral disengagement (panel b): (i) the opportunity cost for the US of a high-intensity symmetrical warfare with China decreases; (ii) the economic value of the diplomatic concessions made by the US to China for maintaining peace is reduced; (iii) the probability of a peaceful settlement of geopolitical disputes remains at 1 and then drops when the change in trade costs exceeds +15%. As discussed on page 36, the net impact of these three forces on geoeconomic welfare gains is conceptually ambiguous. However, quantitatively, the pattern is clear: geoeconomic gains are positive and increase as long as the deescalation probability is unaffected; then, they decrease.

Welfare implications are reported on panel (c). Peacetime real consumption decreases when the US raises its bilateral trade barriers with China. While this consumption drop is welfare-reducing, it is more than offset by the evolution of the geoeconomic welfare gains. As a result, US welfare in the shadow of war—which is equal to the sum of both consumption and geoeconomic gains—first increases and reaches an optimal level for a 15% rise in trade barriers; then it declines gradually and finally passes below its factual level for a 21% increase in trade barriers.

Overall, this exercise shows that, in presence of latent geopolitical disputes susceptible to escalate into armed conflict, the welfare implications of trade policy may fundamentally differ from what is predicted by a model calibrated for peacetime only. When geopolitics matter, the relevant welfare metric must factor in real consumption *and* geoeconomic gains (Equations 33 and 34).

EU enlargement to Ukraine. This exercise is motivated by the current war in Ukraine. I quantify the geoeconomic gains to be expected from a counterfactual accession of Ukraine to the European Union. The scenario consists in simulating the changes in consumption and geoeconomic factors that should have been observed if Ukraine had fully integrated EU-28 common market in 2018. I take the observed trade patterns in 2018 as a baseline and follow the procedure detailed on page 37. First, I compute the world matrix of trade shares that should prevail, everything else equal, in presence of an enlarged common market. To simulate this policy impact, I use existing gravity estimates of the historical gains attached to the creation of the EU single market (from Mayer and Thoenig (2016), Table 1, column 5). The comparison between the baseline and the counterfactual trade patterns informs us not only on the contribution of the accession to regional trade between members (e.g. Germany and Ukraine) but also, thanks to the underlying general equilibrium analysis, on its contribution to mutilateral trade between members and non-members (e.g. Russia and Ukraine) or between non-members. In a second step, I use these counterfactual trade flows to estimate the changes in the geoeconomic factors.

Before turning to the quantification results, let describe the expected economic consequences of Ukraine's accession to EU single market. First, bilateral accessibility between Ukraine and the other member countries improves. The expected drop in tariff and non-tariff barriers should lead to a rise in competitive pressures on Ukrainian markets and to an improvement in quality and quantity. As a result, Ukrainian imports from the rest of enlarged EU would be boosted and Ukrainian real GDP would increase. Second, the Ukrainian market becoming more competitive, non-EU based firms (e.g. Russian firms) lose market share on Ukrainian markets. All in all, EU enlargement to Ukraine is expected to reduce the bilateral dependence between Russia and Ukraine.

Table 6 presents the quantitative estimates of the geoeconomic consequences of Ukraine's accession to EU. Each row reports changes in the geoeconomic factors attached to a potential dispute—susceptible to escalate into an armed conflict—between Ukraine and the other country of the pair

Table 6: EU-28 enlargement to Ukraine in 2018.

		Δ Import Shares		Country 1						Country 2		
		bil.	mul.	ΔOCW	Δ logC(peace)	$\mathcal{G}$	Δs_{ij}	ΔWIM	ΔPKC	ΔOCW	Δ logC(peace)	$\mathcal{G}$
RUS	UKR	-.83	11.12	-.02	-.02	-1.12	-11.33	-.18	-.47	-.96	4.41	-.19
AUT	UKR	.61	9.81	.12	.05	-.27	-1.87	-.04	-.25	-.37	4.41	.22
DEU	UKR	4.22	6.21	.08	.04	1.36	16.56	.28	.73	1.53	4.41	-.1
HUN	UKR	1.81	8.84	.53	.21	-.29	2.96	.06	-.35	-.17	4.41	.41
POL	UKR	2.69	7.97	.25	.14	.41	7.71	.14	.16	.56	4.41	.1
EU28	UKR	.94	9.51	.15	.06	-.16	-.25	-.01	-.19	-.23	4.41	.22

Note: Each row reports changes in the geoeconomic factors attached to a dispute (susceptible to escalate into an armed conflict) between the two countries of the pair under consideration. Numbers represent percentage-points. The trade data come from Head and Mayer (2021). Col. 3 and 4 report the changes in bilateral and multilateral import shares in joint expenditures. Col. 8-10 successively report the changes in the probability of deescalation *conditional* on a geopolitical dispute, the war intensity mitigation effect of diplomacy and the peace keeping costs from the perspective of country 2. For countries 1 and 2 respectively, are reported the change in the opportunity costs of war (col. 5 and 11), the change in peacetime consumption (col. 6 and 12), the geoeconomic welfare gains (col. 7 and 13). The bottom row reports averaged values across all pairs made of Ukraine and a EU-28 country.

under consideration. The numbers are in line with the mechanisms outlined in the preceding paragraph: the share in expenditure of Ukraine's imports from Russia is reduced by 0.8ppt and is redirected toward EU with an average 0.9ppt increase in import share from each member. Ukraine's peacetime consumption increases by 4.4ppt. From a security perspective, following the drop in bilateral dependence with Russia, the opportunity cost for Ukraine of a high-intensity war with Russia is reduced by almost 1ppt and its peace-keeping cost decreases by 0.5ppt. Nevertheless, the diplomatic relationship deteriorates with a 11.3ppt drop in the probability of deescalation. On net, Ukraine experiences a small geoeconomic welfare loss (-0.2 ppt) that is dominated by its gains in real consumption. The rest of the table illustrates the changes in geoeconomic factors of Ukraine vis-a-vis its main trading partners among EU-28 members. With Austria, the enlargement actually reduces their bilateral dependence (as Ukraine increases its trade even more toward other members) and, consequently, their escalation probability. With Germany and Poland, one observes the reverse: bilateral dependence, OCWs and diplomatic relationship improve.

This analysis highlights the risk of a deleterious impact of trade diversion on diplomacy and conflict. Following the deepening of trade agreements, some countries may experience a reshuffling of their GIS which in turn can increase the risk of inter-state war at the regional level.

5.4 The security dilemma in the data

European integration serves as an illuminating case study highlighting how trade agreements can address security threats. Spolaore (2013) documents how the creation of European Union was driven by a deep motivation to foster interdependencies susceptible to increase future opportunity cost of war between member nations. For instance, the Schuman Declaration of May 9, 1950, which laid the foundation for European integration, proposed the establishment of a common High Authority to oversee the combined production of coal and steel by France and Germany, with the potential for other European countries to participate. The objective of this plan was "*to make it plain that any war between France and Germany becomes not merely unthinkable, but materially impossible.*"

A strand of the literature has explored these geopolitical determinants of trade agreements.

Martin et al. (2012) analyze data spanning the period 1950-2000 and demonstrate that latent geopolitical tensions, as indicated by past wars between countries, increase the likelihood of PTA formation. Baldwin and Jaimovich (2012), Vicard (2012) and Eichengreen et al. (2021) consider military alliances as potential determinants of trade agreements. Moving beyond conflicts, Hinz (2023) presents evidence indicating that geopolitical factors significantly influence the selection of contracting partner countries and the extent of economic integration.

Political acceptability. Reinforcing bilateral interdependence with geopolitical rivals faces a significant obstacle in the form of the political acceptability of engaging in trade with former enemies. Empirical studies have documented the substantial political costs associated with implementing trade policies involving former adversaries. For instance, historical conflicts have been found to hinder current trust and trade between former enemies (Guiso et al., 2009) as exemplified by the minimal level of bilateral dependence between India and Pakistan (Table 2). Moreover, Martin et al. (2012) show that, in contrast with past wars, recent wars deter the formation of trade agreements. All these findings underscore the catch-22 nature of implementing peace-promoting trade agreements with former enemies.

The challenge is particularly pronounced in democracies, where leaders face electoral accountability that restricts their ability to pursue economic ties with rival nations. However, the EU's successful integration, despite a long and intense history of conflict among its member states, stands out as a remarkable example, demonstrating that windows of opportunity can be identified and political obstacles can be overcome.

A role for the multilateral approach to trade agreements. Presumably, multilateralism provides a more politically acceptable approach to facilitating trade with geopolitical rivals compared to bilateral or regional agreements. Additionally, the trade diplomacy channel relies on the existence of functional multilateral institutions that can host negotiations and disseminate information on both economic and political matters. A last element in favor of multilateralism pertains to the geopolitical risks associated with non-cooperative behaviors, as policymakers may not fully internalize the security spillovers of their trade policy. As highlighted in the previous section, trade agreements have the potential to create and divert trade flows, affecting not only the countries directly involved but also third-party nations. This redirection of trade flows impacts the GIS and the related geoeconomic factors, including conflict risk, for all country-pairs. By factoring in the interests of all the actors potentially affected by the policy, the multilateral approach is a way to address these intricate interconnections between geopolitical insecurity and trade architecture. Overall, these three arguments emphasize the importance of strengthening the multilateral trade system in a world of rising geopolitical tensions.

5.5 Trade Sanctions

Economic sanctions are commonly observed during diplomatic disputes. Their objective is to induce a change in the policies of a foreign government by imposing harm on its economy. The Em-

Table 7: Commitment to sanction Russia in case of a war, year 2018.

		Country 1						Country 2	
		ΔOCW	$\mathcal{G}$	s_{ij}	Δs_{ij}	ΔWIM	ΔPKC	ΔOCW	$\mathcal{G}$
UKR	RUS	0	5.49	94.05	5.95	-1.95	5.58	11.16	-5.67
CHN	RUS	0	4.44	100	0	0	4.44	8.88	-4.44
DEU	RUS	0	4.63	70.89	29.11	-1.57	5	10.01	-5.38
POL	RUS	0	5.1	73.4	26.6	-1.61	5.59	11.17	-6.07
USA	RUS	0	4.9	69.99	30.01	-1.55	5.4	10.81	-5.91

Note: Each row reports changes in the geoeconomic factors attached to a dispute (susceptible to escalate into an armed conflict) between the two countries of the pair under consideration. Numbers represent percentage-points. The trade data come from Head and Mayer (2021). For countries 1 and 2 respectively, are reported the change in the opportunity costs of war (col. 3 and 9) and the geoeconomic welfare gains (col. 4 and 10). Col.5 reports the probability of deescalation in absence of credible sanctions (factual). Col. 6-8 successively report the changes in the probability of deescalation, war intensity mitigation effect of diplomacy and peace keeping costs from the perspective of country 2.

bargo Act of 1807 marked the first use of sanctions and embargoes in the modern era (O'Rourke, 2007). Extensive research has been conducted in both political science and economics to study sanctions as a foreign policy instrument (see Hufbauer et al. (2009) for an overview of the research in this area). Motivated by the contemporaneous geopolitical landscape, a number of recent studies have concentrated on examining trade sanctions implemented against Iran and Russia (Haidar, 2017; Crozet and Hinz, 2020; Crozet et al., 2021, among others).

While most of the existing literature examines the economic impact of sanctions on imports, exports and GDP for both targeted and sanctioning countries, there is limited quantitative research investigating whether sanctions effectively lead to the desired policy changes. In this section, I show how the quantitative framework outlined in the previous sections can be used to assess the impact of trade sanctions on geopolitical factors, including the probability of deescalating diplomatic disputes. To illustrate the approach, I apply it to the context of potential conflicts involving Russia.

The scenario takes place in 2018 and assumes that countries other than Russia, $n \neq$ RUS, make a *credible* commitment to impose trade sanctions on Russia if a war breaks out between Russia and one of them (denoted as i). Technically, I assume that the sanctions consist in increasing trade barriers on Russia's multilateral import from third countries n to a level equivalent to the war-induced disruption of bilateral trade between Russia and i. Hence, the trade disruption parameters of Table 1 are now replaced by: $\tau_{\text{bil}} = 0.461$ for the pair i-RUS and $\tau_{\text{sanction}} = 0.461$ for all pairs n-RUS. In this extreme scenario, all countries globally participate in the sanction scheme, and the level of sanctions is significant. However, it is important to note that alternative scenarios can be explored, such as involving a subset of sanctioning countries and implementing less severe sanctions.

Applying the procedure described on page 37 (in its approximated version), I compute the changes in the geoeconomic factors under the sanctions scheme (counterfactual) relative to the factual (absence of sanctions). Table 7 reports the estimated changes associated with a dispute (which has the potential to escalate into an armed conflict) between the two countries of the pair under consideration. The results indicate that in 2018, a credible threat to impose sanctions on Russia in the event of a war with Ukraine would have increased the probability of a peaceful settlement between the two countries from its factual level of 0.94 (as shown in Table 2) to a counterfactual level of 1 (an increase of 5.95 percentage-points). Further examination of the table confirms that similar significant geoeconomic effects would be observed for other disputes involving Russia. Actually, the counterfactual probability of deescalation in the sanction regime is equal to 1 for all-country pairs. These results suggest that credible sanctions would have fully prevented the risk of a high-intensity war involving Russia. Clearly, this conclusion is reached in a scenario that overlooks two empirically relevant considerations. First, the feasibility of making credible commitments to sanctions is actually limited. Additionally, in reality, not all countries participate in the sanctions scheme, which tends to diminish their effectiveness.

6 Concluding Remarks

In this paper, I have presented a generic quantitative framework suited for exploring various aspects of the trade and war question. To enhance clarity in the presentation, the modeling structure is intentionally kept simple: it basically combines the workhorse trade model of structural gravity with a game of diplomatic negotiation aimed at deescalating geopolitical tensions. A key prediction is that the welfare gains associated with trade policies conducted in the shadow of war encompass not only the standard gains experienced during peacetime but also the following set of *endogenous* geoeconomic factors: (i) diplomatic concessions made to avert war; (ii) probability of war; (iii) cost of war itself. Importantly, the analysis also highlights how the geography of import sourcing influences these geoeconomic factors.

Methodologically, a contribution of the paper has been to extend the standard toolkit of trade policy evaluation to accommodate the inclusion of conflict risk. This refinement enables to look at policies that are relevant for the current context marked by geopolitical tensions, such as the China-US trade war, Ukraine's accession to the EU, and trade sanctions against Russia. The quantitative results show that, in the presence of geopolitical disputes that have the potential to escalate into high-intensity warfare, the welfare implications of trade policy may diverge significantly from predictions based solely on models calibrated for peacetime conditions. Overall, the analysis emphasizes the need for caution in policy formulation. It highlights the fact that policies designed for peaceful periods may have unintended consequences when implemented in a conflict-prone context. In this regard, the quantitative tools presented in this paper provide a first insight into how to align the geography of import sourcing with the realities of geopolitics.

What are the potential directions for future research on the trade and war question? Providing a definitive answer is undoubtedly challenging. However, three potential avenues can be identified. First, the quantifications presented in this paper serve as an illustrative demonstration of the methods employed, rather than definitive calculations. Future research aimed at obtaining more precise estimates should employ non-approximated methods, enrich the structure of the trade model, and explore more realistic scenarios. Second, an overlooked area in the literature pertains to the role of industrial lobbies and other special interest groups in the containment or escalation of tensions. Third, the paper has shed light on the fundamental security dilemma faced by policymakers. One conclusion is that the diversification of import sourcing in response to geopolitical tensions can—by reducing interdependencies with geopolitical rivals—paradoxically reinforce conflict risk. Exploring the intricate feedback loops between geopolitical insecurity and trade architecture is a crucial and unexplored question. All these topics present exciting opportunities for future research in the field. By delving deeper into these areas, scholars can contribute to a more comprehensive understanding of the relationship between trade, conflict, and geopolitical dynamics, ultimately providing valuable insights for policymakers and practitioners.

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Appendix

A Diplomatic Game

A.1 Game resolution in Martin et al. (2008a)

This section outlines the key stages and outcomes of the diplomatic game resolution, which is covered in detail in Appendix A of Martin et al. (2008a) (MMT hereafter). For a comprehensive understanding of the resolution process and the definitions of variables used in the following formulas, readers are advised to refer to the original article.

Players' outside options, $\tilde{U}_i^W$ and $\tilde{U}_j^W$, which correspond to their wartime utility, are assumed to be uniformly distributed over the triangle $\Gamma \equiv MM_AM_B$ (see Figure 3 in MMT) and vary respectively over the intervals $[\underline{v}_i, \bar{v}_i]$ and $\left[\underline{v}_j, \bar{v}_j\right]$. In their footnote 27 is reported the wartime utility that player i optimally announces during the negotiation:

$$\hat{U}_i^W = \underline{v}_i + \frac{1}{4}\left(S^P - \underline{v}_i - \underline{v}_j\right) + \frac{2}{3}\left(\tilde{U}_i^W - \underline{v}_i\right), \tag{35}$$

where S^P is the joint surplus in peacetime.

Reaching an agreement requires the announcements of players i and j to be compatible in the following manner:

$$\hat{U}_i^W + \hat{U}_j^W \leq S^P. \tag{36}$$

Moreover, in the case of an agreement, the post-transfer utility level of player i is given by

$$U_i(\text{peace}) - \widetilde{T}_{ij} = \hat{U}_i^W + \frac{S^P - \hat{U}_i^W - \hat{U}_j^W}{2}, \tag{37}$$

where $\widetilde{T}_{ij}$ represents the (positive or negative) utility transfer from i to j agreed upon by the players.

The probability of reaching an agreement corresponds to the ratio of the surface of the triangle MAB over the surface of MM_AM_B. In order to compute the surface of MAB, I use lemma 1 from MMT (also discussed on page 871 in their article):

$$MA = MB = \frac{3}{4}MA' = \frac{3}{4}\left(S^P - \underline{v}_i - \underline{v}_j\right). \tag{38}$$

The preceding relation leads to

$$MAB = \frac{MA \times MB}{2} = \frac{9}{32}\left(S^P - \underline{v}_i - \underline{v}_j\right)^2.$$

The surface of the second triangle is given by

$$MM_AM_B = \frac{MM_A \times MM_B}{2} = \frac{(\bar{v}_i - \underline{v}_i) \times \left(\bar{v}_j - \underline{v}_j\right)}{2}.$$

As a consequence, the probability of reaching an agreement is equal to

$$\texttt{Pr}(\text{de-escalation}) = \frac{MAB}{MM_AM_B} = \frac{9}{16}\frac{\left(S^P - \underline{v}_i - \underline{v}_j\right)^2}{(\bar{v}_i - \underline{v}_i) \times \left(\bar{v}_j - \underline{v}_j\right)}. \tag{39}$$

A.2 Derivation of the geoeconomic factors in Section 3.2.2

I will now explain how the preceding relationships can be utilized to derive the theoretical results presented in Section 3.2.2. It is worth noting that the results concerning the geoeconomic factors expand upon the analysis of MMT and are not covered in their paper.

Change of variables. The formulas originally derived by MMT are expressed with utility specified in *levels*. However, the model resolution in Section 3.2.2 and the related formulas emphasize the role of OCW, which essentially represents a utility *difference* between peace and war. Therefore, it becomes necessary to reformulate all equations from the preceding section to express them in terms of utility differences. To facilitate this change of variables, it is first useful to establish a mapping between the variables used by MMT and those employed in Section 3.2.2:

$$\begin{cases} S^P = U_i(\text{peace}) + U_j(\text{peace}) \\ \tilde{U}_i^W = \tilde{U}_i(\text{war}) \\ \underline{v}_i = \min \tilde{U}_i(\text{war}) \\ \bar{v}_i = \max \tilde{U}_i(\text{war}) \\ S^P - \underline{v}_i - \underline{v}_j = \max \widetilde{\texttt{UCW}}_i + \max \widetilde{\texttt{UCW}}_j \end{cases}, \tag{40}$$

where the left variables belong to the system of notation used by MMT.

Furthermore, rather than announcing a *level* of utility at war, it is equally effective for the player to declare a utility *difference* in comparison to peace. This particular variable is referred to as the announced utility cost of war in the main text:

$$\widetilde{\texttt{UCW}}_i^a \equiv U_i(\text{peace}) - \hat{U}_i^W. \tag{41}$$

Combining Equations (35), (40) and (42) leads to

$$\widetilde{\texttt{UCW}}_i^a = U_i(\text{peace}) - \min \tilde{U}_i(\text{war}) - \frac{1}{4}\left(U_i(\text{peace}) + U_j(\text{peace}) - \min \tilde{U}_i(\text{war}) - \min \tilde{U}_j(\text{war})\right)$$
$$- \frac{2}{3}\left(\tilde{U}_i(\text{war}) - \min \tilde{U}_i(\text{war})\right).$$

Rearranging the terms and using the definition $\widetilde{\texttt{UCW}}_i \equiv U_i(\text{peace}) - \tilde{U}_i(\text{war})$, I obtain the utility cost of war that is optimally announced by i

$$\widetilde{\texttt{UCW}}_i^a = \frac{2}{3}\widetilde{\texttt{UCW}}_i + \frac{1}{12}\max \widetilde{\texttt{UCW}}_i - \frac{1}{4}\max \widetilde{\texttt{UCW}}_j. \tag{42}$$

Using (40) and (42), the compatibility condition (36) can be reformulated as

$$0 \leq \widetilde{\texttt{UCW}}_i^a + \widetilde{\texttt{UCW}}_i^a.$$

Likewise, the transfer agreed upon by the players can be reformulated by combining (37), (40) and (42)

$$\begin{aligned}
\widetilde{T}_{ij} &= U_i(\text{peace}) - \hat{U}_i^W - \frac{S^P - \hat{U}_i^W - \hat{U}_j^W}{2} \\
&= U_i(\text{peace}) - \hat{U}_i^W - \frac{U_i(\text{peace}) + U_j(\text{peace}) - \hat{U}_i^W - \hat{U}_j^W}{2} \\
&= \frac{U_i(\text{peace}) - \hat{U}_i^W}{2} - \frac{U_j(\text{peace}) - \hat{U}_j^W}{2} \\
&= \frac{\widetilde{\texttt{UCW}}_i^a - \widetilde{\texttt{UCW}}_j^a}{2},
\end{aligned} \tag{43}$$

which corresponds to Equation (9) in the main text. Finally, the probability of reaching an agreement (Equation (10) in the main text) is obtained by combining (39) and (40)

$$\texttt{Pr}(\text{de-escalation}) = s_{ij} = \frac{9}{16} \frac{\left[\max \widetilde{\texttt{UCW}}_i + \max \widetilde{\texttt{UCW}}_j\right]^2}{\left[\max \widetilde{\texttt{UCW}}_i - \min \widetilde{\texttt{UCW}}_i\right] \times \left[\max \widetilde{\texttt{UCW}}_j - \min \widetilde{\texttt{UCW}}_j\right]}. \tag{44}$$

Geoeconomic factors. In order to compute the geoeconomic factors, I retain the parametrization choices from Section 3.2.1. Firstly, the geopolitical valences, which represent preference shifters in (1) and (2), are set such that $v_i(\text{war}) = 0$ and $v_i(\text{peace}) = v_i \in \mathbb{R}$. As a consequence, OCW and UCW are respectively characterized by the relations (5) and (6). Secondly, the war shocks $\tilde{u}_i$ and $\tilde{u}_j$, that are jointly uniformly distributed over the triangle $\Gamma = MM_AM_B$, are assumed to both vary in the interval $[0, \bar{u}]$ with $\bar{u} \equiv 3\eta/4$. Hence, their joint probability density function (pdf) is equal to $\phi(x, y) = 2/\bar{u}^2$ for $(x, y) \in \Gamma$ and $\phi(x, y) = 0$ otherwise.

Probability of de-escalation:
Given that $\tilde{u}_i$ varies in the range $[0, 3\eta/4]$, the functional form (6) implies

$$\max \widetilde{\texttt{UCW}}_i = \texttt{OCW}_i + v_i \qquad \text{and} \qquad \min \widetilde{\texttt{UCW}}_i = \texttt{OCW}_i + v_i - \frac{3}{4}\eta. \tag{45}$$

Combining the preceding relations with (44) leads to the probability of deescalation (Equation (11) in the text):

$$\begin{aligned}
s_{ij} &= \frac{1}{\eta^2} \times \left[\texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j\right]^2 \quad \text{for} \quad \texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j < \eta, \\
&= 1 \quad \text{for} \quad \texttt{OCW}_i + \texttt{OCW}_j + v_i + v_j \geq \eta.
\end{aligned} \tag{46}$$

Peace-Keeping Cost:
Plugging (6), (42) and (45) into (43) yields the transfer negotiated by the two countries

$$\widetilde{T}_{ij} = \frac{\texttt{OCW}_i + v_i - \texttt{OCW}_j - v_j}{2} + \frac{\tilde{u}_j - \tilde{u}_i}{3}.$$

The next step consists in computing the expected value of $\widetilde{T}_{ij}$ *conditional* on peace. As depicted in the aforementioned Figure 3, an agreement is reached and peace is maintained for all realizations of the war shocks $\tilde{u}_i$ and $\tilde{u}_j$ that are located in the triangle MAB. Importantly, MAB is symmetrical around the 45° line and the two random variables are assumed to be uniformly distributed. As a consequence, their expected values conditional on peace are identical:

$$\mathbb{E}\left[\tilde{u}_i|\text{peace}\right] = \mathbb{E}\left[\tilde{u}_j|\text{peace}\right].$$

Combining the two preceding relations leads to the characterization of the peace-keeping cost (Equation (14) in the text)

$$\mathbb{E}\left[\widetilde{T}_{ij}|\text{peace}\right] \equiv \texttt{PKC}_i = \frac{\texttt{OCW}_i + v_i - \texttt{OCW}_j - v_j}{2}. \tag{47}$$

War Intensity Mitigation:

War Intensity Mitigation is defined by Equation (12) in the main text

$$\texttt{WIM}_i = \mathbb{E}\left[\widetilde{\texttt{UCW}}_i\right] - \mathbb{E}\left[\widetilde{\texttt{UCW}}_i|\text{war}\right]. \tag{48}$$

In expectation, Equation (6) writes as follows:

$$\mathbb{E}\left[\widetilde{\texttt{UCW}}_i\right] = \texttt{OCW}_i + v_i - \mathbb{E}\left[\tilde{u}_i\right] \qquad \text{and} \qquad \mathbb{E}\left[\widetilde{\texttt{UCW}}_i|\text{war}\right] = \texttt{OCW}_i + v_i - \mathbb{E}\left[\tilde{u}_i|\text{war}\right].$$

As a consequence,

$$\texttt{WIM}_i = \mathbb{E}\left[\tilde{u}_i\right] - \mathbb{E}\left[\tilde{u}_i|\text{war}\right]. \tag{49}$$

First, let's compute the unconditional average of the war shock. This process is relatively straightforward, given the distributional assumptions mentioned earlier. Specifically, it entails integrating the uniform joint pdf over the entire triangle Γ:

$$\begin{aligned}\mathbb{E}\tilde{u}_i &= \int\int_{(x,y)\in\Gamma} x\phi(x,y)dxdy = \int_0^{\bar{u}}\int_0^{\bar{u}} x\phi(x,y)dxdy = \int_0^{\bar{u}} x\frac{2}{\bar{u}^2}dx\int_0^{\bar{u}-x} dy\\ &= \int_0^{\bar{u}} x(\bar{u}-x)\frac{2}{\bar{u}^2}dx = \frac{\bar{u}}{3}.\end{aligned}$$

From the preceding relations and the parameter assumption $\bar{u} = 3\eta/4$, I obtain the equation reported in footnote 6:

$$\mathbb{E}\left[\widetilde{\texttt{UCW}}_i\right] = \texttt{OCW}_i + v_i - \frac{\eta}{4}. \tag{50}$$

Computing the expected value of the war shock conditional on war is more convoluted. As depicted in Figure 3 of MMT, bargaining failure and war happen whenever the joint realization of the war shocks $(\tilde{u}_i, \tilde{u}_j)$ is located in the trapezoid ABM_BM_A. Their conditional joint pdf, denoted $\psi(x,y)$ is equal to a constant ψ which is equal to the inverse of the surface of ABM_BM_A. In turn, this surface is equal to the difference between the surfaces of the triangles MM_BM_A and MBA. Thus, for $(x,y) \in ABM_BM_A$, $\psi(x,y) = \psi = 2/\left(\bar{u}^2 - \bar{x}^2\right)$ where, for notational convenience, I use the notation shortcut $\bar{x} \equiv MA$. This leads to:

$$\begin{aligned}\mathbb{E}\left[\widetilde{\texttt{UCW}}_i|\text{war}\right] &= \int\int_{(x,y)\in ABM_BM_A} x\psi(x,y)dxdy = \int_0^{\bar{x}}\int_{\bar{x}-x}^{\bar{u}-x} x\psi dxdy + \int_{\bar{x}}^{\bar{u}}\int_0^{\bar{u}-x} x\psi dxdy\\ &= \psi\int_0^{\bar{x}} xdx\int_{\bar{x}-x}^{\bar{u}-x} dy + \psi\int_{\bar{x}}^{\bar{u}} xdx\int_0^{\bar{u}-x} dy = \psi\int_0^{\bar{x}} x(\bar{u}-\bar{x})dx + \psi\int_{\bar{x}}^{\bar{u}} x(\bar{u}-x)dx\\ &= \psi(\bar{u}-\bar{x})\frac{\bar{x}^2}{2} + \psi\left[\bar{u}\frac{\bar{u}^2-\bar{x}^2}{2} - \frac{\bar{u}^3-\bar{x}^3}{3}\right] = \psi\frac{\bar{u}^3-\bar{x}^3}{6} = \frac{\bar{u}^3-\bar{x}^3}{3\left(\bar{u}^2-\bar{x}^2\right)}.\end{aligned}$$

Taking the difference between the unconditional and conditional expectations, and using (49), I get

$$\mathtt{WIM}_i = \frac{\bar{u}}{3} - \frac{\bar{u}^3 - \bar{x}^3}{3\left(\bar{u}^2 - \bar{x}\right)^2} = \frac{1}{3}\frac{\bar{x}^2}{\bar{u} + \bar{x}}.$$

From parametric assumptions, $\bar{u}$ can be replaced by $(3\eta/4)$ and $\bar{x}$ by MA. Moreover, Equations (38), (40) and (45) imply $MA = (3/4) \times \left(\mathtt{OCW}_i + \mathtt{OCW}_j + v_i + v_j\right)$. Thus, the preceding equation can be reformulated as

$$\mathtt{WIM}_i = \frac{1}{4}\frac{\left[\mathtt{OCW}_i + \mathtt{OCW}_j + v_i + v_j\right]^2}{\eta + \mathtt{OCW}_i + \mathtt{OCW}_j + v_i + v_j}, \tag{51}$$

which corresponds to Equation (13) in the text.

Expected Welfare:
I now compute the ex-ante expected welfare, at stage zero of the game, namely when the geopolitical dispute arises but the realization of the war shocks is still unknown and diplomatic negotiations are still unsettled. Making use of conditional expectations and considering the definitions of peacetime post-transfer utility and wartime UCW, I get

$$\begin{aligned}\mathbb{E}\tilde{U}_i &= s_{ij} \times \mathbb{E}\left[\tilde{U}_i|\text{peace}\right]) + (1 - s_{ij}) \times \mathbb{E}\left[\tilde{U}_i|\text{war}\right])\\ &= s_{ij} \times \left(U_i(\text{peace}) - \mathbb{E}\left[\widetilde{T}_{ij}|\text{peace}\right]\right) + (1 - s_{ij}) \times \left(U_i(\text{peace}) - \mathbb{E}\left[\widetilde{\mathtt{UCW}}_i|\text{war}\right]\right)\\ &= U_i(\text{peace}) - s_{ij} \times \mathbb{E}\left[\widetilde{T}_{ij}|\text{peace}\right] - (1 - s_{ij}) \times \mathbb{E}\left[\widetilde{\mathtt{UCW}}_i|\text{war}\right].\end{aligned}$$

From relations (47), (48) and (50), this leads to

$$\mathbb{E}\tilde{U}_i = U_i(\text{peace}) - s_{ij} \times \mathtt{PKC}_i - (1 - s_{ij}) \times \left(\mathtt{OCW}_i + v_i - \frac{\eta}{4} - \mathtt{WIM}_i\right),$$

which corresponds to relation (15) in the text.

B Derivation of Equation (25)

The hat-algebra is applied to Equation (22)

$$\hat{\pi}_{ii} = \frac{1}{\hat{A}_i^{1-\sigma}} \times \frac{1}{\hat{P}_i^{1-\sigma}} \times \hat{w}_i^{1-\sigma}, \tag{52}$$

where the change in the price index is obtained from combining (18) and the parameters retained for the war damages

$$\hat{P}_i^{1-\sigma} = \sum_{k=1}^{N} \pi_{ki} \left(\frac{\hat{\tau}_{ki}\hat{w}_k}{\hat{A}_k}\right)^{1-\sigma} = \pi_{ii}\left(\frac{\hat{w}_i}{\hat{A}_i}\right)^{1-\sigma} + \pi_{ji}\left(\frac{\hat{\tau}_{\text{bil}}\hat{w}_j}{\hat{A}_j}\right)^{1-\sigma} + \sum_{n\neq i,j} \pi_{ni}\left(\hat{\tau}_{\text{mul}}\hat{w}_n\right)^{1-\sigma}. \tag{53}$$

Combining these relations yield:

$$\hat{\pi}_{ii} = \left[\pi_{ii} + \pi_{ji}\left(\frac{\hat{\tau}_{\text{bil}}\hat{A}_i\hat{w}_j}{\hat{A}_j\hat{w}_i}\right)^{1-\sigma} + \sum_{n\neq i,j} \pi_{ni}\left(\frac{\hat{\tau}_{\text{mul}}\hat{A}_i\hat{w}_n}{\hat{w}_i}\right)^{1-\sigma}\right]^{-1}. \tag{54}$$

This equation corresponds to Equation (25) in the text.

C Approximated Procedure: Derivation of Equation (27)

Plugging (24) into the definition of OCW given by Equation (5) leads to

$$\texttt{OCW}_i = -\log \hat{A}_i + \frac{1}{\sigma - 1} \log \hat{\pi}_{ii}. \tag{55}$$

Let first compute $\log \hat{\pi}_{ii}$ in the preceding relation. This term corresponds to the log of Equation (25) in which, according to the MTI approach, all wage changes can be neglected

$$\log \hat{\pi}_{ii} = -\log \left[\pi_{ii} + \pi_{ji} \left(\frac{\hat{\tau}_{\text{bil}} \hat{A}_i}{\hat{A}_j} \right)^{1-\sigma} + \sum_{n \neq i,j} \pi_{ni} \left(\hat{\tau}_{\text{mul}} \hat{A}_i \right)^{1-\sigma} \right].$$

Using the accounting identity $\pi_{ii} + \pi_{ji} + \sum_{n \neq i,j} \pi_{ni} = 1$, the preceding relation can be rewritten as

$$\log \hat{\pi}_{ii} = -\log \left[1 - \pi_{ji} \left[1 - \left(\frac{\hat{\tau}_{\text{bil}} \hat{A}_i}{\hat{A}_j} \right)^{1-\sigma} \right] - \sum_{n \neq i,j} \pi_{ni} \left[1 - \left(\hat{\tau}_{\text{mul}} \hat{A}_i \right)^{1-\sigma} \right] \right]. \tag{56}$$

At this stage, for notational convenience, the war damages are scaled in % change: $1 - \alpha_i \equiv \hat{A}_i$, $1 - \alpha_j \equiv \hat{A}_j$, $1 + \tau_{\text{bil}} \equiv \hat{\tau}_{\text{bil}}$ and $1 + \tau_{\text{mul}} \equiv \hat{\tau}_{\text{mul}}$. Making use of these parameters, a first-order approximation of Equation (56) is given by

$$\begin{aligned}
\log \hat{\pi}_{ii} &\approx \pi_{ji} \left[1 - \left(\frac{\hat{\tau}_{\text{bil}} \hat{A}_i}{\hat{A}_j} \right)^{1-\sigma} \right] + \sum_{n \neq i,j} \pi_{ni} \left[1 - \left(\hat{\tau}_{\text{mul}} \hat{A}_i \right)^{1-\sigma} \right] \\
&= \pi_{ji} \left[1 - \frac{(1 + \tau_{\text{bil}})^{1-\sigma} (1 - \alpha_i)^{1-\sigma}}{\left(1 - \alpha_j\right)^{1-\sigma}} \right] + \sum_{n \neq i,j} \pi_{ni} \left[1 - (1 + \tau_{\text{mul}})^{1-\sigma} (1 - \alpha_i)^{1-\sigma} \right] \\
&\approx \pi_{ji} (\sigma - 1) \left(\tau_{\text{bil}} - \alpha_i + \alpha_j \right) + \sum_{n \neq i,j} \pi_{ni} (\sigma - 1) (\tau_{\text{mul}} - \alpha_i).
\end{aligned} \tag{57}$$

Combining (55) and (57) and using the approximation $\log \hat{A}_i = \log (1 - \alpha_i) \approx -\alpha_i$, I obtain the following first-order approximation of OCW

$$\texttt{OCW}_i = \alpha_i + \pi_{ji} \left(\tau_{\text{bil}} - \alpha_i + \alpha_j \right) + \sum_{n \neq i,j} \pi_{ni} (\tau_{\text{mul}} - \alpha_i), \tag{58}$$

which corresponds to Equation (27) in the main text.