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

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Abstract

This chapter presents a quantitative toolkit designed to explore the two-way interaction between international trade and interstate war. The toolkit is based on a flexible modeling framework that combines two core elements: (i) a structural gravity model of trade and (ii) a game of diplomatic negotiation aimed at de-escalating geopolitical tensions and preventing armed conflicts. Methodologically, the framework extends conventional quantitative procedures for trade policy evaluation by incorporating endogenous conflict risk. A series of empirically relevant scenarios is simulated to assess the welfare gains of trade policy in the shadow of war. Additionally, the framework is used to structure a review of the 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

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1 Introduction

The war in Europe and rising 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 call for reconsidering the design and objectives of trade policy in the shadow of high-intensity warfare. Globalization is thus gradually shifting from a liberal paradigm to a realist one. Nevertheless, many questions remain regarding the management of conflict risk in international trade: What is the best strategy for sourcing imports? Should we engage in trade relations that could be disrupted by war, or prioritize risk diversification? Can trading with geopolitical rivals have a pacifying effect?

Montesquieu's view of *Doux Commerce* is arguably an 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 of war? Can economic calculations genuinely counterbalance the political calculus of major powers? The answers are not straightforward and primarily hinge on quantitative analysis.

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

A generic model of trade and war is first built. To this end, diplomatic negotiation is modeled as the exchange of concessions and compensations between countries to resolve their (exogenous) geopolitical disputes. These disputes may escalate into armed conflict if negotiations fail due to pervasive informational asymmetries and non-credible threats. To address these ideas, I opt for a framework that is robust to the specifics of the modeling assumptions: I rely on the wide class of negotiation protocols introduced in a seminal contribution to the mechanism design literature by Myerson and Satterthwaite (1983). Despite its inherent richness, this bargaining game under asymmetric information admits a surprisingly simple characterization of the equilibrium, providing a closed-form mapping between the OCW and the (endogenous) probability of escalation to armed conflict.

[1] The trade literature has increasingly focused on structural approaches using data-driven models. In contrast, the economics of conflict literature often faces a disconnect between theoretical models and empirical analysis, which is mostly based on reduced-form econometric specifications.

In a second step, the diplomatic game is integrated into a workhorse quantitative model of trade, known as structural gravity, to estimate OCW, conflict risk, and welfare. This class of models, developed over the past 15 years, is highly economical in terms of data requirements: it needs only trade shares observed during peacetime and a parsimonious set of calibrated structural parameters for quantification. To illustrate the numerical procedure, I apply it to prominent country pairs such as Russia-Ukraine and China-USA. While the resulting estimates should not be considered definitive, they offer insights into how the historical evolution of trade dependencies may have contributed to the deterioration of their geopolitical relationships. Solving for the trade equilibrium allows us to revisit and refine a central theoretical prediction from the literature on trade and war regarding the geography of import sourcing: bilateral import dependence tends to pacify, while, for plausible parameter values, multilateral import dependence tends to destabilize.

The theoretical and empirical literature on interstate conflict and international trade is then surveyed through this conceptual framework. Quantitative research in this area began with the seminal work of Polachek (1980). Early studies faced significant estimation biases due to the complex causal mechanisms linking trade and war. More recent advancements have provided modeling tools that integrate both trade and conflict dimensions within a unified framework, allowing for the development of theory-consistent econometric specifications that can be empirically tested. Additionally, empirical causal analysis practices have improved significantly, reflecting broader trends in economics. The survey starts from the chapter by Polachek and Seiglie (2007) in the Handbook of Defense Economics and reviews the subsequent literature.

A final objective of the chapter is to study the welfare implications of trade policy in the presence of latent geopolitical tensions. The theoretical analysis shows that welfare in the shadow of war consists of two components. The first is the standard trade gains realized during peacetime. The second, termed "geoeconomic welfare gains," comprises the following factors: (i) diplomatic concessions to prevent war; (ii) the probability of war; and (iii) the cost of war. Geoeconomic gains can be either positive or negative, depending on how the geoeconomic factors endogenously respond to policy-induced changes in trade flows. The numerical method for estimating these gains is presented and applied to evaluate some empirically relevant policies, such as EU enlargement to Ukraine and trade sanctions against Russia. The results indicate that the welfare implications can differ significantly from predictions made by models calibrated solely for peacetime conditions. In the simulations, although the probability of war is typically extremely small, the costs of peace-preserving diplomatic concessions can be quantitatively significant. Thus, the welfare impact of conflict is not limited to actual war outbreaks; its containment and prevention carry substantial costs—this is "the shadow of war".

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 promoting discipline during negotiations. However, if negotiations fail, the opportunity cost transforms into the actual cost of war, creating an inherent 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. Determining the optimal strategy for policymakers remains complex and context-dependent. Nonetheless, the quantitative tools presented in this chapter are valuable for addressing this question.

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 welfare implications of trade policy in the shadow of war are discussed and several empirically relevant scenarios 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 geopolitical tensions.[2] To see whether those two views receive some support in the data, it is useful to take first a historical perspective.

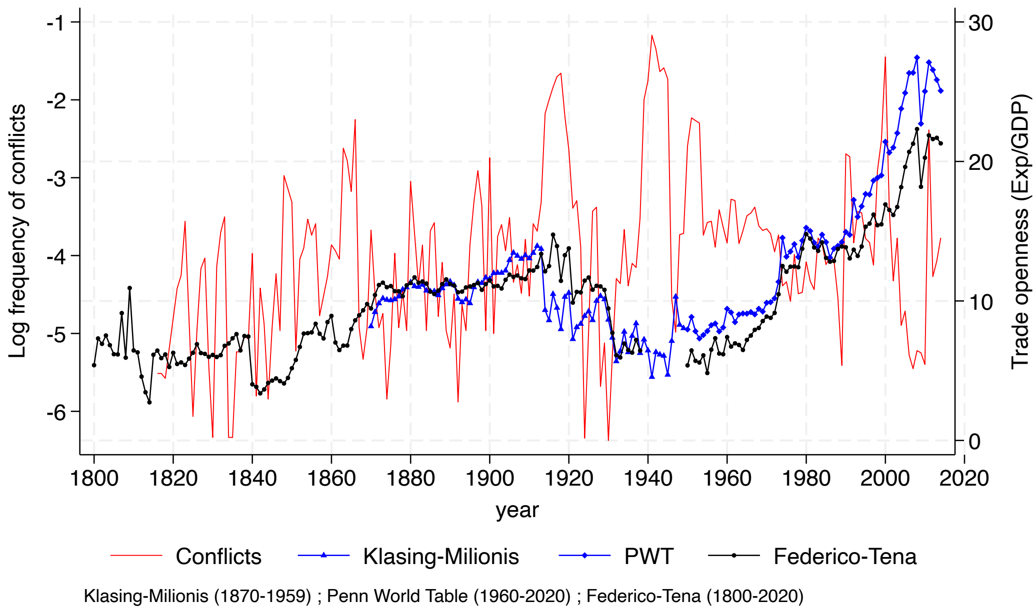
There is little doubt that, in the long-run, trade and conflict have co-evolved. Findlay and O'Rourke (2009) show how fighting for resources and growing global commerce were closely connected throughout Eurasia's economic history in the past millennium. Likewise, in the Mediterranean Sea's history, trade 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 confounding factors. For example, sharing a common border significantly increases bilateral trade flows and, at the same time, can be a source of political disputes between neighbors. In this regard, the evidence presented in the next two figures should be interpreted as correlational rather than causal.

Figure 1 illustrates the historical relationship between trade openness and military conflicts

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

Figure 1: Global Trade and Interstate Conflicts



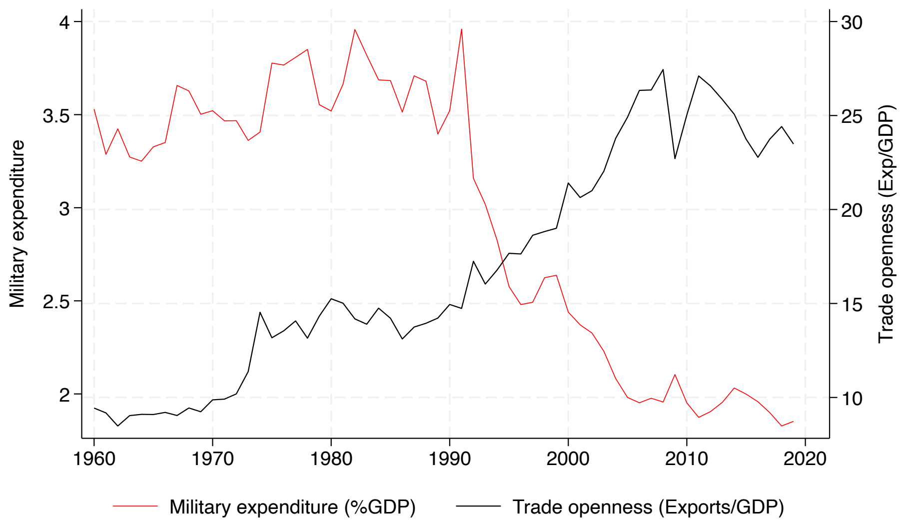
Source: Trade data come from Klasing and Milionis (2014), Federico and Tena-Junguito (2019) and Penn World Table (2023). Conflicts correspond to Militarized Interstate Disputes (hostility levels 4 and 5) from the COW dataset.

over the past two centuries.[3] Clearly, this relationship is not straightforward. The first wave of globalization in the late 19th century is characterized by increased trade openness and numerous military conflicts, including World War I. The interwar period experienced a simultaneous decline in both world trade and conflict. 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 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]Figure 1 displays the (log) ratio of the yearly amount of militarized interstate disputes (MID) summed across all country-pairs divided by the total number of country-pairs in a given year. MIDs come from the COW dataset and are characterized by a hostility level of 4 (use of force) and 5 (conflicts with at least 1000 deaths of military personnel). 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 (in % of GDP) come from SIPRI; trade data come from Penn World Table (2023).

3 Trade and War: Theory

In this section, a quantitative model of international trade and interstate war is built and simulated. The framework encompasses various elements of the existing theoretical literature and offers 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 find that war substantially disrupts trade flows (Keshk, Pollins, and Reuveny, 2004; Mansfield and Bronson, 1997; Pollins, 1989; Reuveny and Kang, 1998), others detect no effect (Mansfield and Pevehouse, 2000; Morrow, Siverson, and Tabares, 1998; Morrow, 1999). One limitation of these early studies is their focus on politically significant cases involving major powers or neighboring nations, leading to sample selection biases by excluding country-pairs with a low likelihood of conflict. Moreover, these studies often neglect both the contemporaneous and lagged effects of war on trade, as well as the third-party impacts of bilateral conflicts. Additionally, most of them rely on pooled estimators without pair-specific fixed effects, failing 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 aggregate 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. 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 factors: first, their sample begins after 1950, excluding the world wars; and second, their analysis includes not only full-scale wars but also low-intensity disputes (coded as level 3 in the MID dataset). Similarly, Fuchs and Klann (2013) show that even mild diplomatic incidents can disrupt trade. Their gravity estimates indicate that hosting high-level meetings with the Dalai Lama leads to a statistically significant reduction in bilateral trade with China in the following year.

Firm-level data. More recent studies use firm-level data to examine war-induced trade disruptions, with findings that mirror those based on aggregate data. The use of granular data has enabled researchers to address potential reverse causation from trade to conflict and to identify the underlying mechanisms contributing 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 from 25.7% in 2012 to 9.9% in 2016 and Ukraine's import shares from Russia from 32.4% to 13.1%. Hence, despite the conflict, Russia has remained Ukraine's largest trading partner. Using firm-level data, their study sheds light on an interesting mechanism: firms located in Ukrainian districts with a lower proportion of ethnic Russian residents experienced a greater decline in trade with Russia. The decline was associated with an erosion of trust and the emergence of local nationalism. This result aligns well with theoretical research, which emphasizes that wars can reduce trade not only by destroying physical capital but also by reshuffling social capital towards in-groups (Rohner et al., 2013). Looking at low-intensity disputes, Michaels and Zhi (2010) study how firm-level trade was affected by the deterioration of France-US relations following France's opposition to the US request for a UN Security Council mandate to use military force against Iraq in 2002-2003. Despite the absence of a bilateral war risk, economic sanctions, or formal trade barriers, the authors estimate that this shift in attitudes led to a reduction in France-US bilateral trade by approximately 9%. Similar empirical patterns are documented in other studies that use disaggregated data to analyze trade disruptions 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 increases the OCW.

Yet, at first glance, one might assume that trade losses due to war are insignificant compared to the vast economic and human costs of conflict: welfare costs of interstate conflict are massive (Auray and Eyquem, 2019; Rohner and Thoenig, 2021; Federle et al., 2024), while typical estimates of the welfare gains from trade are smaller (Costinot and Rodríguez-Clare, 2014; Head and Mayer, 2014).

Surprisingly, there have been few attempts in the literature to assess the contribution of foregone trade 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 Wars I and II. Averaging across all belligerents, they find 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 implies that for these countries, foregone trade raised the cost of WWII by roughly one-third (=2.5/6.6). It is worth noting that their estimates were obtained using 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 closing a gap in the literature.

3.2 A quantitative model of trade and war

The framework 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 OCW, 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. To streamline the exposition, I use one of the simplest quantitative trade models, specifically the one originally derived by Anderson (1979). In a companion paper to this chapter (Mayer et al., 2024), we use a more sophisticated trade model, enriched with an input-output structure; we consider more policy scenarios and offer more realistic quantitative estimates. Overall, the framework generalizes the approach of Martin et al. (2008a) by providing a comprehensive welfare analysis of trade policy.

In the model, the escalation from geopolitical disputes to military conflict is conceptualized as a breakdown in diplomatic negotiations. Among the many causes for interstate wars, I focus specifically on bargaining failure for three reasons. First, as argued by Powell (2006), unresolved informational issues during negotiation (alongside commitment problems) constitute first-order factors leading to conflict. These informational problems arise 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 is geopolitical. Therefore, diplomacy is a natural margin through which trade influences 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 impede workers' ability to ship their production to distant markets. These frictions generate a gravity equation of trade, which is crucial for quantifying the OCW. The specific details of the trade model are discussed in Section 3.2.3.

A geopolitical dispute between two potential belligerent countries, labeled i and j, is assumed. This dispute escalates into a war if diplomatic negotiations between their leaders fail. In the model, disputes are exogenous while the likelihood of escalation is endogenous to the trade equilibrium. The remaining third countries, denoted as $n \neq i, j$, are considered neutral and do not interfere with the negotiation process (this assumption avoids the complexity of modeling third-party intervention). However, the model does not exclude the possibility of third-party countries imposing trade sanctions on the belligerents in the event of escalation (see the discussion of the parameter $\hat{\tau}_{\text{mul}}$ on page 17).

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) conditional 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 wage 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.[4] 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 equilibrium.

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 con-

[4]Private information is modeled here as uncertainty about the opponent's outside option, with the model allowing for correlation between these options. Alternatively, Hoerner et al. (2015) and Meirowitz et al. (2019) analyze dispute resolution and peace mediation within a diplomatic game where uncertainty specifically pertains to the probability of winning, a modeling approach that also leads to interdependent outside options.

sumption 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 is implemented through a bilateral transfer of geopolitical valence denoted as T. The analysis will reveal how the feasibility or success of this transfer ultimately depends on the extent of private information about the war shocks $\tilde{u}_i$ and $\tilde{u}_j$, which is the only negotiation friction considered in this chapter. Note however that, in addition to asymmetric information, commitment and agency problems also affect war diplomacy, as discussed by Jackson and Morelli (2007) in their landmark theoretical study. They demonstrate how the pro-war political bias of leaders can undermine the feasibility of peace-maintaining geopolitical transfers. Incorporating such agency and commitment problems into the setting of this chapter constitutes an exciting avenue for future research.

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 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. I follow Martin et al. (2008a) who model diplomacy in a way that is both general and tractable, allowing for seamless integration with a trade model. They build upon the bargaining game under asymmetric information of Myerson and Satterthwaite (1983), one of the most influential works in the mechanism design literature. To better align the framework with the realities of diplomatic interstate negotiations, they adopt the variant of this setup developed by Compte and Jehiel (2009):

- Veto rights: Leaders can always choose to unilaterally quit the negotiation table and enter into conflict, regardless of any attempts to prevent them.
- Unconstrained diplomacy: Leaders have the freedom to choose any type of *non-binding* protocol for conducting their negotiations. This includes options such as an ultimatum (i.e., a unilateral take-or-leave offer), a one-shot conference to settle peace, or a sequence of meetings with offers and counter-offers, among others. Rational leaders will ultimately select the protocol that is ex-ante efficient in maximizing their utility before observing their private information. This assumption of unconstrained diplomacy adds realism to the model and, methodologically, 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, they can update their beliefs regarding the disagreement payoff of the other country. To capture this idea, $\tilde{u}_i$ and $\tilde{u}_j$ are assumed to be 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 Martin et al. (2008a)). The domain of variations of $\tilde{u}_i$ and $\tilde{u}_j$ is $[0, 3\eta/4]$ where η is a positive parameter measuring the extent of informational asymmetry.[5]

Solving the game. As shown by Compte and Jehiel (2009), a conceptual appeal of this bargaining game is that, despite its inherent richness, the equilibrium of the game remains simple. Indeed, the second-best protocol—optimally adopted by the two countries under imperfect information—is a

[5]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 $\max U\tilde{C}W_i(\text{war}) = \texttt{OCW}_i + v_i - \min \tilde{u}_i = \texttt{OCW}_i + v_i$.

Nash bargaining protocol which takes the following form (see Mayer et al. (2024) for the computational details):

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 will strategically misreport their true $\widetilde{\texttt{UCW}}_k$. This is why their announcements depend on the realization of the underlying war shocks.[6]

2. 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 stop and war is initiated, with each country receiving its disagreement payoff.

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 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, the country receives a transfer. Hence, the preceding equation emphasizes the incentive for each leader to report a lower utility cost of war. But this comes at 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

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

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

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

[6]It is optimal for leader i to announce $\widetilde{\texttt{UCW}}_i^a = \frac{2}{3}\widetilde{\texttt{UCW}}_i + \frac{1}{12} \max \widetilde{\texttt{UCW}}_i - \frac{1}{4} \max \widetilde{\texttt{UCW}}_j$, and symmetrically for leader j.

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 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 the appendix of Mayer et al. (2024). 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:[7]

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

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 occurrence, 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) util-

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

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

ity 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 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 underlines the multi-faceted welfare impact of increasing $\texttt{OCW}_i$. First, it reduces welfare simply because the costs are larger in wartime.[8] 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 quantitative model of trade, drawing upon the extensive literature on structural gravity (see Costinot and Rodríguez-Clare (2014) and Head and Mayer (2014) for two excellent surveys). 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 purpose, 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.

I retain the trade model from Anderson (1979) due to its analytical simplicity and minimal notation. However, it is important to note that the tools introduced in this section can be refined and applied to more complex 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 associated to the CES utility is then given by

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

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

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. 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 OCW is equal to the log change in real consumption between peacetime and wartime. Therefore, the analysis involves computing the economic equilibrium in peace (factual) and in the hypothetical state of war between 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 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 disruption: In line with empirical evidence surveyed in section 3.1, trade frictions increase between belligerents and with the rest of the world. These parameters capture not only the war-induced destruction of trade infrastructure and logistics but also the potential for either the belligerents themselves or third-party countries to impose trade sanctions on the belligerents. 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 the parameterization could be refined 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). 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 war-induced productivity loss leads to a decrease in consumption, as $\hat{A}_i < 1$. The denominator states that any war-induced increase in internal trade, $\hat{\pi}_{ii} > 1$, which can be seen as a move towards autarky, would decrease consumption. Conversely, any war-induced decrease in internal trade, $\hat{\pi}_{ii} < 1$, 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 A):

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

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.

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

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 $\{s_{ij}, \texttt{WIM}_i, \texttt{PKC}_i\}$.

3.4 Geography of Import Sourcing (GIS)

I now examine the impact of external trade dependence of the countries i and j on their OCWs and other geoeconomic factors. The analysis will show 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

[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.

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 emphasized 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).[10] Applying the MTI approach to Equation (25) and combining with (24), one obtains the following first-order approximation of OCW (see Appendix B):

<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:

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

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 $\{s_{ij}, \mathtt{WIM}_i, \mathtt{PKC}_i\}$.

Equation (27) points out 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:

- <u>Trade logistics disruption</u>: 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.

- <u>Consumption Insurance</u>: The decrease in wartime productivity leads to an increase in the

[10] An alternative approach has been recently developed by Kleinman et al. (2020). Quite interestingly, their method allows to compute first-order general equilibrium effects that take into account wage changes.

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 $-\alpha_i + \alpha_j < 0$.

- 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.[11] In line with this view, the analysis is now 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. The latter condition is often met for the parameter values observed in the literature (see Table 1). Plugging these two parameter restrictions into (27) and combining with (11), one gets the probability that diplomatic negotiations are successful at preventing 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.

The preceding relation shows how the GIS influences peace:*bilateral sourcing facilitates diplomacy* (positive impact of $\left(\pi_{ji} + \pi_{ij}\right)$), while *multilateral openness goes against it* (negative impact of $\sum_{n \neq i,j} \left(\pi_{ni} + \pi_{nj}\right)$). Martin et al. (2008a) 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. This finding calls for a 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. They are analyzed in Section 5.

[11] 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 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 militias. It is often associated to low-intensity violence (for the reasons discussed in footnote 11). 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 then 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 between the "weak" side (country i) and 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.

The numerical procedure is now applied to quantify the geoeconomic factors related to several prominent country-pairs. For simplicity, I use the approximated formula (27) in the simulations and focus entirely on the case of high-intensity symmetrical warfare.

Calibration of the parameters. Table 1 displays the calibrated parameters. I explain below how they are recovered. The trade disruption parameters come 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.[12]

[12] Few attempts in the literature have estimated the costs of interstate war in a quantitative macro framework. Chupilkin and Kóczán (2022) address this issue using a model-free empirical design with a large dataset of historical conflicts. Auray and Eyquem (2019) rely on a radically different approach by estimating a DSGE model on time series data from the two World Wars. Their estimates of the war-induced drop in TFP for France (5%) and Germany

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.

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.

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 (excluding non-tradable sectors). 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 com-

(6%), two belligerents that experienced war directly on their territory, are close to the average effect (8%) estimated by Chupilkin and Kóczán (2022). In a related study, Federle et al. (2024) calibrate an international business cycle model using a new dataset spanning 150 years of interstate wars across more than 60 countries. They estimate the impulse response function of TFP to the war shock for countries that experienced war on their territory. Their results show that the impact on productivity is substantial, with an initial drop of nearly 9%, peaking at about 20%, and remaining nearly 10% lower than its pre-war baseline more than eight years after the war onset.

pute the Pivotal Valence of Peace that is equal to $\texttt{PVP}_{ij} \equiv \eta - \left(\texttt{OCW}_i + \texttt{OCW}_j\right)$. In Equation (11), this corresponds to the cutoff value of geopolitical valence above which diplomacy always manages to secure peace: Mathematically, for $v_i + v_j \geq \texttt{PVP}_{ij}$, the probability of diplomatic success is $s_{ij} = 1$. Intuitively, a positive PVP indicates that *economic incentives alone (i.e. the OCWs) are not strong enough to guarantee peace with probability one*. This one can be enforced with certainty only if the two countries have an intrinsic preference for peace, i.e. a joint valence that is positive and above $\texttt{PVP}_{ij}$.

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% 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 1% 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 0.5%. Clearly, these cases are in the upper tail of the distribution of PKCs. Indeed, for proximate country-pairs, the average concession amounts to 0.1%. 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 1.1% 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 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 −6.6% 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.

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 percentages. 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: History of 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 cumulated number of MIDs of a given hostility-level experienced by the country-pair.

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 country-pairs that experienced contrasting evolutions in their bilateral trade dependence.

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

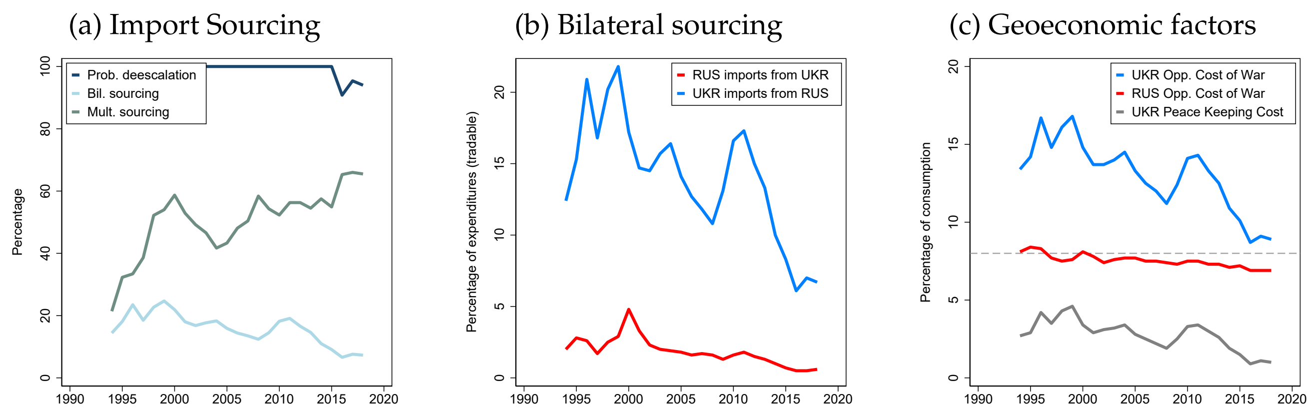
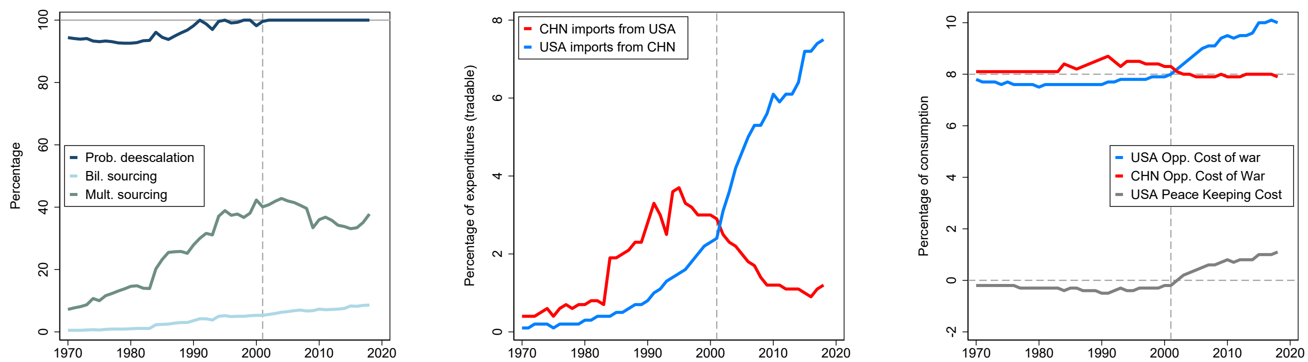


Figure 3 illustrates the time-series evolution of geoeconomic factors for the RUS-UKR country-pair from 1994 to 2018. In panel (a), it can be observed that bilateral dependence between the two countries was initially high following the collapse of the Soviet Union but steadily decreased over time, primarily driven by a significant increase in multilateral sourcing. Panel (b) shows that the drop in bilateral sourcing was in fact asymmetrical, with Ukraine gradually decoupling from Russia. As a result of this substantial bilateral disengagement, the opportunity cost for Ukraine of a high-intensity war with Russia has decreased from 18% of real consumption in the mid-1990s to less than 9% in 2018 (panel c). A similar pattern, albeit less pronounced, can be observed for Russia. Note that the dashed line represents the benchmark 8% loss in TFP, as calibrated in Table 1. Consequently, the costs of 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% in 1999 to 1% in 2018. As a consequence, their diplomatic relationship gradually deteriorated and the probability of deescalation of disputes (panel a) 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 trajectory that was the opposite of that observed for the RUS-UKR pair. The reason is the significant increase in their bilateral dependence (panel a), particularly after China's accession to the WTO in 2001. This evolution was asymmetrical (panel b) and driven by the threefold increase in the share of Chinese imports in US expenditures on tradable goods, reaching 7.5% in 2018. On the other hand, US imports as a share of Chinese expenditures 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 (panel c). Overall, the probability of deescalation increased and remained consistently equal to 1 after 2001 (panel a). However, ensuring peace came at a cost: The asymmetrical evolution of import sourcing resulted in a substantial increase in US Peace Keeping Costs (panel c). 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.

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

(a) Import Sourcing (b) Bilateral sourcing (c) Geoeconomic factors



3.6 Additional mechanisms

In this section, I survey additional theoretical arguments that have been put forward in the literature on the relationship between international trade and 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 (Martin et al., 2012; Vicard, 2012). 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 tensions. 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 military conflicts with one another (Oneal et al., 2003). In line with this "democratic peace", 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 often-overlooked aspect of the relationship between trade and conflict is the impact of conflict-induced trade disruption on the interests of various groups within and across countries. On the one hand, such disruption may benefit protectionist interests by reducing foreign competition due to trade barriers. On the other hand, it may negatively affect exporters who face increasing non-tariff barriers and other trade restrictions in foreign markets. This implies that pro-trade lobbies may be more aligned with pursuing a peaceful resolution of disputes compared to protectionist lobbies. Consequently, the risk of disputes escalating into conflicts is likely influenced by the relative ability of pro- and anti-trade lobbies to mobilize and shape political outcomes.[13] A future research direction is to model how trade lobbying interacts with armed conflicts and their resolution.

[13] 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.

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 address why countries fail to negotiate Pareto-dominant peace. Therefore, it is not ideal for explaining the fundamental out-of-equilibrium nature of war—why, in reality, countries allocate significant funds towards military expenditures but often refrain from engaging in actual interstate conflict. While most of these papers offer theoretical insights, I will review a few empirical studies in the next section 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 confirmed this initial finding, lending further support to the hypothesis that trade promotes peace.[14] 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 various forms, on the frequency of wars between country-pairs. However, as argued by influential contributions from Oneal and Russett (2001) and Green et al. (2001), these papers typically do not account for the fact that both trade and war are endogenous. In particular, country-pair $\times$ year empirical designs are often estimated like pooled cross-sectional regression, ignoring time-invariant

[14] 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)

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).

unobserved heterogeneity (i.e. country-pair fixed effects). Starting with Blomberg and Hess (2006), a second generation of quantitative papers uses more sophisticated econometric techniques to run estimations on country-pair panel datasets. The remainder of this section focuses on this second generation of research.[15]

4.1 Bringing the model to the data

Data. The main sources of information on interstate conflicts 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 explored more frequent but lower-intensity disputes. These include analyzing voting patterns in the United Nations General Assembly to reveal bilateral similarity in countries' foreign policies (e.g., Redding, 2020; Vicard, 2012), perceptions by political decision-makers regarding whether countries view each other as adversaries (measures of strategic rivalries as classified by Thompson (2001) and Colaresi et al. (2008)), and examining military assistance to capture geopolitical alignments (Bove et al., 2014).

Econometric equation. Combining Equations (11), (21), (24), and (25) yields an econometric model that predicts the probability of conflict as a function of import sourcing. This model is nonlinear

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

and 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, their restrictions ensure the validity of the first-order approximation of the OCW formula (27) which leads to the following econometric model:

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

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. The theoretical prediction in section 3.4 is that $\alpha \leq 0$ and $\beta \geq 0$, indicating a pacifying impact of bilateral sourcing and a destabilizing impact of multilateral sourcing.

Estimation Challenges. Equation (30) faces two estimation challenges: the observability of disputes and the endogeneity of trade variables.

1. The theoretical Equation (28) links import sourcings 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. Its likelihood is the product of the probability of a dispute and the conditional probability of escalation:

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

   Disputes vary across country-pairs and time and these panel variations must be accounted for in the regressions. Indeed, the estimates could 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. Vicard (2012) uses a bivariate probit model with censoring, which involves jointly estimating two equations: one for modeling dispute initiation and the other for modeling escalation. Martin et al. (2008a) take a less structural 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. The list of approaches used to address the endogeneity of import sourcing in Equation (30) includes: (i) lagging bilateral and multilateral import sourcing to mitigate contemporaneous reverse causality; (ii) controlling for potential co-determinants of conflicts and trade patterns (model 4 in Table 3 of Martin et al. (2008a)); (iii) including country-pair fixed effects in a panel setting; and (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 made of a gravity equation of trade and a conflict regression, they explicitly model the dual effect of distance on both variables. Their results confirm that bilateral trade openness reduces war. Examining low-intensity 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) through the lens of 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 from 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 within the agreement. However, they also observe that PTAs increase the likelihood of conflicts between member and non-member countries, leading to peace diversion. These contrasting patterns align well with the theoretical predictions on the geoeconomic impact of GIS discussed in Section 3.4.

4.3 GIS and the costs of conflict containment

Seitz et al. (2015) and Garfinkel et al. (2020) apply 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) pertains to his empirical study of the influence of RTAs on the likelihood of conflict. His aim is to isolate the trade diplomacy channel (as discussed in section 3.6.1) while accounting for the changes in economic interdependence induced by RTAs. He 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. His premise is that trade diplomacy operates primarily for deep RTAs, as these agreements involve a substantial shared institutional framework.

Using COW data from 1950 to 1991, Vicard (2012) estimates a variant of Equation (30), with the main explanatory variable being a binary indicator for the presence of a trade agreement 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 a similar impact. Importantly, these results hold even after controlling for trade dependency—bilateral and multilateral import sourcing as defined in Equation (30)—suggesting that the effect is driven by the trade diplomacy channel. He conducts an extensive set of robustness checks, which includes an instrumental variable approach to address endogeneity concerns regarding RTA formation. Quantitatively, deep RTAs are found to reduce the probability of a dispute escalating into war by about two-thirds.

4.5 Micro-level evidence on trade and war

A promising and recent research avenue explores 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 shows 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 exploit 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 of imports from Southern countries to Northern countries on violence. They combine variations in agricultural tariffs over time with disparities in crop suitability across a grid of 9km $\times$ 9km cells covering 27 Southern countries and all PTAs signed with major Northern countries between 1995 and 2014. The empirical strategy leverages the observation that variations in agro-climatic conditions within a country create exogenous differences in crop suitability. They find that in cells where crop suitability is higher for liberalized crops, the implementation of PTAs leads to an increase in both economic output and political violence. In a similar vein, Gallea and Rohner (2021) perform a spatial analysis of global trade and find that while conflicts are more prevalent in strategic areas near maritime chokepoints like straits or capes, the expansion of global trade openness actually reduces the likelihood of conflicts in these critical locations.

Shifting the focus from international trade to foreign direct investment, Sonno (2020) investigates the impact of multinational enterprises activity on the occurrence of violent conflict in Africa from 2007 to 2018. Using a novel and rich dataset with geo-coded information on the affiliates of identified foreign companies, he finds that the presence of affiliates significantly increases local conflict intensity, with particularly pronounced effects in land-intensive sectors like agriculture and in regions targeted for large-scale land acquisitions. Land use data indicate that conflicts are more likely to arise in areas where land previously used for agriculture has been taken over by multinationals. Additionally, Afrobarometer data show that local residents near affiliates' operations are more likely to voice concerns about government land management and agricultural policies. Overall, this fascinating disaggregated study emphasizes land expropriation as a key mechanism through which multinationals' activities may contribute to the escalation of violence.

5 Trade Policy in the Shadow of War

Trade policy in the shadow of war involves a complex interplay between economics and geopolitics, raising unresolved questions. For example, as geopolitical climate deteriorates, the existing literature offers limited quantitative guidance on whether countries should (i) increase bilateral dependence with rivals to reduce escalation risk, or (ii) diversify import sources as a safeguard against trade disruptions. Below, I illustrate how the framework presented provides insights into these issues.

5.1 Geoeconomic welfare gains: theory

The goal is to integrate endogenous conflict risk into the current quantitative toolkit for trade policy evaluation, which has thus far been designed for peacetime scenarios.[16] 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

[16] 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.

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 as 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* in geoeconomics, related to using policy to either strengthen or reduce bilateral import dependence with geopolitical rivals. While a quantitative analysis is essential for informed decision-making, the following thought experiment is useful for outlining the key intuitions. Consider a policy that increases bilateral import dependence between country i and its rival j, thereby raising i's opportunity cost of war: $\Delta\texttt{OCW}_i > 0$.

- The 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 (see footnote 8). This channel is captured by the positive term $(\Delta\texttt{OCW}_i - \Delta\texttt{WIM}_i > 0)$ on the RHS of Equation (34). Secondly, a rising OCW undermines country i's diplomatic bargaining power, forcing i to make greater concessions in order to maintain peace ($\Delta\texttt{PKC}_i > 0$).

- The policy 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. The quantification exercise in the next section comes back to the details of this chain of adjustments.

5.2 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 impact of various policies on the creation/diversion of trade flows and welfare. This field has been very active in the recent years and has reached a certain consensus on the methods (Costinot and Rodríguez-Clare, 2014; Head and Mayer, 2014). They all combine 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, these methods provide an estimate of the expected changes in trade shares, the relevant metric for ultimately computing the changes in the OCW and other 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 $\mathcal{G}_i$.

5.3 Geoeconomic welfare gains: application

The method outlined in the preceding section is now used to conduct two policy experiments. First, a complete return to autarky, which may be unrealistic, serves the purpose of enhancing our understanding of the underlying mechanisms. The second scenario, EU enlargement to Ukraine, holds greater policy relevance. Note that the findings here illustrate the method rather than offer policy prescriptions. Indeed, the analysis relies on an approximated OCW procedure that ignores war-induced wage changes, does not explore sensitivity to alternative parameter calibrations, and is conducted within a simplified trade framework that excludes intermediate goods, sector heterogeneity, and input-output linkages. Yet, sector heterogeneity could matter quantitatively due to low substitution elasticities in some sectors (Ossa, 2015), and input-output linkages could be important because of critical components (e.g., rare earths) and technologies (e.g., advanced chips). As Costinot and Rodríguez-Clare (2014) notes, such omissions may lead to conservative estimates of welfare gains and losses, and, consequently, OCWs. Our companion paper (Mayer et al., 2024) addresses these issues by simulating a more complex and realistic quantitative setup using non-approximated GE methods.

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 set of country-pairs of 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 15.8ppt 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).[17] 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 42.9 ppt for proximate countries (Equation 11).[18] 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 average, a significant quantitative impact. Clearly, all these averages conceal significant heterogeneity across country-pairs. For example, the France-Germany or China-USA dyads would actually experience a decrease in OCW and probability of deescalation.

EU enlargement to Ukraine. In this scenario, motivated by the war between Russia and Ukraine, I quantify the geoeconomic gains to be expected from a counterfactual accession of Ukraine to the European Union. The simulation computes the changes in consumption and geoeconomic factors that should have been observed if Ukraine had fully integrated EU-28 common market in 2018 (i.e., *before* the Russian invasion). 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.

[17] Table 2 conveys useful information on the estimated *levels* of these variables in 2018.

[18] 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.

Before turning to the geoeconomic consequences, let first describe the economic channels. Following its accession to EU single market, bilateral accessibility between Ukraine and the other member countries improves. The drop in tariff and non-tariff barriers leads 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 are boosted and Ukrainian real GDP and consumption increase. As Ukrainian markets become more competitive, non-EU based firms (e.g. Russian firms) lose market shares on Ukrainian markets. Hence, EU enlargement to Ukraine contributes to reduce further the bilateral dependence between Russia and Ukraine.

Table 6 presents the quantification results. 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 under consideration. The numbers are in line with the economic channels outlined in the preceding paragraph. The decoupling between the Russian and Ukrainian economies is exacerbated with a 0.83ppt decrease in bilateral sourcing and a 11.12ppt increase in multilateral sourcing. Ukraine's peacetime consumption increases by 4.41ppt. From a security perspective, thanks to the decoupling, the opportunity cost for Ukraine of a high-intensity war with Russia is reduced by 0.96ppt and its peace-keeping cost decreases by 0.47ppt. The diplomatic relationship with Russia deteriorates further with a 11.33ppt drop in the probability of deescalation. On net, Ukraine experiences a small geoeconomic welfare loss (-0.19 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 deescalation probability. With Germany and Poland, one observes the reverse: bilateral dependence, OCWs and diplomatic relationship improve. Over-

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.

all, this discussion underscores the risk that trade diversion poses to diplomacy and conflict. As trade agreements deepen, some countries may see a reshuffling of their GIS, potentially harming diplomatic relations.

5.4 The security dilemma in the data

European integration exemplifies how trade agreements can mitigate security threats. The formation of the EU aimed to create interdependencies that would increase the opportunity cost of war between member nations (Spolaore, 2013). For instance, the Schuman Declaration of May 9, 1950, proposed a common High Authority to oversee the coal and steel production of 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 significant obstacles due to the political acceptability of trading with former adversaries. Historical conflicts often impede trust and trade between former enemies (Guiso et al., 2009), as seen in the minimal bilateral dependence between India and Pakistan (Table 2). Additionally, Martin et al. (2012) shows that, in contrast with past wars, recent wars deter the formation of trade agreements. These pieces of evidence stress the catch-22 nature of implementing peace-promoting trade agreements with former enemies.

This challenge is more acute in democracies, where leaders are constrained by electoral accountability when pursuing economic ties with rivals. However, the EU's successful integration, despite a history of conflict among its members, demonstrates 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 functional multilateral institutions that can host negotiations and disseminate information on both economic and political matters. Another advantage of multilateralism is its handling of geopolitical risks associated with non-cooperative behaviors, as policymakers may not fully internalize the security spillovers of their trade policies. As discussed 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 related geoeconomic factors, including conflict risk, for all country-pairs. By factoring in the interests of all actors potentially affected by the policy, the multilateral approach addresses these intricate interconnections between geopolitical insecurity and trade architecture. Overall, these arguments underscore the importance of strengthening the multilateral trade system in a world of rising geopolitical tensions.

5.5 Trade Sanctions

The Embargo Act of 1807 marked the first use of sanctions and embargoes in the modern era (O'Rourke, 2007). Nowadays, economic sanctions are commonly observed during diplomatic disputes, aiming to induce a change in the policies of a foreign government by harming its economy. Extensive research has studied sanctions as a foreign policy tool (see Hufbauer et al. (2009) for an overview), with recent studies focusing on sanctions against Iran and Russia (Haidar, 2017; Crozet and Hinz, 2020; Crozet et al., 2021, among others). Yet, there is limited evidence on whether sanctions lead to the desired policy changes. In this section, I demonstrate how the quantitative framework outlined earlier can assess the impact of trade sanctions on geopolitical factors, including the probability of de-escalating diplomatic disputes. To illustrate this approach, I apply it to 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.

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.

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 in the geoeconomic factors associated with a dispute 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 94% to a counterfactual level of 100% (an increase of 5.95ppt). Further examination of the table confirms that similar significant geoeconomic effects would be observed for other disputes involving Russia. In fact, the counterfactual probability of a successful de-escalation under the sanction regime is 100% for all country pairs. These results suggest that credible and pervasive sanctions could have fully prevented the risk of a high-intensity war involving Russia. Clearly, this conclusion overlooks two empirically relevant considerations. First, the feasibility of making credible commitments to sanctions is limited. Second, not all countries participate in the sanctions scheme, which tends to diminish their effectiveness.

6 Concluding Remarks

This chapter presents a quantitative framework suited for exploring the trade and war question. It combines a simple structural gravity model of trade with a diplomatic game, deriving a welfare formula for trade in the shadow of conflict. Welfare includes not only standard trade gains in peacetime but also the following geoeconomic factors: (i) diplomatic concessions to avert war; (ii) the probability of war; and (iii) the cost of war. The analysis highlights how the geography of import sourcing affects these geoeconomic factors.

Methodologically, the framework integrates endogenous conflict risk into the quantitative toolkit for policy evaluation. Counterfactual simulations show that the welfare implications of trade policy can diverge significantly from predictions based on models calibrated exclusively for peacetime conditions. These findings emphasize the need for caution in policy formulation amidst geopolitical tensions. In this context, the tools presented in this chapter provide valuable insights into aligning import sourcing strategies with geopolitical realities.

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 numerical applications presented in this paper serve as an illustrative demonstration of the methods, rather than definitive calculations. More policy-oriented research should use non-approximated GE numerical procedure and enrich the structure of the trade model. Second, an overlooked area in the literature is the role of industrial lobbies and other special interest groups in either containing or escalating tensions. Third, the chapter sheds light on the fundamental security dilemma faced by policymakers. One key finding is that diversifying import sources in response to geopolitical tensions—by reducing interdependencies with rivals—can paradoxically increase conflict risk. Exploring the intricate feedback loops between geopolitical insecurity and trade architecture remains a crucial yet underexplored area. All these topics present exciting opportunities for future research in the field.

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Appendix

A Derivation of Equation (25)

The hat-algebra is applied to Equation (22)

$$\hat{\pi}_{ii} = \frac{1}{\hat{A}_i^{1-\sigma}} \times \frac{1}{\hat{P}_i^{1-\sigma}} \times \hat{w}_i^{1-\sigma}, \tag{35}$$

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

$$\hat{P}_i^{1-\sigma} = \sum_{k=1}^{N} \pi_{ki} \left(\frac{\hat{\tau}_{ki}\hat{w}_k}{\hat{A}_k} \right)^{1-\sigma} = \pi_{ii} \left(\frac{\hat{w}_i}{\hat{A}_i} \right)^{1-\sigma} + \pi_{ji} \left(\frac{\hat{\tau}_{\text{bil}}\hat{w}_j}{\hat{A}_j} \right)^{1-\sigma} + \sum_{n \neq i,j} \pi_{ni} \left(\hat{\tau}_{\text{mul}}\hat{w}_n \right)^{1-\sigma}. \tag{36}$$

Combining these relations yield:

$$\hat{\pi}_{ii} = \left[\pi_{ii} + \pi_{ji} \left(\frac{\hat{\tau}_{\text{bil}}\hat{A}_i\hat{w}_j}{\hat{A}_j\hat{w}_i} \right)^{1-\sigma} + \sum_{n \neq i,j} \pi_{ni} \left(\frac{\hat{\tau}_{\text{mul}}\hat{A}_i\hat{w}_n}{\hat{w}_i} \right)^{1-\sigma} \right]^{-1}. \tag{37}$$

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

B Approximated Procedure: Derivation of Equation (27)

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

$$\texttt{OCW}_i = -\log \hat{A}_i + \frac{1}{\sigma - 1} \log \hat{\pi}_{ii}. \tag{38}$$

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

$$\log \hat{\pi}_{ii} = -\log \left[1 - \pi_{ji} \left[1 - \left(\frac{\hat{\tau}_{\text{bil}}\hat{A}_i}{\hat{A}_j} \right)^{1-\sigma} \right] - \sum_{n \neq i,j} \pi_{ni} \left[1 - \left(\hat{\tau}_{\text{mul}}\hat{A}_i \right)^{1-\sigma} \right] \right]. \tag{39}$$

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 (39) is given by

$$
\begin{aligned}
\log \hat{\pi}_{ii} &\approx \pi_{ji}\left[1-\left(\frac{\hat{\tau}_{\text{bil}}\hat{A}_i}{\hat{A}_j}\right)^{1-\sigma}\right]+\sum_{n\neq i,j}\pi_{ni}\left[1-\left(\hat{\tau}_{\text{mul}}\hat{A}_i\right)^{1-\sigma}\right] \\
&= \pi_{ji}\left[1-\frac{\left(1+\tau_{\text{bil}}\right)^{1-\sigma}\left(1-\alpha_i\right)^{1-\sigma}}{\left(1-\alpha_j\right)^{1-\sigma}}\right]+\sum_{n\neq i,j}\pi_{ni}\left[1-\left(1+\tau_{\text{mul}}\right)^{1-\sigma}\left(1-\alpha_i\right)^{1-\sigma}\right] \\
&\approx \pi_{ji}\left(\sigma-1\right)\left(\tau_{\text{bil}}-\alpha_i+\alpha_j\right)+\sum_{n\neq i,j}\pi_{ni}\left(\sigma-1\right)\left(\tau_{\text{mul}}-\alpha_i\right). \qquad (40)
\end{aligned}
$$

Combining (38) and (40) and using the approximation $\log \hat{A}_i = \log\left(1-\alpha_i\right) \approx -\alpha_i$, I obtain the following first-order approximation of OCW

$$
\texttt{OCW}_i = \alpha_i + \pi_{ji}\left(\tau_{\text{bil}}-\alpha_i+\alpha_j\right)+\sum_{n\neq i,j}\pi_{ni}\left(\tau_{\text{mul}}-\alpha_i\right), \qquad (41)
$$

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