Make Trade not War?*

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Abstract

This paper analyses theoretically and empirically the relation between trade and war. We show that the intuition that trade promotes peace is only partially true. In a model where war can occur because of asymmetric information, countries that trade more bilaterally have a lower probability of bilateral war because of the opportunity cost associated to the loss of trade gains. However, countries more open to trade have a higher probability of war because multilateral trade openness decreases bilateral dependence to any given country and therefore the opportunity cost of war. Using a theoretically grounded econometric model, we empirically test these predictions on a large data set of military conflicts on the 1948-2001 period and find strong evidence for these contradictory effects of trade. Our empirical results also confirm the theoretical prediction of our model that multilateral trade openness increases more the probability of war between countries which are close to each other. This may explain why military conflicts have become more localized over time. We also find evidence that information flows between countries decreases the probability of war.

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1 Introduction

"The natural effect of trade is to bring about peace. Two nations which trade together, render themselves reciprocally dependent; for if one has an interest in buying, the other has an interest in selling; and all unions are based upon mutual needs."

Montesquieu, De l'esprit des Lois, 1758.

This paper explores the impact of trade liberalization on the prevalence of international conflicts. Our main theoretical result is that an increase in bilateral trade between two countries reduces the probability of conflicts between them but increases the probability of conflicts with other countries. Another theoretical finding is that the worldwide intensification of trade flows, as observed after the WWII has changed the nature of conflicts, with less global confrontations, involving several and distant countries, but more local confrontations, involving fewer and closer countries. The rationale is that globalization, by enabling trade links with distant regions, has reduced countries' dependency on local trade and thus reduced the opportunity costs of local wars. On the period 1948-2001, we find strong evidence in favor of the contradictory effects of bilateral trade vs multilateral trade and the role of asymmetric information is confirmed .

Our work is motivated by the growing concern that the end of the Cold War did not contribute to pacifying international relations. This contradicts the liberal-institutionalist view of trade as held in political science (see Oneal and Russet 1999) which argues that globalization and the spread of free markets and democracy should limit conflicts between countries. The intellectual origin of this vision can partly be traced back to the Kantian view of international relations as exposed in Kant's *Essay on Perpetual Peace (1795)* and was very influential*:* for example, the idea of European integration was precisely conceived to prevent the killing and destruction of the two World Wars from ever happening again[1]. A rough look at the 1870-2001 period (see figure 1[2]) suggests however that the correlation between trade openness and war is not a clear cut one: positive on the 1870-1930 period and then negative on the 1930-1989 period. The end of the XIXth century, the first era of globalization with rising trade openness, was a period of multiple military conflicts, culminating with World War I. Then the interwar period was characterized by a simultaneous collapse of world trade and conflicts. After World War II, world trade increased rapidly while the number of conflicts decreased (although the risk of a global conflict was obviously high). There is no clear evidence that the 1990s was a period of lower prevalence of military conflicts even taking into account the increase in the number of sovereign states;

[1]Before this, the 1860 Anglo-French commercial Treaty was signed in part to diffuse tensions between the two countries. Outside Europe, MERCOSUR was created in 1991 in part to curtail the military power in Argentina and Brazil, then two recent and fragile democracies with potential conflicts over natural resources.

[2]Figure 1 depicts the occurrence of Militarized Interstate Disputes (MID) between pairs of countries divided by the number of countries. It therefore controls for the difference across time in the number of countries. MIDs are ranging from level 1 to 5 in terms of hostility level. Figure 1 accounts for level 3 (display of force), level 4 (use of force) and 5 (war, which requires at least 1000 death of military personnel). See section 3.1 for a more precise description of the data.Trade openness is the sum of world trade (exports and imports) divided by world GDP as calculated by Estevadeordal et al. (2003).

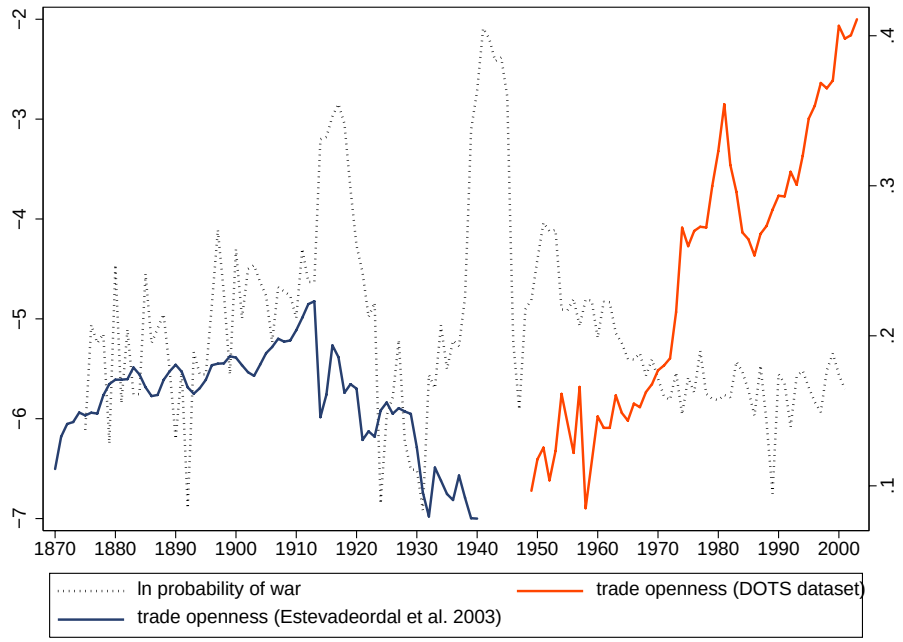

Figure 1: Militarized conflict probability and trade openness over time

in fact if anything, the 1990s may have marked the beginning of a new era of violent international conflicts, and the first years of the twenty-first century suggests the same. Another surprising fact is related to the changing nature of military conflicts after the WWII. Figure 2 depicts the average distance between countries in military disputes (see footnote 1 for the characterization of these). It strongly suggests that military conflicts have become more localized over time.

The objective of this paper is to shed light on the following question: if trade promotes peace as illustrated by the European example, why is it that globalization, interpreted as trade liberalization at the global level, has not lived up its to its promise of decreasing the prevalence of violent interstate conflict? We offer a theoretical and empirical answer to this question, based on the interaction between asymmetric information and trade between many countries.

Our analysis first highlights that information flows matter: the larger is information asymmetry between countries, the more inefficient is the bargaining process and so the highest is the probability of war. Second, a pair of countries with lower bilateral trade barriers, will have a lower probability of bilateral war. Third, multilateral trade openness has an opposite effect: any pair of countries which decides to lower the trade barriers with the rest of the world will decrease their degree of bilateral dependency and this results in a higher probability of bilateral war. A theoretical prediction of our model is that globalization of trade flows, interpreted as a worldwide decrease in trade costs, changes the nature of conflicts from global to local.

The intuition that trade increases economic dependency and the opportunity cost of war is there-

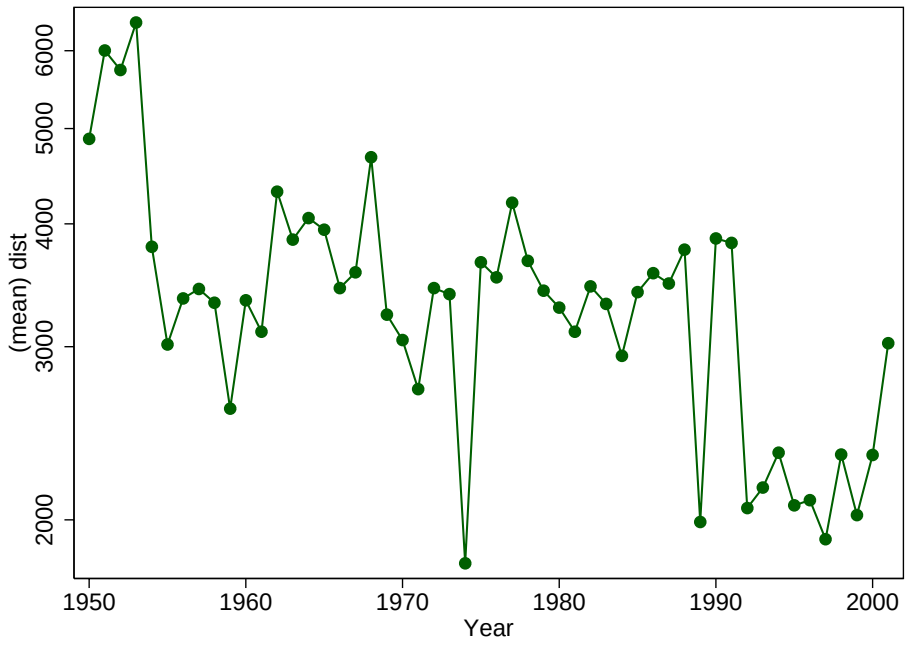

Figure 2: Average distance of militarized conflicts over time

fore only partly right even in a model in which trade is beneficial to all countries. That trade is unambiguously conducive to peace is only true in a two country world. However, multilateral trade liberalization makes world conflicts such as the two world wars or the cold war less likely.

We test these theoretical predictions on the 1948-2001 period using a data set from the correlates of war project, that makes available a very precise description of interstate armed conflicts. The mechanism at work in our theoretical model rests on the hypothesis that war disrupts trade and therefore puts trade gains at risk. We first test this hypothesis. Using a gravity model of trade, we find that bilateral trade costs indeed increase significantly with a bilateral war. However, multilateral trade costs do not increase significantly with war. This is a required condition for multilateral trade openness to increase the probability of bilateral war in our theoretical model. Second, using a theory grounded econometric model, we successfully test the predictions of the model related to the contradictory effects of bilateral and multilateral trade on war. Those results hold in front of various robustness checks; in particular we control for potential contamination by co-determinants of war and trade**,** such as distance, common language and culture, political regimes, political affinity, etc. We also test the effect of informational asymmetry on the probability of war and find evidence that countries that exchange less information are more likely to go to war. This last result echoes Izquierdo et alii (2003) who provide evidence for the informational impact of trade. Finally, we find a quantitatively large effect of trade on the probability of war. A one standard deviation increase in bilateral trade between two countries decreases their probability of military conflict by around 15%. On our sample, where the

average annual probability of conflict is around 0.4% between any two countries, this would decrease the probability to 0.34%. A one standard deviation increase in multilateral trade (excluding bilateral trade) would increase the probability of military conflict between two countries by around 19%.

The related literature stems from political sciences to political economy. The question of the impact of trade on war is old and controversial among political scientists (see Barbieri and Schneider, 1999 for a recent survey). From a theoretical point of view, the main debate is between the "trade promotes peace" liberal school and the neo-marxist school which argues that asymmetric trade links lead to conflicts. The main difference between these two positions comes from the opposing view they have on the possibility of gains from trade for all countries involved. From an empirical point of view, recent studies in political science test the impact of bilateral trade (in different forms) on the frequency of war between country dyads. Many find a negative relation (see for example Polachek, 1980; Polachek, Robst and Chang, 1999 and Oneal and Russet, 1999). However, some recent studies have found a positive relation (see Barbieri 1996 and 2002)[3]. These papers however do not test structural models of trade and war but various ad-hoc specifications[4]. A notable exception is a recent paper by Glick and Taylor (2005) who study the reverse causal link, namely from war to trade. They control for the standard determinants of trade as used in the gravity equation literature. More importantly, to our knowledge our paper is the first to derive theoretically the ambiguous effect of trade on peace (positive for bilateral trade and negative for multilateral trade) and to empirically test this prediction.

The recent literature on the number and size of countries (see Alesina and Spolaore, 1997 and 2003) has also clear connections with our paper. Alesina and Spolaore (2003a and b) study the link between conflicts, defense spending and the number of countries. Their model aims to explain how a decrease in international conflicts can be associated to an increase in localized conflicts between a higher number of smaller countries. Their explanation is the following: when international conflicts become less frequent, then the advantages of large countries (in terms of provision of public and defense goods) decreases so that countries split and the number of countries increases. This itself leads to an increase in the number of (localized) conflicts. On the contrary, the number and size of countries in our model are exogenous and we abstract from this mechanism. Note that in these models trade increases as countries split because what was internal trade becomes international trade split. The mechanism at work in our model is complementary to the one they identify as the decrease of trade costs and the specific form it takes is the exogenous force that can influence the number of conflicts both at the global and the local level.

The next section derives the theoretical probability of escalation to war between two countries

[3]The debate between these authors rests on various issues: 1) whether to test the relation between trade and war on all possible state pairs or only on the so-called "politically relevant dyads", contiguous states or "major powers". In our study, we use all country pairs and do not select a subset. 2)

[4] The list of controls they include are usually those most cited in the political science literature (such as whether the countries are democratic or authoritarian, military capabilities etc...) but rarely include determinants of trade that could also affect the probability of war. For example, Barbieri does not include distance as one her controls even though it is well known in trade that bilateral distance heavily affects bilateral trade. Distance also affects negatively the probability of conflicts (see Kocs, 1995). A similar argument can be made on other determinants of trade.

as a function of the degree of asymmetric information, bilateral and multilateral trade costs and analyses the ambivalent role of trade on peace. The third section first tests the impact of war on both bilateral and multilateral trade and tests the impact of trade openness, bilateral and multilateral, on the probability of military conflicts between countries.

2 The model

In this section, we analyze a simple model of negotiation and escalation to war. We then embed it in a model of trade to assess the marginal impact of trade on war.

2.1 A canonical view of negotiation and war

We follow the rationalist view of war among political scientists (see Fearon 1995, for a survey) and economists (see Grossman, 2003) which aim is to explain the puzzle that wars are costly but do occur, even in the presence of rational leaders who consider the risks and costs implied by wars[5]. The rationalist view is the most natural structure for our argument on the role of trade because trade gains are then taken into account in the decision to go to war. In the rationalist school view, different strategies for modelling escalations to war and the involved processes of negotiations between countries exist. Most of the studies share two important features: war is considered as Pareto dominated by peace and imperfect information explains why negotiations may fail and wars occur. However, those studies greatly differ with respect to the views they take on institutional setting and the negotiations protocols. Clearly, as argued by Grossman (2003), institutions do matter to understand why some disputes, but not all, escalate into war.

We build a model where war may result from the failure of a bargaining game between two countries. The structure of this game is fairly general: its two main features are Pareto domination of war and imperfect information. However, contrary to the standard literature in political science, the only institutional constraint we impose is that the negotiation protocol (bilateral or multilateral negotiations, repeated stages...) chosen is the one that maximizes ex-ante welfare of both countries. This more general view has two advantages. First, it avoids the main drawback of the existing literature, namely the high sensitivity of results to the underlying restrictions made on institutions. Second, it is consistent with the rationalist school view of war, as rationality should imply that leaders are willing to choose the institutional setting and negotiation protocol which is the most efficient.

[5]Scholars in political sciences have developed two alternative types of argument : i) agents (and states leaders) are sometimes irrational; as such they neglect the costs of war; ii) leaders may be those who enjoy the benefits of war while the costs are suffered by the other agents (citizens and soldiers).

We ignore those alternative explanations of war because it is unlikely that the trade openness channel interacts with them. Indeed an irrational leader may decide to go on war whatever the trade loss suffered by his country. Similarly the way the trade surplus (and the trade loss in case of conflict) is shared between political leaders and the rest of the population is not obvious. Hence, marginally, a larger level of trade openness has no clear cut impact on the trade-off between the marginal benefits of war enjoyed by political leaders and the marginal costs suffered by the population.

Consequently, Internal politics do not play a role in our theoretical analysis. Studies on the relation between domestic politics and war include Garfinkel (1994) and Hess and Orphanides (1995, 2001).

Consider two countries i and j. Exogenous conflicts arise between these two countries. As Grossman (2003) points out, "only a small fraction of disputes between states result in inter-state war" and our objective is to analyze the determinants of escalation of disputes into war. We do not model the probability of conflicts themselves but in the empirical section, we assume they are potentially affected by the presence of a common border, distance, past wars... If a conflict arises, it can end peacefully if countries succeed through a negotiated settlement or it can end with war if negotiations fail. For simplicity, the model we consider has no time dimension. We come back to this issue in the empirical section.

Leaders in both countries care about the utility level of a representative agent. In peace, representative agents in both countries get: (U_i^P, U_j^P). In a situation of war, they get a stochastic outside option $(\tilde{U}_i^W, \tilde{U}_j^W)$. Escalation to war is avoided whenever country i and j agree on a sharing rule of the peace-surplus S^P. Peace pareto-dominates war so that the surplus in a situation of peace is larger than the surplus in war:

$$S^P \equiv U_i^P + U_j^P > \tilde{U}_i^W + \tilde{U}_j^W \equiv \tilde{S}^W \tag{1}$$

In a deterministic setting, it is clear that i and j would always agree on a sharing rule and avoid escalation to war. With imperfect information, ex-post inefficiency and escalation to war can arise because players are uncertain on the value of disagreement payoffs in case of war. Whether countries end up in peace or war depends on the bargaining protocol. If both countries negotiate directly in a one-shot way rather than in a multi-stage way, they are not able to reveal information; furthermore an arbitrage procedure could be driven by a third agent (a neutral country or the UN for example). As we allow rational leaders to choose the optimal bargaining protocol, it is clear that they will choose the most efficient negotiation protocol among all possible protocols, namely the one which ex-ante gives the largest expected welfare.

Solving for such a second best protocol in bargaining under private information constitutes one of the most celebrated results in the mechanism design literature (Myerson and Satherwaite 1983). However, we cannot apply directly Myerson and Satherwaite's results because they assume that 1) private information should be independently distributed between agents; 2) once an agent has agreed to participate in the negotiation, it has no further right to quit the negotiation table. Hereafter we want to relax both assumptions because we believe they are not realistic in the context of interstate conflicts that may escalate in wars[6]. First, it is reasonable to think that in case of war, the disagreement payoffs are partially correlated: losses for one country (in terms of territory, national honor or freedom for example) may partially mirror gains for the other country. Second, in reality no institution (even or especially the UN) has the power to forbid a sovereign country to leave negotiations and enter war.

[6]It is fundamental to relax simultaneously both assumptions. Relaxing the first one only would imply that war never occurs; indeed in the correlated case with interim participation constraints, Cremer and Mc Lean (1988) have shown that the first best efficiency can be obtained and players always reach an agreement.

Compte and Jehiel (2004) show that relaxing assumption 2 in order to let agents quit negotiations at any time implies that private information, even if correlated, results in inefficiency, which in our context translates into possible escalation to war.

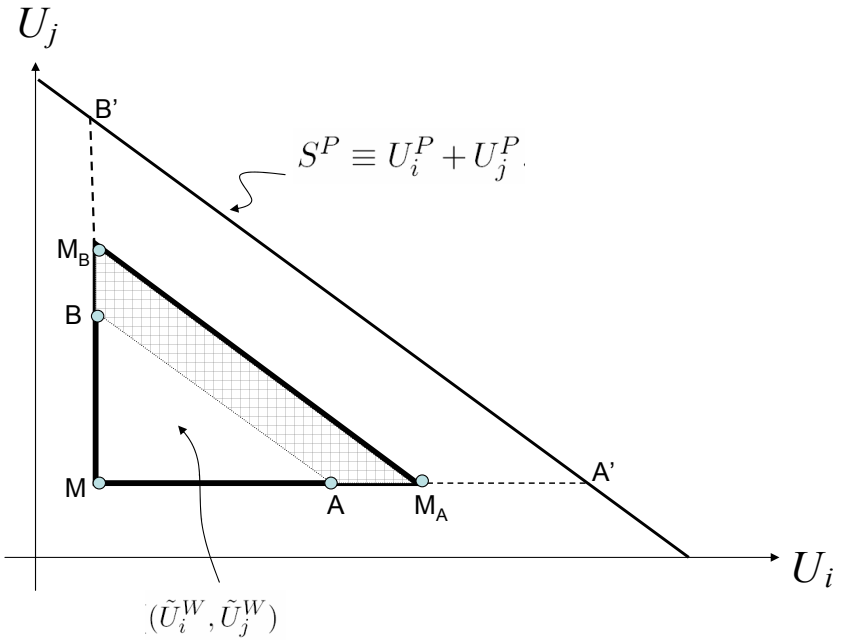

Figure 3: Peace Negotiation under uncertainty

Hence the class of protocols we want to consider is smaller than in the initial approach by Myerson and Satherwaite as we will consider only *no commitment mechanisms*.

The bargaining problem is depicted in figure theory. We assume that stochastic outside options $(\tilde{U}_i^W, \tilde{U}_j^W)$ are equal on average to the equilibrium values (U_i^W, U_j^W) as determined in the next section. More precisely:

$$\tilde{U}_i^W = (1 + \tilde{u}_i).U_i^W \text{ and } \tilde{U}_j^W = (1 + \tilde{u}_j).U_j^W \tag{2}$$

where $\tilde{u}_i$ and $\tilde{u}_j$ are privately known by each country. Private information is partially correlated as $(\tilde{u}_i, \tilde{u}_j)$ are drawn in a uniform law distributed in the triangle Γ (see figure theory) where minimum and maximum values for $(\tilde{u}_i, \tilde{u}_j)$ are respectively $-V/2$ and $+V$. Unconditional mean and variance are: $E(\tilde{u}_i) = E(\tilde{u}_j) = 0$ and $var(\tilde{u}_i) = var(\tilde{u}_j) = V^2/8$. Hence, the parameter V measures the degree of informational asymmetry between the countries.

Following Compte and Jehiel (2005) we show in appendix that the bargaining protocol chosen optimally by the two countries corresponds to a *Nash Bargaining protocol*. Importantly with such a protocol (described in the appendix), disagreements arise for every outside option $(\tilde{U}_i^W, \tilde{U}_j^W)$ inside the dashed area ABM_jM_i where A and B are such that: $\overline{MA} = 3/4.\overline{MA'}$ and $\overline{MB} = 3/4.\overline{MB'}$. Intuitively countries do not reach an agreement when the disagreement and agreement payoffs are sufficiently close.

Hence the probability of escalation to war corresponds to the surface of ABM_jM_i divided by the surface of the triangle MM_iM_j : $\Pr(escalation_{ij}) = 1 - \frac{\overline{MA}.\overline{MB}}{\overline{MM_i}.\overline{MM_j}}$. Assuming that the informational

noise V is sufficiently small, we get:

$$\Pr(escal_{ij}) \simeq 1 - \frac{1}{4V^2}.\frac{\left[\left(U_i^P + U_j^P\right) - (U_i^W + U_j^W)\right]^2}{U_i^W.U_j^W} \tag{3}$$

The probability of escalation to war is determined positively by the degree of asymmetric information as measured here by the observational noise V^2 and negatively by the difference in the surplus under peace and under war. Trade may affect both determinants of war. The next section is devoted to build an explicit model of trade so as to express the probability of war as a function of trade parameters.

2.2 A simple model of trade

Our theoretical framework used to derive the trade related opportunity costs brought by escalation to war as depicted in equation (3) is based on a standard new trade theory model with trade costs. The reason we use such a model is that we want to take into account the relative ease that countries in a situation of war have to substitute from one origin to another. A model with constant elasticity of substitution obviously facilitates this analysis. Also, distance between countries plays an important empirical role for both trade and war. Hence, trade costs, that can account for distance, are an important part of our story, and they are relatively easy to manipulate in new trade models.

The world equilibrium:

The world consists of R countries which produce differentiated goods under increasing returns. The utility of a representative agent in country i has the standard Dixit-Stiglitz form:

$$U_i = \left[\sum_{j=1}^{R} n_j x_{ij}^{1-1/\sigma}\right]^{1/(1-1/\sigma)} \tag{4}$$

where n_j is the number of varieties produced in country j; x_{ij} is country i demand for a variety of country j (all goods produced in j are demanded in the same quantity); $\sigma > 1$ is the elasticity of substitution. Dual to this is the price index for each country:

$$P_i = \left(\sum_{j=1}^{R} n_j p_j^{1-\sigma} {T_{ij}}^{1-\sigma}\right)^{1/(1-\sigma)} \tag{5}$$

where p_j is the mill price of products made in j and $T_{ij} > 1$ are the usual iceberg trade costs between country i and country j. If one unit of good is exported from country j to country i, only $1/T_{ij}$ units are consumed. Trade costs can arise because of geographical distance, political borders or trade restrictions. The value of demand by country i for varieties of country j is given by:

$$m_{ij} = n_j E_i \left(\frac{p_j T_{ij}}{P_i}\right)^{1-\sigma} \tag{6}$$

where E_i is total expenditure of country i.

In each country the different varieties are produced under monopolistic competition and the entry cost in the monopolistic sector is assumed to require c units of a freely tradable good which is chosen as world numeraire. Produced in perfect competition with labor only, this sector serves to fix the wage rate in country i to labor productivity a_i. It is not essential to our argument but simplifies the analysis. This productivity is common to both the perfect competition and the imperfect competition sectors so that mill prices in the manufacturing sector in all countries are identical and equal to the usual mark-up over marginal cost (here equal to 1): $\sigma/(\sigma-1)$. As labor is the only factor of production, and agents are each endowed with one unit of labor, this implies that $E_i = a_i$. Also, free entry implies $n_i = \hat{L}_i/(c\sigma)$ where $\hat{L}_i \equiv a_i L_i$ is effective labor, productivity multiplied by L_i the number of workers in country i.

Standard analysis yields the indirect utility at the world equilibrium:

$$U_i = \frac{\hat{L}_i}{\frac{\sigma}{\sigma-1}(c\sigma)^{\frac{1}{\sigma-1}}} \left(\sum_{h=1}^{R} \hat{L}_h T_{ih}^{1-\sigma} \right)^{1/(\sigma-1)} \tag{7}$$

¿From the previous equation, we see that $U(\mathbf{x}_i)$, the welfare of country i, depends on a vector of structural parameters $\mathbf{x}_i = (\hat{L}_i, \left(\hat{L}_h\right)_{h\neq i}, T_{ij}, (T_{ih})_{h\neq i})$.

The impact of war on structural parameters:

We assume that the possible economic effects of a war between country i and country j are: a decrease of λ percent in effective labor $\hat{L}_i$ and $\hat{L}_j$ in both countries (which may come from a loss in productivity or in factors of production), and an increase of τ_{ij} percent and τ_{ih} percent, in respectively the bilateral and the multilateral trade costs T_{ij} and T_{ih}, $h \neq i, j$. Remember that for simplicity, we have abstracted from the time dimension. Wars can in fact have long lasting effects on productivity, factors of production and trade costs. Hence, these effects should be interpreted more generally as the contemporaneous equivalent of present and future changes in productivity, factors of production etc.

To sum up, a country i's welfare under peace is $U_i^P = U(\mathbf{x}_i)$ where the vector $\mathbf{x}_i \equiv (\hat{L}_i, \hat{L}_j, T_{ij}, T_{ih})$. Under war, country i's welfare is stochastic (see equation (2)) but is equal on *average* to an equilibrium value $U_i^W = U\left[\mathbf{x}_i(1-\mathbf{\Delta}_i)\right]$ with: $\mathbf{\Delta}_i \equiv (\lambda, \lambda, -\tau_{ij}, -\tau_{ih})$.

According to our model of escalation developed in the previous section, the probability of escalation to war between country i and country j is given by (3). Together with (7), we show in appendix that war occurs with a probability :

$$\Pr(escal_{ij}) \simeq 1 - \frac{1}{V^2}.\left[W_1.\lambda + W_2.\tau_{ij} + W_3.\tau_{ih}\right]^2 \tag{8}$$

The probability of escalation to war depends on the degree of asymmetric information as measured by V and on the welfare differential between war and peace for both countries i and j. This differential has three components. The first one, $W_1 > 0$, says that war reduces available resources among

belligerents. There is a negative impact on welfare through the direct impact on income and an indirect effect on the number of varieties produced at Home and imported from the other country. The second component, $W_2 > 0$, stands for the fact that war potentially increases bilateral trade barriers and therefore decreases bilateral trade. Similarly the third component $W_3 > 0$ stands for the possible increase of multilateral trade costs.

2.3 Comparative statics: increasing trade openness and war

All the computational details are given in appendix. By differentiating condition (8), we obtain the effect on the probability of bilateral war of an *exogenous* decrease in bilateral trade barriers T_{ij}, which itself generates an *exogenous* increase in bilateral trade:

$$\frac{d\Pr(escal_{ij})}{d(-T_{ij})} \approx -\hat{L}_i\tau_{ij} - \sum_{h\neq j,i}^{R} \hat{L}_h T_{ih}^{1-\sigma}.\left(\frac{\lambda}{\sigma-1} + \tau_{ij} - \tau_{ih}\right) \tag{9}$$

Condition 1: A sufficient condition to sign this expression is that $\tau_{ih} < \tau_{ij}$ for $h \neq i, j$, : the increase in bilateral trade costs following a war between country i and *j is higher than the increase in multilateral trade costs.*

Although, this condition may not apply for all conflicts (in particular in the case of the two World Wars of the past century), it does not seem like a very strong condition. In the empirical section, we test this condition and find that it holds for conflicts after World War II.

Result 1: If condition 1 is fulfilled, then more bilateral trade openness between countries i and *j decreases the probability of escalation to war between these two countries : $\frac{d\Pr(escal_{ij})}{d(-T_{ij})} < 0$*

The intuition is that bilateral trade acts as a deterrent to escalation to war because war implies an opportunity cost in terms of welfare trade gains foregone.

Similarly, the impact on the probability of escalation to war of an increase in multilateral trade (through an exogenous decrease in T_{ih}, the trade barriers between country i and a third country h) is:

$$\frac{d\Pr(escal_{ij})}{d(-T_{ih})} \approx \hat{L}_i\left(\frac{\lambda}{\sigma-1} - \tau_{ih}\right) + \hat{L}_j T_{ij}^{1-\sigma}\left(\frac{\lambda}{\sigma-1} + \tau_{ij} - \tau_{ih}\right) \tag{10}$$

Condition 2: A sufficient condition to sign this expression is that $\tau_{ih} < \frac{\lambda}{\sigma-1}$ for $h \neq i, j$, : the increase in trade costs with h following a war with j, is small enough compared to the welfare loss due to the decrease in effective factors of production.

This condition is stronger than condition 1 and more difficult to test. However, in the empirical section, we find that τ_{ik} is not only lower than τ_{ij} but also not significatively different from zero so that as long as military conflicts imply a loss in effective factors of production (labor or productivity in the context of our model), this condition should hold.

Result 2: If condition 2 is fulfilled, then an increase in multilateral trade openness of country i with other countries than country j implies a higher probability of escalation to war with country j: $\frac{d\Pr(escal_{ij})}{d(-T_{ij})} > 0$

The intuition is that multilateral trade openness reduces the economic dependence of a country with respect to a given trade partner. Hence, the welfare impact of the loss of bilateral trade due to war is mitigated by the openness of the country as it can easily substitute to other trade partners. Another way to say this is that the weight of a specific trade partner in the consumption basket decreases as multilateral trade openness increases.

A direct consequence of these two results is that regional and multilateral trade liberalization may have very different implications for the prevalence of war. Regional trade agreements between a group of countries will unambiguously lead to lower prevalence of regional conflicts. Multilateral trade liberalization may increase the prevalence of wars.

We can use our model to shed some light on the following question: why did the process of globalization not lead to a decrease of the number of military conflicts as was hoped in the beginning of the 1990s? For simplicity, we assume from now on that the world is made of R *similar countries with symmetric trade barriers*, $T_{ij} = T$ for all i, j. We consider now globalization of trade flows as a uniform decrease in trade barriers between all pairs of countries. Combining equations (9)-(10) we get that for two countries i, j the probability of war is given by:

$$\frac{d\Pr(escal_{ij})}{d(-T)} \approx (R-2)\left(\frac{\lambda}{\sigma-1} - \tau_{ih} - \frac{\tau_{ij}}{R-2}\right) \tag{11}$$

Result 3: If condition 2 is fulfilled, and as long as the number of countries R is sufficiently large then globalization, interpreted as a symmetric decrease in trade costs, increases the probability of war between any given pair of countries i and j: $\frac{d\Pr(escal_{ij})}{d(-T)} > 0$.

The reason is that in a world where countries can easily substitute from one trade partner to another, globalization reduces the bilateral economic dependence of any given pair of countries. The intuition that trade is good for peace only holds for bilateral trade, or when we restrict the analysis to a two country world.

Note that this positive effect of globalization on the probability of escalation to bilateral war is larger when the number of countries R increases. It can also be checked from (9) and (10) that for a given level of globalization, an increase in the number of countries leads to a higher probability of war between any pair of countries under the same condition. This is reminiscent of the results of Alesina and Spolaore (2003) although the mechanism here is very different. The reason here for the increase in war probability between any two countries is not directly that more countries generate more conflicts as in Alesina and Spolaore (2003), but that a higher number of countries (like lower trade costs) imply less economic dependence with any given country.

There are two important provisos to this (pessimistic) message. The first one is that we have sofar deliberately ignored the effect of trade on information flows and therefore on information asymmetries

as measured by V.

Result 4: If globalization is interpreted as generating more information flows ($dV/dT < 0$), it decreases the probability of war between any given pair of countries i and j: $\frac{d\Pr(escal_{ij})}{dV}\frac{dV}{d(-T)} < 0$.

If trade, whether bilateral or multilateral, generates interactions between agents and therefore information flows, then it should decrease information asymmetries between countries, $dV/d(-T) < 0$. This proposition is also tested in our empirical section. In this case, another effect of globalization would be present, leading to a decrease in the probability of war. Contrary to the trade gains channel, the information channel should work in the same direction whether trade liberalization takes place at a bilateral (or regional) or multilateral level. Information flows are complements rather than substitutes so that trade liberalization, bilateral or multilateral, should decrease information asymmetry and the probability of war. This last result echoes Izquierdo et alii (2003) who provide evidence for the informational impact of trade.

The second important proviso is that even though multilateral trade liberalization may increase the probability of bilateral wars, it also changes the nature of war in terms of global versus local wars. To see this, suppose we can disentangle trade costs T_{ij} between country i and country j into distance related costs d_{ij} and trade policy related costs T such that:$T_{ij} = Td_{ij}$. Suppose furthermore that countries are identical except for bilateral distance, then it can be shown easily that (11) becomes:

$$\frac{d\Pr(escal_{ij})}{d(-T)} \approx (R-2)d_{ij}^{1-\sigma}\left(\frac{\lambda}{\sigma-1} - \tau_{ih} - \frac{\tau_{ij}}{R-2}\right) \tag{12}$$

Result 5: Globalization changes the nature of interstate conflicts: it decreases the probability of a global war but increases the probability of local wars.

The simplest way to see the first part of this result is to take the case of $R = 2$. This is the case of a world war between two groups or coalitions of countries. If war increases trade costs between the two coalitions but not (or less so) inside coalitions, then equation (12) implies, that multilateral trade liberalization decreases unambiguously the probability of multilateral or world war for the same reason that bilateral trade liberalization induces lower probability of bilateral war.

The second part of the result is that the positive effect of multilateral trade liberalization on war is larger for countries with low bilateral distance d_{ij}. The intuition is that multilateral trade liberalization, by increasing trade with many other countries, decreases bilateral economic dependence and therefore the opportunity cost of bilateral war. This is more so for countries which, everything else constant, trade a lot bilaterally for example because of low bilateral distance.

Hence, controlling for the effect of trade on information flows, multilateral trade reduces the probability of "global" wars but may increase the probability of "local" conflicts. On the other hand, bilateral trade liberalization and more generally regional trade agreements, by increasing bilateral or regional dependence, lead to lower probability of bilateral or regional militarized conflicts. This also suggests that in a world with multiple regional trade agreements in parallel with multilateral trade

agreements, "small scale" wars, may be in higher number as in the 1990s, would mostly be limited in terms of the number of countries involved, and would occur mostly between countries that do not belong to regional trade agreements and do not trade much bilaterally.

3 Empirical Analysis

3.1 Data description

Most of the data we use in this paper comes from the correlates of war project, that makes available (at http://cow2.la.psu.edu/) a very large array of datasets concerning armed conflicts but also country characteristics over the last century. Our principal dependent variable is the occurrence of a Militarized Interstate Dispute (MID) between two countries. This dataset is available for the years 1816 to 2001, but we restrict our attention to the years 1948-2001, because this is the period for which our principal explanatory variable, bilateral trade over income product, is available on a large scale. Each militarized dispute is coded with a hostility level ranging from 1 to 5 (1=No militarized action, 2=Threat to use force, 3=Display of force, 4=Use of force, 5=War).[7] International war is a relatively rare phenomenon. A common and arbitrary but reasonable criterion of war is that at least 1,000 deaths of military personnel must occur. By this standard, only about 150 international wars have been fought since 1815, of which fewer than 100 were interstate wars. At the dyadic level of analysis the number of pairs of states at war is larger, since in multi-state wars each state on one side would be paired with every state on the other. Even so, the small number of warring dyads inhibits the creation of truly robust estimates of relative determinants of wars. Consequently, it is common to analyze the causes of MIDs using a broader definition: use or threat to use military force. These are explicit, overt, not accidental, and government approved; they may take the form of verbal diplomatic warnings, troop or ship movements constituting a demonstration of force, or actual use of force at any level up to and including war. We thus consider our explained variable to be a MID of hostility level 3, 4 or 5. We have also investigated with a hostility level of MID restricted to 4 and 5 and find qualitatively similar results.

Bilateral trade is constructed from two different datasets. The first one is the dataset assembled by Katherine Barbieri (see http://sitemason.vanderbilt.edu/site/k5vj7G/new_page_builder_4), which uses mostly information from the IMF since WWII and from the League of Nations international trade statistics and various other sources including individual countries before the second world war. Her data spans over the 1870-1992 period. We completed it for the post-WWII period using the IMF DOTS database (the same primary source as Barbieri (2002) for this period). Income data comes from two different sources, Barbieri (2002), which assembles a dataset for the 1948-1992 period, and the World Bank WDI database for 1960-2001. Variables for the bilateral trade regressions accounting

[7] Much more detail about this data is available in Jones et al. (1996), Faten et al. (2004) and online on the correlates of war project.

for bilateral trade impediments of facilitating factors (distance, contiguity, colonial links) come from the CEPII bilateral distance database (www.cepii.fr/anglaisgraph/bdd/distances.htm).

Among covariates explaining war, are the democracy index for each country. This comes from the Polity IV database (available at www.cidcm.umd.edu/inscr/polity) and we use the composite index that ranks each country on a -10 to + 10 scale in terms of democratic institutions. We also use the correlation between countries' positions during votes on resolutions in the General Assembly of the United Nations as an index of their "political affinity". The UN votes correlation is based on the roll-call votes. This form of vote happens when one Member State requests the recording of the vote so that its stand, or the stand of another Member State, on the issue under discussion is clearly identified. This recording must be requested before the voting is conducted. This annual database created by Gartzke et al. (1999) covers the period 1946-1996.

3.2 The effect of war on trade barriers

The first step of our empirical analysis is to assess the impact of past wars on both bilateral and multilateral trade patterns. This is interesting in itself as no such analysis exists. In particular, we are interested to quantify the effect of wars on trade and to analyse how long lasting these effects have been. This empirical analysis is also crucial to understand the effect of trade on the probability of wars. Hence, this section aim is to test conditions 1 and 2 that bilateral trade barriers increase more than multilateral trade barriers after a war and that a bilateral conflict has little effect on multilateral trade barriers. Remember that these are the conditions that enable us to sign the impact of trade on the probability of escalation to war. We therefore want to evaluate empirically τ_{ij} and τ_{ih}, the impact of war on the levels of bilateral and multilateral trade barriers.

To do this, note that using (8), reintroducing time subscripts and neglecting constants we get that bilateral imports at time t of country i from country j can be written as:

$$m_{ijt} = \hat{L}_{jt} T_{ijt}^{1-\sigma} E_{it} P_{it}^{\sigma-1}. \tag{13}$$

Bilateral exports are an increasing function of income in the importing country (E_{it}), of effective amount of labor in the exporting country ($\hat{L}_{jt}$) and of bilateral trade openness $T_{ijt}^{1-\sigma}$ (since $\sigma > 1$) and the country specific price index P_{it} which in particular increases with the peripherality of the country. While the rest of the equation is relatively straightforward to estimate, this term is hard to measure empirically but important theoretically (see for example Anderson and Van Wincoop, 2003) . In words, wars are likely to affect remote countries with large price indices very differently from centrally located countries. Omitting the price index potentially leads to mispecification. Suppose for instance that New-Zealand enters in a conflict with Australia. If bilateral trade costs between the two countries rise, the price index of New-Zealand will increase more than for a non peripheral country because Australia is its main trade partner. The omission of this term will bias downward the coefficient on the bilateral trade effects of war. Several solutions have been recently proposed to this problem (see Combes et al., 2005, for a review). The simplest in our case is to use a convenient feature

of the CES demand structure that makes relative imports from to given exporter independent of the characteristics of a third. We can eliminate price indices in the bilateral trade equation by choosing the imports from the United States as a benchmark of comparison for all imports of each importing country:

$$\frac{m_{ijt}}{m_{iut}} = \frac{\hat{L}_{jt}}{\hat{L}_{ut}} \left(\frac{T_{ijt}}{T_{iut}} \right)^{1-\sigma}, \tag{14}$$

where the first term of relative productivity-adjusted labor forces is proportional to relative output, and the second term involves trade costs of imports of country i from country j, relative to the US. Since the price index of the importer does not depend on characteristics of the exporter, it cancels out here, which solves the mentioned issue in estimation.[8] The last step is to specify the trade costs function. Here, we follow the gravity literature in the list of trade costs components (see Frankel, 1997 and Rose, 2000, 2004 for recent worldwide gravity equations comparable to our work in terms of time and country coverage). We separate trade costs between non-policy related variables (bilateral distance, contiguity and similarity in languages, colonial links) and policy-related ones (trade agreements and communist regime) and those induced by militarized incidents:

$$T_{ijt} = d_{ij}^{\delta_1} \exp(\delta_2 \text{cont}_{ij} + \delta_3 \text{lang}_{ij} + \rho_1 \text{col}_{ij} + \rho_2 \text{ccol}_{ij} + \rho_3 \text{fta}_{ijt} + \rho_4 \text{gatt}_{ijt} + \rho_5 \text{com}_{ijt} + \rho_6 \text{war}_{ijt}), \tag{15}$$

where d_{ij} is bilateral distance, cont_{ij}, col_{ij}, ccol_{ij}, com_{ijt} are dummy variables indicating respectively whether the two countries have a common border, whether one was a colony of the other at some point in time, whether the two have been colonized by a same third country and whether one is a communist regime. We also account for common membership in a free trade area (the fta_{ijt} dummy, which includes the EU, CUSA/NAFTA, the ASEAN/AFTA agreements, MERCOSUR, and a myriad of other agreements reported in Baier and Bergstrand (2004), each under their different time varying membership configurations). A dummy for common membership of GATT/WTO is also included. ρ_6 is therefore the coefficient of interest for us. Combining (15) with (14), our variable of interest, the war_{ijt} dummy, therefore has an effect on trade costs (with elasticity $(1-\sigma)\rho_6$) which can estimated by the following equation:

$$\begin{aligned} \ln\left(\frac{m_{ijt}}{m_{iut}}\right) &= \ln\left(\frac{\text{GDP}_{jt}}{\text{GDP}_{ut}}\right) + (1-\sigma)\left[\delta_1 \ln\left(\frac{d_{ijt}}{d_{iut}}\right) + \delta_2(\Delta_{\text{us}}\text{cont}_{ij}) + \delta_3(\Delta_{\text{us}}\text{lang}_{ij})\right] \\ &\quad +(1-\sigma)\left[\rho_1(\Delta_{\text{us}}\text{col}_{ij}) + \rho_2(\Delta_{\text{us}}\text{ccol}_{ij}) + \rho_3(\Delta_{\text{us}}\text{reg}_{ij}) + \rho_4(\Delta_{\text{us}}\text{gatt}_{ij}) + \rho_5\text{com}_{ijt}\right] \\ &\quad +(1-\sigma)\rho_6(\Delta_{\text{us}}\text{war}_{ijt}), \end{aligned} \tag{16}$$

where the shortcut Δ_{us} designates the fact that all variables are in difference with respect to the United States so that for instance, $\Delta_{\text{us}}\text{lang}_{ij} = (\text{lang}_{ij} - \text{lang}_{iu})$.

[8] Note that war can naturally also affect outputs of trading partners, but this will not result in biased coefficients on the effect of wars on T_{ijt} here as long as we observe GDPs and include them in the regression.

3.3 Results

We estimate the impact of wars on bilateral trade through both a traditional gravity equation, which neglects the price index issue (results are in Table 1), and with equation (16) that takes into account this concern by considering all variables (including the war variable) relative to the United States (results are in Table 2). All regressions include year dummies (not shown in the regression tables). All estimates other than the war variables, in both sets of results, are reasonably similar to what is usually found in the literature[9]. Income elasticities are remarkably close to the unitary value predicted by theory, while the distance coefficient is also very close to the traditional values found. All trade costs variables have the expected signs and magnitudes, with a positive impact of language proximity and a large effect of colonial linkages between the trading partners.

The first way to look at the impact of war on trade is simply to introduce in the gravity equation a variable equal to the number of years of peace between the two countries (this variable is divided by 100 to ease the readability of coefficients). Peace here means that there is no conflict of levels 3 to 5 in the MID data set. This is done in the first column of both tables. The effect is positive and significant only in the odds with US specification. The coefficient implies that a decade of bilateral peace between two countries increases bilateral trade by $(\exp(0.42) - 1) \times 0.1 = 5.2\%$. However, this variable specifies the impact of armed conflict in a quite restrictive way, notably through the linearity it imposes.

We therefore investigate the effect of wars on bilateral trade, allowing for the possibility that war can have contemporaneous as well as delayed effects on bilateral trade barriers. Hence, in column (2) of both tables, we include variables war_{ijt} to war_{ijt-10} and the coefficient for each of those tells us the decrease of trade due to a war that occurred at date t to $t-10$. Whether in the traditional gravity equation or in the difference with the US version (our preferred specification), the impact of a bilateral military conflict has a sizable impact on bilateral trade. During a military conflict, trade falls by aound 26%, while an additional fall close to 20% occurs the following year in the basic gravity version. In our preferred specification, the impact is larger: the corresponding falls are 34% and 33%. We also find that the fall is long lasting as the war coefficient is significant and negative for around 10 years. In columns (3), we report the first estimate of a regression that includes ten more war dummies from year $t-11$ to $t-20$. In both specifications, the effect of the conflict ceases to be negatively significant after the tenth year and is generally not significantly different from zero.

In the fourth column of both tables, we investigate whether trade flows "anticipate" a war. We add dummies for the five years preceding the war. If those are also negative and significant, it will point to a common cause that structurally explains why a specific country pair both trades less than the gravity norm, and experiences armed conflicts. In addition, if the coefficients values increase (in absolute value) as we get closer to the war, it might suggest for example that business climate deteriorates between the belligerent countries before the war itself. Looking at what happens to trade

[9] We have checked that the inclusion of the control GDP/capita variable, often introduced in the gravity literature, but which does not come naturally in our theoretical setup, does not change our results.

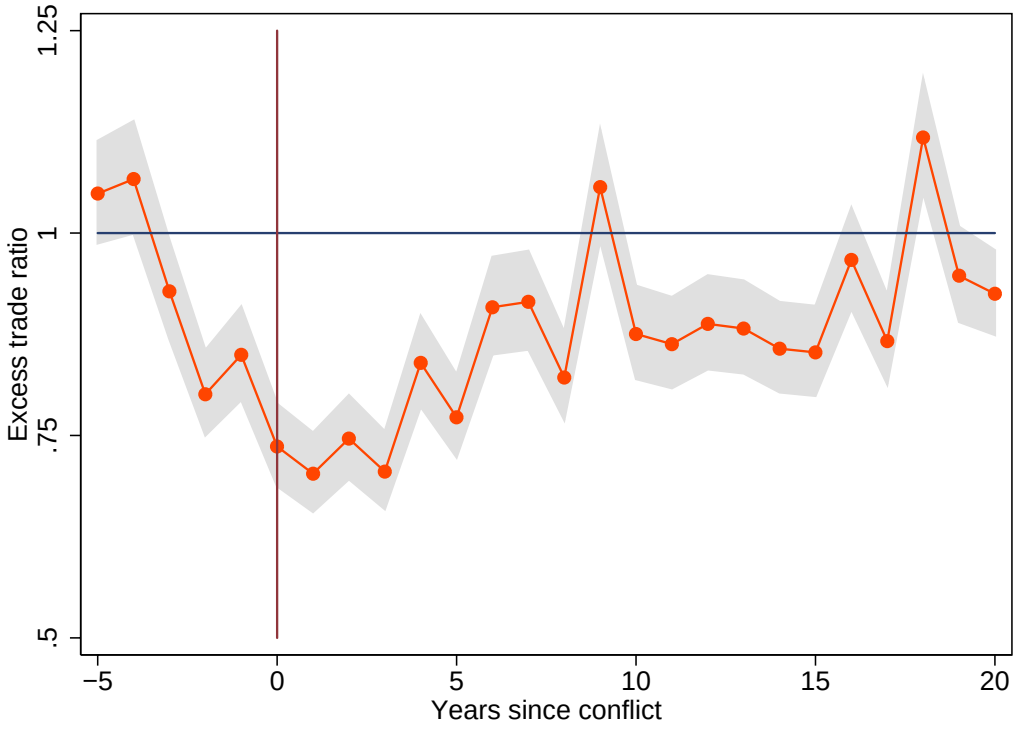

Figure 4: The impact of a conflict on bilateral trade

flows *before* the war is therefore important as it can reveal potential static and dynamic omitted variable bias in the analysis. In the traditional gravity equation, no significant effect can be detected. In the version in difference to the US specification, the dummies for the three years preceding the war are negative and significant. We have experienced with the use of Switzerland as an alternative to US as the norm. Whereas other results were similar, the impact of war on past trade was insignificant. This suggests that we can use trade lagged by four years as an instrumental variable of current trade in the regressions that test for the impact of trade on war in the next section. To summarize, and after having experienced with many different time windows both backward and forward, whereas the evidence that trade is affected by the expectation of war is mixed, war has a large and persistent effect on future trade. The effect lasts between ten and twenty years.

We also want to investigate the impact of wars on total (multilateral) trade. This is done by inserting in the bilateral trade equation dummies set to one when the exporter or the importer is in war with *another* country than the trade partner. It therefore also gives the impact of wars on overall exports and imports with countries not at war. We perform this exercise only in the odds specification and we investigate the impact for the five years preceding the conflict as well as the ten years after the conflict. This regression involves 75 dummies (on top of the year dummies and of the other variables from equation 16): 25 for the bilateral impact and 50 for the multilateral effects. This regression yields

our preferred estimates as it accounts for the full set of potential bilateral and multilateral impacts of war over a long period of time (and deals properly with the price index issue). Admittedly, the table is difficult to read, and we prefer to represent estimates of interest graphically, using three different "event-type" figures. Figure 4 shows, using this regression, the fall of trade relative to "natural" trade with 5% confidence intervals in grey bands. There is a significant effect of an upcoming war on bilateral trade for the three years preceding the war. The effect of war on contemporaneous trade is large: The coefficient is -0.75, implying a 25% decrease in trade from its natural level. During the second year, the impact is almost identical. It then decreases in absolute value, and the fighting dyad recovers a level of trade not statistically different from the norm in the 18th year after the war. As in the regression tables, robustness checks available upon request show that after the 10th year, trade volumes largely return to a natural level. We have checked that the probability of missing trade data is not affected by the occurence of war[10]. This might be an issue as missing bilateral trade data could be interpreted as a consequence of a conflictual bilateral relation and this could lead to underestimate the impact of war on trade.

In figures 5 and 6, using the same regression, the impact on multilateral exports and imports is depicted, respectively. They show that the effect is either non statistically significant, for exports, or negative but very small, for imports (around 5% when significant). Overall, these empirical results confirm the validity of our conditions 1 and 2 derived in the theoretical sections. These conditions are necessary to establish the theoretical results that bilateral trade openness reduces the probability of bilateral a war but that multilateral trade openness increases the probability of a bilateral war, a prediction that we proceed to testing in the next section.

3.4 The impact of trade on war

Estimating the determinants of the probability of escalation to war requires to substitute the trade parameters in equations (8), (22) and (23) by their observational counterparts as given by (13) and (14). We use the national accounting identity:$\frac{m_{iit}}{E_{it}} + \frac{m_{ijt}}{E_{it}} + \sum_{h\neq j,i}^{R} \frac{m_{iht}}{E_{it}} = 1$, where m_{iit} is the value of trade internal to country i and (m_{ijt}, m_{iht}) are the observed trade flows. And we assume that $\forall(i,j)$, $(\tau_{ij}, \tau_{ih}) = (\tau_{bil.}, \tau_{multi.})$, namely that the bilateral and multilateral trade losses as estimated in the previous section are constant across countries. Finally we get the probability of escalation as a function of observed bilateral and multilateral trade flows:

$$\Pr(escal_{ijt}) = 1 - \frac{1}{V^2}.\left\{\frac{\sigma\lambda}{\sigma-1} + \tau_{bil.}\frac{m_{ijt}}{E_{it}} - \left(\frac{\lambda}{\sigma-1} - \tau_{multi.}\right)\sum_{h\neq j,i}^{R}.\frac{m_{iht}}{E_{it}}\right\}^2 \tag{17}$$

The probability of war is the probability of conflict between countries i and j multiplied by $\Pr(escal_{ijt})$, the conditional probability of escalation given that a conflict exists. Hence, the equation that we

[10]In the subsample of countries not at war, the probability that bilateral trade data is missing one year and present the year before is 4.95%. In the subsample of countries at war, the probability that bilateral trade data is missing one year and present the year before is very close at 5.04%.

Table 1: Impact of wars on trade (gravity version)

	Dependent Variable: ln imports			
Model :	(1)	(2)	(3)	(4)
ln GDP origin	0.90^a	0.92^a	0.96^a	0.90^a
	(0.01)	(0.01)	(0.01)	(0.01)
ln GDP destination	0.82^a	0.85^a	0.87^a	0.85^a
	(0.01)	(0.01)	(0.01)	(0.01)
ln distance	-0.94^a	-0.96^a	-0.96^a	-0.94^a
	(0.01)	(0.02)	(0.02)	(0.02)
contiguity	0.20^a	0.25^a	0.37^a	0.22^a
	(0.07)	(0.07)	(0.07)	(0.07)
similarity in language index	0.32^a	0.30^a	0.36^a	0.25^a
	(0.06)	(0.06)	(0.07)	(0.07)
colonial link ever	1.42^a	1.22^a	1.00^a	1.18^a
	(0.08)	(0.08)	(0.08)	(0.08)
common colonizer post 1945	0.83^a	0.72^a	0.68^a	0.64^a
	(0.05)	(0.05)	(0.06)	(0.06)
preferential trade arrangement	0.54^a	0.46^a	0.43^a	0.38^a
	(0.05)	(0.05)	(0.05)	(0.06)
number of gatt/wto members	0.08^a	0.09^a	0.13^a	0.09^a
	(0.02)	(0.02)	(0.02)	(0.02)
one communist regime among partners	-0.73^a	-0.72^a	-0.70^a	-0.77^a
	(0.03)	(0.03)	(0.03)	(0.03)
number of peaceful years / 100	-0.08^a			
	(0.03)			
bil. war + 0 years		-0.26^a	-0.26^a	-0.20^a
		(0.06)	(0.06)	(0.04)
bil. war + 1 years		-0.21^a	-0.19^a	-0.22^a
		(0.05)	(0.05)	(0.04)
bil. war + 2 years		-0.16^a	-0.14^a	-0.18^a
		(0.04)	(0.04)	(0.04)
bil. war + 3 years		-0.16^a	-0.19^a	-0.15^a
		(0.03)	(0.04)	(0.04)
bil. war + 4 years		-0.05	-0.04	-0.05
		(0.04)	(0.04)	(0.04)
bil. war + 5 years		0.01	0.03	0.01
		(0.03)	(0.03)	(0.03)
bil. war + 6 years		-0.05^c	-0.07^b	-0.04
		(0.03)	(0.03)	(0.03)
bil. war + 7 years		-0.02	-0.04	0.00
		(0.03)	(0.03)	(0.03)
bil. war + 8 years		-0.07^a	-0.08^a	-0.07^b
		(0.03)	(0.02)	(0.03)
bil. war + 9 years		-0.07^a	-0.09^a	-0.06^b
		(0.03)	(0.03)	(0.03)
bil. war + 10 years		-0.10^b	-0.09^a	-0.12^a
		(0.04)	(0.02)	(0.04)
bil. war + 11 years			-0.01	
			(0.02)	
...				
bil. war - 1 years				-0.05
				(0.04)
bil. war - 2 years				0.00
				(0.04)
bil. war - 3 years				-0.07^c
				(0.04)
bil. war - 4 years				-0.05
				(0.04)
bil. war - 5 years				-0.07
				(0.06)
N	448718	361575	291154	292918
R^2	0.632	0.645	0.661	0.634
RMSE	1.803	1.782	1.75	1.753

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account correlation of errors among dyads.

Table 2: Impact of wars on trade (odds version relative to the USA)

	Dependent Variable: $\ln m_{ijt}/m_{iut}$			
Model :	(1)	(2)	(3)	(4)
ln GDP origin /US	0.94^a	0.96^a	0.99^a	0.94^a
	(0.01)	(0.01)	(0.01)	(0.01)
ln distance /US	-1.10^a	-1.10^a	-1.09^a	-1.07^a
	(0.02)	(0.02)	(0.02)	(0.02)
contiguity /US	0.42^a	0.40^a	0.43^a	0.41^a
	(0.06)	(0.07)	(0.07)	(0.07)
similarity in language index /US	-0.08	-0.03	0.08	-0.11^c
	(0.06)	(0.06)	(0.06)	(0.06)
colonial link ever /US	0.52^a	0.40^a	0.27^a	0.39^a
	(0.06)	(0.06)	(0.06)	(0.06)
common colonizer post 1945 /US	0.83^a	0.67^a	0.68^a	0.59^a
	(0.05)	(0.06)	(0.06)	(0.06)
preferential trade arrangement /US	0.33^a	0.30^a	0.29^a	0.27^a
	(0.05)	(0.05)	(0.05)	(0.05)
number of gatt/wto members /US	0.20^a	0.20^a	0.21^a	0.20^a
	(0.03)	(0.03)	(0.03)	(0.03)
one communist regime among partners /US	-1.17^a	-1.14^a	-1.14^a	-1.16^a
	(0.04)	(0.04)	(0.05)	(0.04)
number of peaceful years/US (/100)	0.42^a			
	(0.03)			
bil. war + 0 years		-0.34^a	-0.33^a	-0.33^a
		(0.03)	(0.03)	(0.03)
bil. war + 1 years		-0.33^a	-0.32^a	-0.37^a
		(0.03)	(0.03)	(0.03)
bil. war + 2 years		-0.27^a	-0.31^a	-0.24^a
		(0.03)	(0.03)	(0.03)
bil. war + 3 years		-0.37^a	-0.39^a	-0.28^a
		(0.03)	(0.03)	(0.03)
bil. war + 4 years		-0.17^a	-0.19^a	-0.14^a
		(0.02)	(0.02)	(0.03)
bil. war + 5 years		-0.11^a	-0.13^a	-0.20^a
		(0.02)	(0.02)	(0.02)
bil. war + 6 years		-0.16^a	-0.17^a	-0.09^a
		(0.03)	(0.03)	(0.03)
bil. war + 7 years		-0.16^a	-0.17^a	-0.09^a
		(0.02)	(0.02)	(0.02)
bil. war + 8 years		-0.20^a	-0.17^a	-0.20^a
		(0.02)	(0.02)	(0.02)
bil. war + 9 years		-0.09^a	0.01	-0.06^b
		(0.02)	(0.02)	(0.03)
bil. war + 10 years		-0.40^a	-0.19^a	-0.32^a
		(0.03)	(0.02)	(0.03)
bil. war + 11 years			-0.12^a	
			(0.02)	
...				
bil. war - 1 years				-0.14^a
				(0.03)
bil. war - 2 years				-0.21^a
				(0.03)
bil. war - 3 years				-0.12^a
				(0.03)
bil. war - 4 years				0.05^b
				(0.02)
bil. war - 5 years				0.05^c
				(0.03)
N	433088	349785	281286	281127
R^2	0.561	0.568	0.58	0.553
RMSE	1.997	1.972	1.949	1.929

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account correlation of errors among dyads.

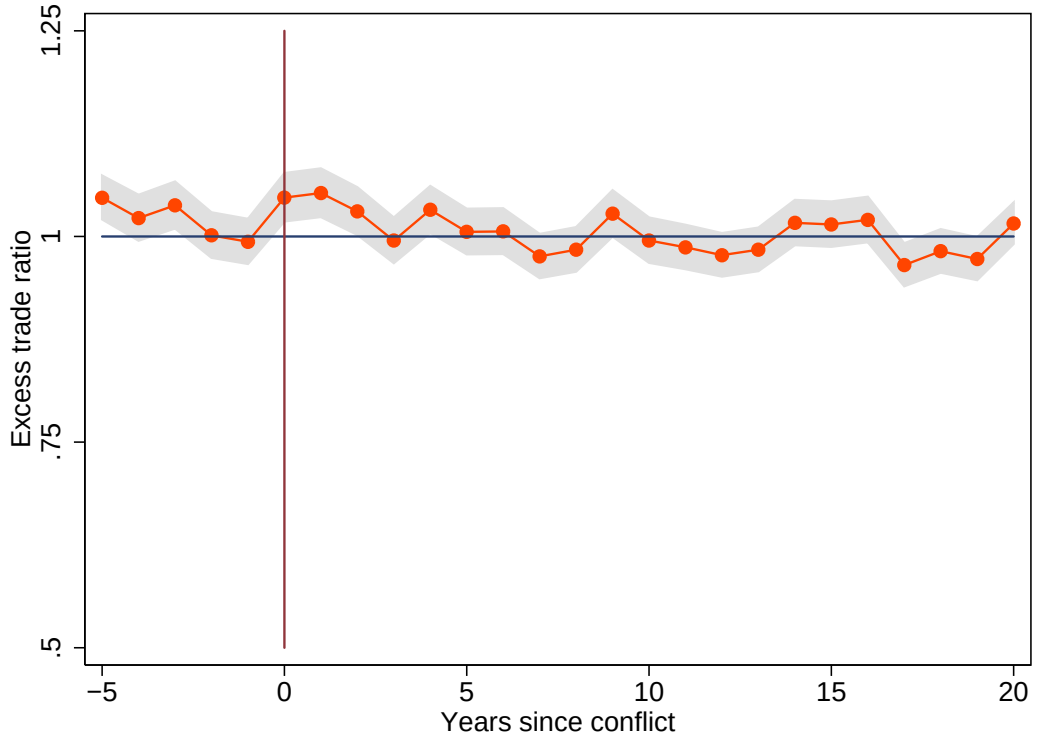

Figure 5: The effect of wars on total exports

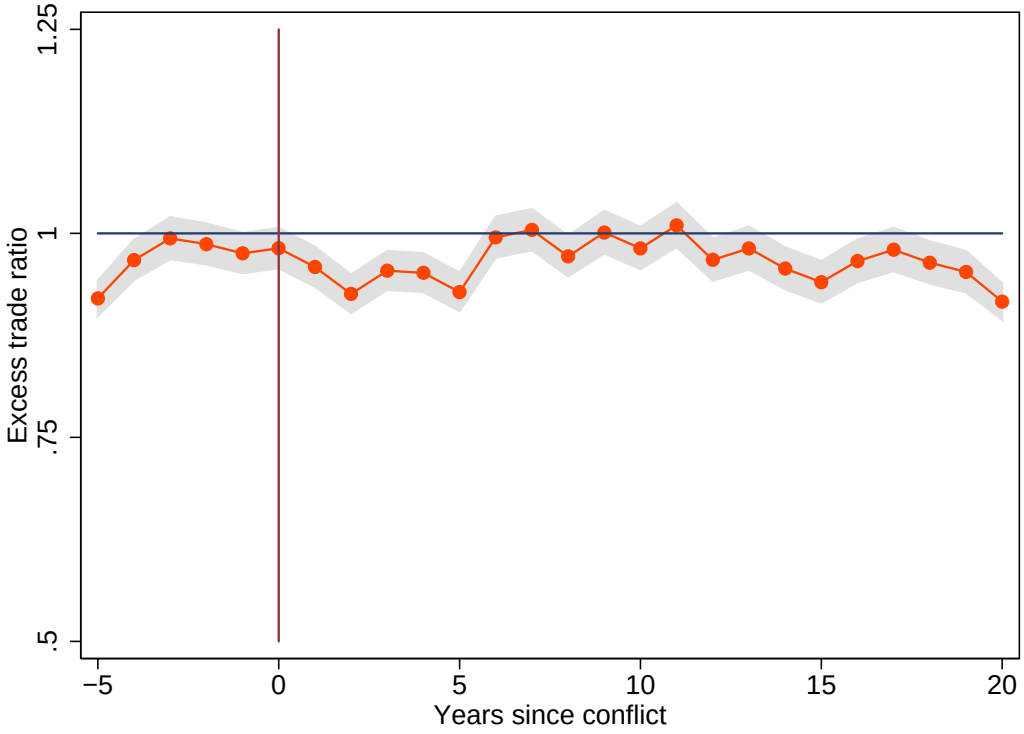

Figure 6: The effect of wars on total imports

estimate through logit, allowing for a possible asymmetry between country i and j is:

$$\Pr(war_{ijt}) = \gamma_0 + \gamma_1 controls_{ijt} + \gamma_2 . \ln\left(\frac{m_{ijt}+m_{jit}}{E_{it}E_{jt}}\right) + \gamma_3 \ln\left(\sum_{h\neq j,i}^{R} \frac{m_{iht}+m_{jht}}{E_{it}E_{jt}}\right) \quad (18)$$

Given that we checked that conditions 1 and 2 were empirically valid in the previous section, our model predicts $\gamma_2 < 0$ and $\gamma_3 > 0$: a negative impact of bilateral trade openness between i and j on the probability of war (result 1) but a positive impact of multilateral trade openness on the probability of war (result 2). Note that multilateral trade openness is defined here, following the theoretical model, as total imports of the two countries excluding their bilateral trade as a ratio of GDPs[11].

3.5 Results

We test equation (18) in logit in three different ways. First, we instrument trade by its lagged value (4 years). Results of this first estimation are provided in Table 3. This enables us to remove the contemporaneous (large) effect of war on trade. While the preceding section did not find any strong evidence of this, it might be argued that omitted variables could still cause both lagged trade to fall and conflictuality to rise. The cross-section analysis would then not be satisfactory. We implement two strategies to solve this problem. In Table 4, we use the last five years deviation from average dyadic historical trade levels (expressed relative to GDPs over our whole 1948-2001 time period). This enables us to partially control for the presence of omitted dyadic specific fixed effects that may bias our estimates. The bias may come for instance from the fact that some countries (because of cultural, historical or other reasons that we cannot fully control for) have good bilateral relations and therefore trade large amounts with respect to their income while also having a low probability of war. Table 5 finally controls fully for those possible fixed country pair effects, using panel data logit estimation together with lagged values of trade over GDP of the last five years.

In Table 3, column (1) shows that the number of years of peace between two countries has, unsurprisingly, a large negative effect on the probability of war between these two countries. We also introduce the variable $\ln\left(\frac{m_{ijt}+m_{jit}}{E_{it}E_{jt}}\right)$: the log of the sum of lagged (4 years) bilateral trade flows in percentage of the product of GDPs as specified in (18). The coefficient is negative and significant as predicted by the theory. We also introduce a dummy for all observations for which trade flows (both exports and imports) are reported as zero. These are not missing values but country pairs for which no trade is reported. There are many such observations. Interestingly, such pairs of countries have a lower probability to go to war. In absence of this dummy, the coefficient on bilateral trade is positive and

[11] In the empirical political science literature on the subject (see among others Polachek, 1980; Polachek, Robst and Chang, 1999, Oneal and Russet, 1999, Barbieri 1996 and 2002), authors include various measures of trade. An important advantage of our theory driven exercise is that the way trade should enter in the regression is determined. The debate between authors in this literature has recently focused on two issues: 1) whether to test the relation between trade and war on all possible state pairs or only on the so-called "politically relevant dyads", contiguous states or "major powers". In our study, we use all country pairs and do not select a subset. 2) temporal dependence. We follow most of the literature and add the number of peaceful years between two countries.

insignificant[12]. The first control we use is distance in column (2). The reason is that it is reasonable to think that distance affects both trade and the probability of war negatively. Indeed, bilateral distance has a strong negative and significant effect on the probability of war and the coefficient on bilateral trade becomes more negative and significant as expected[13]. We then test in column (3) for the effect of multilateral openness by adding the variable $\ln\left(\sum_{h\neq j,i}^{R}\frac{m_{iht}+m_{jht}}{E_{it}E_{jt}}\right)$: the log of the sum of lagged multilateral (excluding bilateral) trade flows in percentage of the product of GDPs as specified in (18). The impact is negative and significant. This may come from the assumption in this regression that the effect of openness is the same for all countries. However, result 5 in the theoretical section predicts that the effect should be stronger for country pairs with low bilateral distance . Hence, in column (4), we add an interraction dummy between distance and the multilateral openness variable. Our theoretical model predicts a negative sign on this interaction term. Our theoretical model predicts that the positive impact of multilateral openness on the bilateral probability of war should itself depend negatively on the distance between the two countries (see equation (12)). Remember that the mechanism at work in our model is that multilateral openness loosens bilateral dependence and therefore the opportunity cost of a bilateral war. This mechanism should be stronger for countries that are close to each other than for distant countries as shown in (12). The introduction of the interaction term is important both because it is a further test of the mechanism at work but also because its absence could bias the coefficient on the multilateral openness variable. In column (4), the interaction term is negative as predicted and significant at 1%. The multilateral openness becomes positive and significant at 1% as predicted by our theory. In column (5), we add controls which have been shown by the literature on gravity equations, and by our own estimations in the preceding section, to have an important effect on trade and which may also affect the probability of war. These are most notably contiguity, the index of similarity of language, the existence of a free trade area and the number of GATT members in the dyad, whether the pair was ever in a colonial relationship, whether they had a common colonizer and whether one of the countries is a communist regime. Consistent with theory, the coefficient on bilateral trade and on the free trade area are significant and negative. In this case, all the variables of main interest have the expected sign and are significant at 1% (bilateral trade, multilateral trade and the interaction term). We have also controlled for GDP/capita of the country pair. This control is insignificant in all regressions, does not alter our results and therefore we do not report it.

In column (6), we add political controls which are possible determinants of a war and which could be correlated with trade flows, yielding biased (inflated in absolute value) estimates of the impact of trade openness on conflicts. These are the sum of areas of the two countries (in log), the product of the democracy indexes and the correlation of UN votes. The first control is potentially important because large area countries are typically countries with important minorities that can be the source

[12]The dummy for zero trade is important only in this regression. We have checked that in all other regressions, its absence does not change the sign or significance of the coefficients of interest.

[13]The ommission of distance as a control in Barbieri (2003) is, we believe, the main reason why our results are opposite to hers on the bilateral trade variable. The dummy of zero trade observations can also be interpreted as a control for trade costs as fixed costs.

Table 3: Impact of trade on wars - I (lagged trade)

	Dependent Variable: War between two countries							
Model :	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intcpt	-3.56^a	0.24	-0.40^c	3.67^a	1.60^b	-2.06^c	-2.66^c	-2.77^c
	(0.18)	(0.21)	(0.22)	(0.61)	(0.65)	(1.06)	(1.61)	(1.61)
ln sum of trade flows / product GDPs t-4	-0.10^a	-0.20^a	-0.18^a	-0.19^a	-0.20^a	-0.10^a	-0.10^a	-0.09^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)
dummy for zero trade t-4	-1.56^a	-1.73^a	-1.72^a	-1.75^a	-1.77^a	-1.13^a	-0.91^a	-0.91^a
	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)	(0.14)	(0.24)	(0.24)
number of peaceful years	-0.12^a	-0.10^a	-0.09^a	-0.09^a	-0.08^a	-0.06^a	-0.07^a	-0.07^a
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln distance		-0.74^a	-0.73^a	-1.28^a	-1.03^a	-0.90^a	-0.87^a	-0.80^a
		(0.03)	(0.03)	(0.08)	(0.09)	(0.14)	(0.20)	(0.20)
ln mult. openness (w/o bil. trade) t-4			-0.14^a	0.62^a	0.70^a	0.68^a	0.59^b	0.50^c
			(0.02)	(0.11)	(0.11)	(0.18)	(0.28)	(0.29)
ln distance × ln mult.open				-0.10^a	-0.10^a	-0.07^a	-0.06	-0.04
				(0.01)	(0.01)	(0.02)	(0.04)	(0.04)
contiguity					1.34^a	1.75^a	1.63^a	1.57^a
					(0.08)	(0.12)	(0.18)	(0.18)
common language					0.04	0.08	0.06	0.08
					(0.07)	(0.09)	(0.14)	(0.14)
free trade area					-0.29^c	-0.29^c	-0.14	-0.10
					(0.15)	(0.17)	(0.22)	(0.22)
Nb of GATT members					-0.26^a	-0.34^a	-0.26^a	-0.25^a
					(0.04)	(0.06)	(0.09)	(0.09)
product of democracy indexes						-0.01	0.08	0.15
						(0.16)	(0.20)	(0.20)
sum ln areas						0.23^a	0.25^a	0.25^a
						(0.02)	(0.03)	(0.03)
UN vote correlation						-1.44^a	-1.41^a	-1.63^a
						(0.11)	(0.15)	(0.18)
ln mult. info. (w/o bil. trade) t-2								-0.03^b
								(0.01)
N	325328	322332	318980	318980	318980	200896	113144	113144
R^2	0.275	0.318	0.323	0.325	0.344	0.342	0.342	0.343

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

of conflicts with neighboring nations. Large countries may also be more difficult to defend, making them potentially targets to frequent attacks. Larger countries, because they have a more diverse mix of factor endowments, may also be less open to the rest of the world. Democratic countries may also be more open and less prone to wars. The absence of these two controls may bias the coefficient on multilateral openness downward. Finally, we control for UN vote correlation because we believe this is a good measure of ideological, cultural and historical affinity between countries that may affect both the probability of war and bilateral trade. The absence of this control may bias the coefficient on bilateral trade downwards. In this specification, all coefficients of interest have the expected sign and are significant. The coefficient on bilateral trade flows is negative and significant at the 1% level. The coefficient on multilateral openness remains positive and significant at the 1% level. The interaction term that predicts that multilateral trade openness increases the probability of war between geographically close countries is negative and significant at the 1% level. This is our preferred specification.

Following our model, we finally want to test for the effect of asymmetric information on the probability of war. We do this by adding in column (8), a variable that accounts for multilateral trade in newspapers as a percentage of the countries' GDPs (the source of this data is the COMTRADE database from UNCTAD). Here, we choose a multilateral rather than a bilateral measure because we believe that it is the total volume of information flows that determines the extent of information asymmetry. To be able to compare the effect of information flows and trade in goods flows, we construct this variable like the multilateral trade openness one. In order to avoid contamination by variables which could simultaneously impact the probability of bilateral war and the bilateral flow of informations, we substract from total multilateral trade in newspapers the bilateral value. We lag this variable as in the other regressions. The main problem with this variable is its availability. Including it makes the sample size decrease by 45%. To be able to compare results, we run the regression with (column 8) and without (column 7) the information variable, holding the sample size constant. The information variable is negative and significant at the 5% level as expected. As in our LOGIT procedure, we control for the political regime, this empirical result cannot be driven by the fact that democratic regimes, usually tolerant towards press freedom, are also the most reluctant to go to war. Finally, note that bilateral trade remains negative and significant. In this much reduced data set, the multilateral trade variable is positive but not significant.

In Table 4, we use the last five years deviation from average historical trade levels so as to partially control for the presence of omitted country-pair specific fixed effects that may bias our estimates. The results remain very supportive of our theoretical framework. In all specifications, bilateral trade has a persistent negative and highly significant effect on the probability of war. The effect of multilateral trade openness is in all specifications positive as predicted by theory and is always significant especially in our preferred specification with both political and economic controls [14]. GATT/WTO membership

[14] In this specification, we cannot test meaningfully for the interaction effect between distance and multilateral trade openness because the cross-country dimension is greatly reduced. This implies that the correlation between the interaction term and the multilateral openness variable is 93% in this case.

Table 4: Impact of trade on wars - II (last 5 years deviation from average historical trade level)

	Dependent Variable: War between two countries						
Model :	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intcpt	-2.49^a	1.78^a	1.71^a	-0.64^b	-4.37^a	-5.39^a	-5.39^a
	(0.05)	(0.19)	(0.19)	(0.28)	(0.50)	(0.82)	(0.82)
ln (last 5 years bil. trade open. dev. / mean)	-0.27^a	-0.24^a	-0.24^a	-0.22^a	-0.17^a	-0.20^a	-0.20^a
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
last 5 years 0 trade dummy dev. / mean	-1.88^a	-1.61^a	-1.58^a	-1.35^a	-1.53^a	-1.35^a	-1.35^a
	(0.14)	(0.15)	(0.16)	(0.16)	(0.22)	(0.40)	(0.40)
number of peaceful years	-0.11^a	-0.09^a	-0.09^a	-0.08^a	-0.06^a	-0.06^a	-0.06^a
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln distance		-0.58^a	-0.57^a	-0.29^a	-0.47^a	-0.42^a	-0.42^a
		(0.03)	(0.03)	(0.03)	(0.05)	(0.09)	(0.09)
ln (last 5 years mult. open. dev. / mean)			0.07^c	0.11^b	0.39^a	0.32^a	0.32^b
			(0.04)	(0.04)	(0.07)	(0.12)	(0.13)
contiguity				1.56^a	1.67^a	1.44^a	1.44^a
				(0.09)	(0.12)	(0.22)	(0.22)
common language				-0.30^a	-0.01	0.19	0.19
				(0.07)	(0.10)	(0.17)	(0.17)
free trade area				-0.22	-0.16	-0.52^c	-0.52^c
				(0.15)	(0.17)	(0.31)	(0.31)
Nb of GATT members				-0.29^a	-0.37^a	-0.22^b	-0.22^b
				(0.04)	(0.06)	(0.10)	(0.10)
sum ln areas					0.22^a	0.24^a	0.24^a
					(0.02)	(0.03)	(0.03)
product of democracy indexes					0.21	0.20	0.20
					(0.16)	(0.22)	(0.22)
UN vote correlation					-1.52^a	-1.29^a	-1.29^a
					(0.11)	(0.18)	(0.18)
ln (last 5 years mult. info. open. dev. / mean)							0.00
							(0.05)
N	305323	302991	299082	299082	189366	86404	86404
R^2	0.261	0.292	0.292	0.315	0.341	0.332	0.332

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

seems very consistently associated with lower probabilities of war. Here, as with FTAs, the endogeneity of membership decisions calls for caution in interpretation. The rules to grant membership applied by existing members, as well as the use of GATT membership by candidate governments as a device to commit to better governance in general, suggests that countries can only enter the club once their probability of wars with neighbors has sufficiently declined. Even if more detailed analysis is needed here, it is safe to state that if the question of a statistical relationship between GATT and trade is disputed, the one between GATT and peace seems robust. The last column tests for the effect of asymmetric information through the inclusion of the level of multilateral trade in newspapers. The coefficient is insignificant in this specification.

Table 5: Impact of trade on wars - III (fixed effects with lagged trade)

	Dependent Variable: War between two countries				
Model :	(1)	(2)	(3)	(4)	(5)
ln (last 5 years bil. open. trade avg.)	-0.03	-0.07^a	-0.12^a	-0.22^a	-0.22^a
	(0.02)	(0.02)	(0.03)	(0.06)	(0.06)
last 5 years 0 trade dummy avg.	-0.21	-0.66^a	-1.07^a	-0.90^c	-0.81
	(0.22)	(0.25)	(0.31)	(0.55)	(0.55)
number of peaceful years	-0.01^a	-0.01^a	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln (last 5 years mult. open. trade avg.)		0.13^a	0.18^b	0.22	0.27
		(0.05)	(0.08)	(0.16)	(0.17)
Nb of GATT members		-0.91^a	-0.71^a	-0.88^b	-0.88^b
		(0.12)	(0.16)	(0.40)	(0.40)
free trade area		-0.31	-0.33	-2.10^c	-2.02^c
		(0.26)	(0.30)	(1.09)	(1.08)
UN vote correlation			-0.75^a	-1.86^a	-1.94^a
			(0.22)	(0.44)	(0.44)
product of democracy indexes			0.22	-0.46	-0.37
			(0.28)	(0.42)	(0.42)
ln (last 5 years mult. open. info avg.)					-0.14^c
					(0.07)
N	12918	12602	7751	2651	2651

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

In Table 5, we finally go further and use country-pair fixed effects with lagged values of our trade and information openness variables. Note that this specification is extremely demanding in the sense that identification of the impact of different covariates will be made only inside those pairs of countries that have a conflict at some point in time. That is, the effect of variables is conditional upon the fact that the considered country-pair has had a conflict over our time frame. All non-fighting country-pairs during the 1948 to 2001 period are dropped and will not be used in the identification of the impact of trade on wars for instance. Furthermore, the use of the fixed effects imposes the effect to come

solely from variation within the fighting dyad. Hence, all variables which are constant over time are eliminated from estimation. This can be seen as an extreme version of our regressions. It omits any type of cross-sectional variation that explains for instance why two countries never went at war since WWII, which can be argued to also be interesting information. Although the impact of most variables is usually less significant, results are again in accordance with our theoretical priors. The bilateral trade variable reduces the probability of going at war, and is still significant at the 1% level in most estimations. The multilateral trade variable is positive and significant. Note that the absolute value of those coefficients and their significance levels grow as the set of war covariates is expanded. This underlines the crucial importance of proper war controls in this more demanding estimation procedure to sort out the impact of trade from other determinants of conflicts. In the last column, we again test for the asymmetric information canal. The coefficient is significant at the 10% level and negative as predicted. Hence, this suggests that multilateral openness has opposite impact on the probability of war depending on the nature of flows, goods or information.

Finally, we want to quantify the effect of trade on the probability of military conflict between two countries. A standard approach in our context is to imagine the following counterfactual experience. Take a pair of countries with a mean level of bilateral and multilateral trade openness. Denote this dyad's initial probability of being in militarized dispute as P. Then, increase bilateral trade by one standard deviation. Denote the new probability by P'. Then the rise in the probability of being in conflict is given by:$\frac{P'}{P} = [1 + cv(TR)]^{\hat{b}}$ where $cv(TR)$ is the coefficient of variation (the standard deviation divided by the mean) of the trade variable and $\hat{b}$ is the estimated coefficient divided by 2 (the number of possible states in this binary logit model). Based on $\hat{b} = -0.17$ in specification 6 in table 4, this implies that one standard deviation on bilateral trade between two countries would decrease the probability of military conflict by around 15%. Based on $\hat{b} = 0.39$ in the same regression a one standard deviation on multilateral trade (excluding bilateral trade) would increase the probability of military conflict between two countries by around 19%.

4 Conclusion

Our paper is the first, to our knowledge, to base the empirical analysis of the relation between trade and war on a theoretical model that allows to generate and test a controversial question. Our results are somewhat ambivalent on the impact of trade and more generally of globalization on the prevalence and the nature of war. We have shown that even in a model where trade increases welfare and war is Pareto inferior, higher trade flows may not lead to peace. The intuition that trade promotes peace is only partially right: bilateral trade, because it increases the opportunity cost of bilateral war indeed deters bilateral war. Multilateral trade also deters multilateral, "global" or world wars. However, multilateral trade openness, because it reduces the opportunity costs of going to war with any given country, increases the probability of war between any given pair of country. Trade globalization also affects the nature of war: multilateral trade openness increases the probability of small-scale,

local wars and deters multilateral conflicts. Finally, globalization, both directly and indirectly through trade flows, facilitates information flows, which we show decrease the probability of war if they lead to lower information asymmetry. Our empirical analysis provides strong evidence in favor of these contradictory effects of globalization.

Various extensions are possible especially on the impact of globalization on information flows and through this channel on the probability of war. A recent literature in trade (see Rauch 1999) has argued both theoretically and empirically that trade in differentiated products (as opposed to homogenous products traded anonymously on organized exchanges) should generate more interactions between traders and therefore more international information flows. Hence, we could more precisely test the impact of trade on war through the asymmetry of information channel by distinguishing between different types of trade flows following Rauch distinction between differentiated and homogenous products.

Another possible extension is to focus on the impact of regional trade agreements on the probability of war. This is important in the context for example of the European debate. Many observers are favorable to the enlargement of the European Union because they argue it would decrease the probability that future conflicts escalate into wars. It is obviously important, to judge this argument, to better understand which types of trade agreements are peace promoting. Is regional free trade, allowing an increase in regional trade flows, enough or should countries be tied further by institutional and political ties?

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A Appendix 1: Solving for the second best protocol[15]

The aim of this section is to derive the second best mechanism of our bargaining game under asymmetric information exposed in the main text. To this purpose we rely on Myerson-Satherwaite (denoted M-S) and Compte and Jehiel (2005). We provide a two stage proof. First, we study the equilibrium of a particular protocol, the so-called *Nash bargaining protocol*. We then show that this protocol implements the second best mechanism.

Remember that our setup differs from the M-S setup as 1) at any time, countries may quit negotiations; hence, we impose ex-post participation constraints ; 2) private information is partially correlated between countries; more precisely, the outside options are uniformly distributed on the triangle $\Gamma=(M, M_A, M_B)$ (see figure theory).

$$\Gamma = \{(\tilde{U}_i^W, \tilde{U}_j^W) \mid (\tilde{U}_i^W, \tilde{U}_j^W) \geq \left(\underline{v_i}, \underline{v_j}\right) \text{ and } \tilde{U}_i^W + \tilde{U}_j^W \leq \bar{v}\}$$

with $\underline{v_i} \equiv (1 - V/2).U_i^W$ and $\underline{v_i} \equiv (1 - V/2).U_j^W$ and $\bar{v} = (1 + V).(U_i^W + U_j^W)$. From assumption (1), peace Pareto dominates war, meaning that $\bar{v} < S^P \equiv U_i^P + U_j^P$. In the rest of the section, for the sake of expositional clarity, we assume without loss of generality[16] that $V = 2$ such that

$$\underline{v_i} = \underline{v_j} = 0$$

A.1 The Nash Bargaining protocol

The Nash bargaining protocol was first described in a slightly different setting by Chaterjee and Samuelson (1983). This is a two stage protocol.

- *"announcement stage":* In the first stage, both countries i and j announce an outside option $(\hat{U}_i^W, \hat{U}_j^W)$ and a sharing rule is proposed.

  If the annoucements are compatible, that is, if the sum $\hat{U}_i^W + \hat{U}_j^W \leq S^P$, an agreement is proposed along with transfers $\tau_i(\hat{U}_i^W, \hat{U}_j^W)$ and $\tau_j(\hat{U}_i^W, \hat{U}_j^W)$ chosen so that each party obtains in addition to its announced outside option, half the surplus $S^P - (\hat{U}_i^W + \hat{U}_j^W)$ that is:

  $$\tau_i(\hat{U}_i^W, \hat{U}_j^W) = \hat{U}_i^W + \frac{S^P - (\hat{U}_i^W + \hat{U}_j^W)}{2} \text{ and } \tau_j(\hat{U}_i^W, \hat{U}_j^W) = \hat{U}_j^W + \frac{S^P - (\hat{U}_i^W + \hat{U}_j^W)}{2}$$

  In case the announcements are not compatible, $\hat{U}_i^W + \hat{U}_j^W > S^P$, the bargaining process stops, war is triggered and each party gets its (true) outside option $(\tilde{U}_i^W, \tilde{U}_j^W)$.

- *"agreement stage":* In the second stage, parties sequentially report if they accept the deal[17]. If both parties say "yes", the deal is implemented. Otherwise, negotiation stops, war is triggered and each party gets its (true) outside option $(\tilde{U}_i^W, \tilde{U}_j^W)$.

[15] We follow the proof given in Compte and Jehiel (2005).

[16] In figure theory, assuming $V = 2$ means that M corresponds to the origin $(0, 0)$.

[17] This stage corresponds to our assumption of "no comitment protocol". In the M-S and C-S original approach, this stage is not allowed: the parties agree ex-ante on the sharing rule; they cannot ex-post renegociate.

Clearly, in the second stage, it is a dominant strategy for each party $k \in (i,j)$ with true outside option $\tilde{U}_k^W$ to say "yes" (respectively "no") if $\tau_k \geq \tilde{U}_k^W$ (respectively $\tau_k < \tilde{U}_k^W$). From Compte and Jehiel (2005), we are able to characterize the equilibrium of the outside option announcement game[18]:

Lemma 1: At equilibrium, a party $k \in \{i,j\}$ with (true) type $\tilde{U}_k^W$ announces $\hat{U}_k^W = a(\tilde{U}_k^W)$ where

$$a(\tilde{U}_k^W) = \frac{1}{4}S^p + \frac{2}{3}.\tilde{U}_k^W \tag{20}$$

Consequently, there is an agreement and Peace is maintained when $\tilde{U}_i^W + \tilde{U}_j^W \leq \frac{3}{4}S^P$. War occurs for $\tilde{U}_i^W + \tilde{U}_j^W > \frac{3}{4}S^P$. On Figure theory, disagreement arises for every couple of outside options which are located in the ABM_BM_A dashed area.

Intuitively, it is clear from (20) that the parties i and j do not report their true outside option. One the one hand, the two parties have an incentive to announce higher values of their outside option to get a larger share of the surplus. On the other hand, they have an incentive to announce lower values in order to secure an aggreement. At equilibrium, for high values of their true outside option, the second effect is not strong enough to produce an agreement.

Proof of lemma 1:

The expected gain of player i with type $\tilde{U}_i^W$ when announcing $\hat{U}_i^W$ is

$$\begin{aligned} G(\tilde{U}_i^W, \hat{U}_i^W) &= \int_{\frac{S^p - \hat{U}_i^W + a(\tilde{U}_j^W)}{2} > \tilde{U}_j^W} \max(\hat{U}_i^W, \frac{S^p - \hat{U}_i^W - a(\tilde{U}_j^W)}{2}).\frac{d\tilde{U}_j^W}{\bar{v} - \tilde{U}_i^W} \\ &\quad + \tilde{U}_i^W . \int_{\frac{S^p - \hat{U}_i^W + a(\tilde{U}_j^W)}{2} < \tilde{U}_j^W} \frac{d\tilde{U}_j^W}{\bar{v} - \tilde{U}_i^W} \end{aligned}$$

We now check that it is optimal for party i to announce $\hat{U}_i^W = a(\tilde{U}_i^W)$. Given the form of $a(.)$ it is readily verified that whenever the announcements are compatible, i.e. $a(\tilde{U}_i^W) + a(\tilde{U}_j^W) < S^p$, we have that $a(\tilde{U}_k^W) > \tilde{U}_k^W$ for both $k \in \{i,j\}$, hence the Nash bargaining share of each party k is above $\tilde{U}_k^W$. This allows us to simplify the expression of $G(\tilde{U}_i^W, \hat{U}_i^W)$ when $\hat{U}_i^W$ lies in the neighborhood of $a(\tilde{U}_i^W)$ into:

$$\begin{aligned} G(\tilde{U}_i^W, \hat{U}_i^W) &= \int_{a(\hat{U}_j^W) < S^p - \hat{U}_i^W} . \frac{S^p + \hat{U}_i^W - a(\hat{U}_j^W)}{2} . \frac{d\tilde{U}_j^W}{\bar{v} - \tilde{U}_i^W} \\ &\quad + \tilde{U}_i^W . \int_{a(\hat{U}_j^W) > S^p - \hat{U}_i^W} \frac{d\tilde{U}_j^W}{\bar{v} - \tilde{U}_i^W} \end{aligned}$$

[18] In the general case of $V < 2$, the formula becomes more complicated. Indeed a straightforward variable changes show that at equilibrium, a party $k \in \{i,j\}$ with (true) type $\tilde{U}_k^W$ announces $\hat{U}_k^W = a(\tilde{U}_k^W)$ where

$$a(\tilde{U}_k^W) = \underline{v_k} + \frac{1}{4}(S^p - \underline{v_i} - \underline{v_j}) + \frac{2}{3}(\tilde{U}_k^W - \underline{v_k}) \tag{19}$$

Consequently, there is an agreement and Peace is maintained when $(\tilde{U}_i^W + \tilde{U}_j^W - \underline{v_i} - \underline{v_j}) \leq \frac{3}{4}(S^P - \underline{v_i} - \underline{v_j})$. War occurs for $(\tilde{U}_i^W + \tilde{U}_j^W - \underline{v_i} - \underline{v_j}) > \frac{3}{4}(S^P - \underline{v_i} - \underline{v_j})$. On Figure theory, disagreement arise for every couple of outside options which are located in the ABM_BM_A dashed area.

Differentiating $G(\tilde{U}_i^W, \hat{U}_i^W)$ with respect to $\hat{U}_i^W$ yields:

$$\frac{\partial G(\tilde{U}_i^W, \hat{U}_i^W)}{\partial \hat{U}_i^W} = \frac{1}{\bar{v} - \tilde{U}_i^W} \left[\frac{b(S^p - \hat{U}_i^W)}{2} - (\hat{U}_i^W - \tilde{U}_i^W,).b'(S^p - \hat{U}_i^W) \right]$$

where $b(x) \equiv -\frac{3}{8}S^p + \frac{3}{2}x$ is the inverse of function $a(.)$. Straightforward computations show that

$$\left. \frac{\partial G(\tilde{U}_i^W, \hat{U}_i^W)}{\partial \hat{U}_i^W} \right|_{\hat{U}_i^W = a(\tilde{U}_i^W)} = 0$$

A.2 Second Best

We now show that the Nash bargaining protocol described in the previous section implements the second best.

¿From M-S (1983), we know that when outside options are uniformly distributed on the square $(\tilde{U}_i^W, \tilde{U}_j^W) \in [0, S^p] \times [0, S^p]$ the second best (requiring interim participation constraint but not an ex-post one) is implemented by the Nash bargaining protocol and this leads to an agreement whenever $\tilde{U}_i^W + \tilde{U}_j^W \leq \frac{3}{4}S^P$. But this is also the domain of agreement induced by the Nash Bargaining protocol in our model where outside options are uniformly distributed on the triangle Γ which can be viewed as a restriction of the uniform distribution to a subset of $[0, S^p] \times [0, S^p]$. Naturally this implies that the allocation resulting from the Nash Bargaining protocol induces the second-best in our particular setup.

Indeed by contradiction, assume that in our setup where outside options are uniformly distributed on the triangle Γ, there is a mechanism Ω that generates a strictly higher expected welfare than the Nash Bargaining Protocol. It would then be possible to improve upon the second best of the M-S setup, which we call the MS mechanism. To this purpose, note that any "no commitment" truthful direct mechanism (ie. satisfying the ex-post participation constraints) is a truthful mechanism in the M-S setup (ie. satisfying the interim participation constraint). Hence in the M-S setup, we can build a mechanism Ω' stipulating: for $(\tilde{U}_i^W, \tilde{U}_j^W) \in \Gamma$, we have $\Omega'(\tilde{U}_i^W, \tilde{U}_j^W) = \Omega(\tilde{U}_i^W, \tilde{U}_j^W)$; and for $(\tilde{U}_i^W, \tilde{U}_j^W) \in [0, S^p]^2 - \Gamma$, we have $\Omega'(\tilde{U}_i^W, \tilde{U}_j^W) = MS(\tilde{U}_i^W, \tilde{U}_j^W)$. From the previous remark, such a mechanism Ω' is a truthful direct mechanism. Moreover as Ω generates a strictly higher expected welfare than the Nash Bargaining Protocol on Γ, we have that Ω' generates a strictly higher expected welfare than the Nash bargaining protocol on the whole domain $[0, S^p] \times [0, S^p]$. But this is in contradiction with the fact that the Nash bargaining protocol is the second best for $(\tilde{U}_i^W, \tilde{U}_j^W)$ uniformly distributed on $[0, S^p] \times [0, S^p]$.

In concluion, the Nash bargaining protocol implements the second best. Because we assume that leaders are rational, it is clear that they will choose this protocol to conduct negotiations. But from lemma 1, we know that disagreement arises for every pair of outside options located in the ABM_BM_A dashed area (see Figure theory). Hence the probability of war corresponds to the ratio of the area of disagreement ABM_BM_A over the total area of disagreement MM_AM_B.

B Appendix 2: equilibrium value of the probability of war.

In the main text we assume that the effect of war is the folllowing: A country i's welfare under peace is $U_i^P = U(\mathbf{x}_i)$ where the vector $\mathbf{x}_i \equiv (\hat{L}_i, \hat{L}_j, T_{ij}, T_{ih})$; under war, country i's welfare is stochastic (see equation (2)) but is equal on *average* to an equilibrium value $U_i^W = U\left[\mathbf{x}_i(1-\mathbf{\Delta}_i)\right]$ with: $\mathbf{\Delta}_i \equiv (\lambda, \lambda, -\tau_{ij}, -\tau_{ih})$. According to our model of escalation developed in the previous section, the probability of escalation to war between country i and country j, given by (3), is now equal to:

$$\Pr(escal_{ij}) = 1 - \frac{1}{4V^2}\frac{\left[U(\mathbf{x}_i) - U(\mathbf{x}_i(1-\mathbf{\Delta}_i)) + U(\mathbf{x}_j) - U(\mathbf{x}_j(1-\mathbf{\Delta}_j))\right]^2}{U(\mathbf{x}_i(1-\mathbf{\Delta}_i))U(\mathbf{x}_j(1-\mathbf{\Delta}_j))} \tag{21}$$

In order to get closed forms we assume that the two countries are symmetric: $\mathbf{x}_i = \mathbf{x}_j$ and $\mathbf{\Delta}_i = \mathbf{\Delta}_j$. We restrict our attention to first order effects so that we can use a Taylor expansion of (21), such that:

$$\Pr(escal_{ij}) \simeq 1 - \frac{1}{V^2}.\left[\mathbf{\Delta}_i.\frac{\mathbf{\nabla U}(\mathbf{x}_i)}{U(\mathbf{x}_i)}\right]^2$$

which can be rewritten, using (7) as:

$$\Pr(escal_{ij}) \simeq 1 - \frac{1}{V^2}.\left[W_1.\lambda + W_2.\tau_{ij} + W_3.\tau_{ih}\right]^2 \tag{22}$$

with

$$\begin{aligned} W_1 &\equiv 1 + \tfrac{1}{\sigma-1}.\left(\frac{\hat{L}_i}{\sum_{h=1}^{R}\hat{L}_h T_{ih}^{1-\sigma}} + \frac{\hat{L}_j T_{ij}^{1-\sigma}}{\sum_{h=1}^{R}\hat{L}_h T_{ih}^{1-\sigma}}\right) > 0 \\ W_2 &\equiv \frac{\hat{L}_j T_{ij}^{1-\sigma}}{\sum_{h=1}^{R}\hat{L}_h T_{ih}^{1-\sigma}} > 0; W_3 \equiv \sum_{h\neq j,i}^{R}\frac{\hat{L}_h T_{ih}^{1-\sigma}}{\sum_{h=1}^{R}\hat{L}_h T_{ih}^{1-\sigma}} > 0 \end{aligned} \tag{23}$$

Differentiating condition (22) yields:

$$\frac{d\Pr(escal_{ij})}{d(-T_{ij})} = \Omega.\left[-\hat{L}_i\tau_{ij} - \sum_{h\neq j,i}^{R}\hat{L}_h T_{ih}^{1-\sigma}.\left(\frac{\lambda}{\sigma-1} + \tau_{ij} - \tau_{ih}\right)\right] \text{ with} \tag{24}$$

$$\Omega = \frac{\sigma-1}{V^2}\frac{\hat{L}_j T_{ij}^{1-\sigma}}{\left(\sum_{h=1}^{R}\hat{L}_h T_{ih}^{1-\sigma}\right)^2} > 0 \tag{25}$$

And

$$\frac{d\Pr(escal_{ij})}{d(-T_{ih})} = \Omega.\left[\hat{L}_i\left(\frac{\lambda}{\sigma-1} - \tau_{ih}\right) + \hat{L}_j T_{ij}^{1-\sigma}\left(\frac{\lambda}{\sigma-1} + \tau_{ij} - \tau_{ih}\right)\right] \tag{26a}$$