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CRED WP 2010/14

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Abstract

In anarchic settings, the potential rivals are dragged in an arms race that can degenerate in an open war out of mutual suspicion. We propose a novel commitment device for contestants to avoid both arming and fighting. We allow the players to decentralize the two core decisions that determine whether peace or war ensues. While in centralized countries the decision makers are unable to credibly communicate to their foe their willingness not to arm and not to attack, where the two decisions are dissociated there exists scope for not arming with certainty, and hence overcoming the commitment problem that makes war otherwise inevitable. Using data on the 1975-2001 period, we provide evidence that in countries where the head of the state or the defense minister are military officers, the likelihood of observing an international conflict is higher.

Keywords: Conflict; Private Information; Commitment
JEL classification: D74; D82; F5; H56

*La guerre c'est une chose trop grave pour la confier à des militaires.
War is too serious a matter to entrust it to the military.*

Charles Maurice de Talleyrand, French minister and ambassador (1754-1838)

1 Introduction

To determine the best remedy against the plague, one first needs to understand the conditions favouring its appearance. With this goal in mind, conflict theorists have developed an arsenal of theoretical models characterizing the fundamental elements inciting parties to violently confront each other. A class of models known under the acronym “Guns and Butter” has grown over the past 20 years as the leading theoretical construction in the discipline. The two objects of the field’s name capture the agents’ only resource allocation options in these models: investing in military equipment or in productive activities. The first impulse was initiated by Jack Hirshleifer (1991a; 1991b) and Stergios Skaperdas (1992) some 20 years ago. These authors reached the common conclusion that war is inevitable under some very weak conditions in the

*We are highly grateful to Felix Vardy and Natassa Litina for their very helpful suggestions. We also thank Emmanuel Athanasiou, Ugurhan Berkok, Raul Caruso, Jean-Denis Garon, Charalambos Hristou, Christos Kollias, Frago Kourandi, Desmond Lo, and Emmanuel Reynaud for their comments. Antonis Adam is Lecturer at the University of Ioannina. Contact e-mail: aadam@cc.uoi.gr

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aforementioned setting. Thus while the first wave of models thoroughly analyzed the impact of the model's parameters on the equilibrium outcome, the central question of why conflicts emerge in the first place remained mostly unanswered. Indeed, the best explanation for peaceful outcomes was to be sought in fighting technologies so poor as to make an attack against a weaponless foe unprofitable.

Subsequent research has proposed a rich portfolio of explanations for why peace may occur in "Guns and Butter" models. While no such prior classification has yet been proposed in the literature, these results may be divided into two categories depending on the inefficiencies assumed to be associated with war. One modelling strategy consists in viewing war as a negative-sum game, while the alternative assumption is to consider it to be a zero-sum game¹. The reason peace can be achieved in the former class of games is rather trivial: since peace yields larger payoffs than war in aggregate, there must exist situations making both contestants strictly better off by not attacking each other. The most straightforward way of creating a wedge between peace and war is to assume that war generates *direct* inefficiencies such as destruction (Grossman and Kim, 1995; Meirowitz and Sartori, 2008; De Luca and Sekeris, 2009; Jacobsson, 2009). The negative-sum nature of war can also be the consequence of risk aversion as in Skaperdas (1991), and Skaperdas and Gan (1995): the certain equivalent of peace being preferred over the war lottery, both contestants may be better off by avoiding a militarized conflict. The same concavity-related argument has been applied to the production function, and this leads to equivalent outcomes (Anbarci et al., 2002). Some prominent authors in the field have introduced dynamics in the basic setting. By applying a Folk Theorem logic to the usual "Guns and Butter" model, Garfinkel (1990) creates a gap between peace and war payoffs since the discounted expected payoffs from peace with few or even no weapons can be Pareto superior to the discounted expected payoff of fully militarized wars. In a somehow similar vein, Jackson and Morelli (2009b) use a combination of dynamics and direct costs of war (i.e. destruction) to obtain peace at equilibrium. Lastly, Baliga and Sjöström (2008) develop a model where a small country having potentially secretly developed weapons of mass destruction may have an interest in not revealing this information to the large country willing to contain the former. This result follows from the small country's willingness to save on weapons expenditures since after the degree of military preparedness has been disclosed, the small country finds itself compelled to invest in weapons to deter an invasion from the large country. While this model shares some features with ours, it is a purely negative-sum setting since the confrontation of two purely informed decision makers always produces war outcomes.

The second class of games admitting peace as a potential equilibrium outcome assume that the aggregate utility under peace and war is identical. One proposed mechanism for making peace strictly superior despite this assumed equivalence relies heavily on the agents' ability to precommit not to arm. This is achieved in Beviá and Corchón (2010) by imposing that agents first decide whether to go to war or not, and in a second stage determine the optimal guns to purchase. Scholars have repeatedly argued, however, that such commitments are not self-enforceable in anarchic settings (Fearon, 1995; Powell, 2006) as no third party would prevent a contestant in a static framework from arming and renegeing its initial promise not to attack. An alternative to assuming such an *ad hoc* ability to commit consists in investing in the creation of a third party-enforcer (Genicot and Skaperdas, 2002; Gradstein, 2004, McBride et al., 2010). While such enforcement devices are certainly interesting to analyze, they carry a cost. A more efficient way of reaching peace in anarchic settings would therefore be devoid of any such conflict management possibility. It has equally been claimed that when war is a zero-sum game, anarchy needs not necessarily be conducive

¹Jackson and Morelli (2007) assume that war can be a positive sum game (for the decision-making agents) by introducing the concept of political bias: decision makers' cost/reward ratio from going to war is smaller than that of their country in "politically biased" countries. As a consequence, the decision makers of two interacting countries could simultaneously find it optimal to launch a war each other. In Garfinkel and Skaperdas (2000), the win-win nature of war comes from the foregone waste in guns investment in the future after one of the contestants has been annihilated. These positive-sum game contexts unmistakably generate conflict as will later become clearer.

of conflicts. The argument which rests on players arming and transferring resources ex-post so as to make both contestants exactly indifferent between peace and war is unsatisfactory in two respects. While peace can certainly be achieved if the inequality is broken against war, it bears emphasis that the equilibrium amounts of guns compatible with such equilibria are exactly the same as in the event of war, thus making the difference between peace and war a purely semantic issue. The second argument against this approach - which we elaborate on in the following section - is that such equilibria are extremely fragile since the introduction of either transaction costs, or incremental perturbations in the information structure eradicates these equilibria.

In summary, in anarchic settings, the unique configurations where existing models of “Guns and Butter” have been able to satisfactorily accommodate for peaceful outcomes at equilibrium presuppose that war is modeled as a negative-sum game. The fundamental reason peace is never reached in zero-sum games rests in an underlying arms race logic that constraints both parties to prepare for war despite the Pareto-superior nature of a weaponless and thus peaceful order. On the one hand a weaponless enemy constitutes a perfect prey, thus making the weaponless equilibrium unreachable. On the other hand, arming to deter an aggression makes oneself increasingly willing to use these guns if the foe is expected to be lightly armed. This mechanism has been masterfully described by Jervis (1978) who termed the countries’ tendency to arm out of mutual fear the *security dilemma*: “[M]any of the means by which a state tries to increase its security decrease the security of others” (Jervis, 1978: 169). The pending task, therefore, consists in proposing a mechanism similar to Thomas Schelling’s strategy of tying one’s own hands as exposed in *The Strategy of Conflict* (1960). Having understood the dear consequences of not being able to credibly threaten to retaliate in case of nuclear aggression, Schelling devised a series of mechanisms for the superpowers to *commit* in carrying retaliatory strikes so as to prevent the initial strike from taking place². In this paper we reverse the argument and seek for a mechanism allowing weaponless instead of Terror equilibria (Schelling, 1960, The Royal Swedish Academy of Science, 2005) to emerge. Rather than credibly committing to go to war if ever attacked, we propose a mechanism for the contestants to tie their hands not to arm.

The novel mechanism we present in this paper allows for the emergence of peaceful outcomes in zero-sum games. The “commitment device” consists in assigning to different decision-makers the armaments choice, and the decision of going to war or not. For presentation purposes the former decision-maker is designated as the *Smith* while the latter is denominated the *General*. When these two decision-makers operate their choices in private and do not reveal their actions, the General may refrain from attacking the opposing country even if the Smith has purchased a large amount of guns that would confer this country a strategic advantage on the battle field. Indeed, provided the Smith foregoes building up an army with strictly positive probability, the uninformed General will be reluctant to always initiate hostilities against the other contestant because of the possibility of going to war with an under-furnished army. If these two decision-makers credibly fail to perfectly communicate, the opposing party will be convinced that (i) his foe may be unarmed, and (ii) even when armed he may choose not to initiate hostilities. As a consequence, even when one of the two contesting parties centralizes the two decisions, the “centralized decision-maker” can find it optimal to dispense from arming with a strictly positive probability. This leads to both sides of the contest ending up unarmed and/or unwilling to start a war.

We thus depart from the initial paradigm by introducing imperfect information: while initially no agent possesses private information, informational asymmetries arise when decision makers privately decide their armaments levels. This same modelling assumption is encountered in Meierowitz and Sartori (2008), but their results differ importantly from ours because of the dispersion of the decision making process we introduce. The central result of the former paper is that in attempting to improve their bargaining position contestants

²For an amusing but extremely clear exposition of Schelling’s idea, see Dr Strangelove’s amusing description of the *Doomsday Machine* in the movie “Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb” (1964), directed by Stanley Kubrick.

may refrain from revealing information on their armaments levels, thus increasing the likelihood of war in a negative-sum setting. The negative consequences of imperfect information has been widely pointed at by scholars (Fearon, 1995; Powell, 2006; Jackson and Morelli, 2009a). Indeed, war being potentially avoided through a bargaining process, the likelihood of observing a militarized conflict will increase as the parties mis-represent their mutual strength in an attempt to modify the bargaining threat point in their favour. Somehow surprisingly, our conclusions point at the *positive* consequences of asymmetric information. In the peace equilibria we derive in this model, the probability that parties invest in weapons is strictly inferior to unity, thus implying that both sides of the contest are reducing their expenditures as compared to a perfect information setting. This means that the peaceful outcome with imperfect information can turn out to Pareto-dominate the conflict outcome with perfect information. Should the Smith and the General in a country be able to perfectly communicate, and should this happen in the knowledge of the other country's decision-makers, the latter would have stonger incentives to arm in expectation of war. Interestingly, using Kyle Bagwell's (1995) insight that informational signals may not affect the players' decision-making process, we show that our results hold when allowing the players to communicate, as long as the signal is not perfectly informative³.

The main findings of the paper are the following. On the one hand, war occurs with certainty when two states with centralized decision-making processes face each other. On the other hand, if both countries have distinct agents in charge of the armament and of their use, peace can occur either as a pure strategy where both countries are weaponless, or else as a mixed strategy where the probability of arming and of fighting are both strictly positive but less than unity. When either of these two peaceful equilibria are implemented, the countries in aggregate restrain (or cancel completely) the inefficient arming process, thus implying that the latter situation is potentially Pareto-superior to the outcome with certain conflict. For these peaceful equilibria to be preferred to war by all contestants, it is necessary that the initial size of the countries (i.e. the peaceful sharing of the pie) be not too dissimilar. Indeed, should one contestant be endowed with a small territory, he will always prefer redefining the partition of the total territory by wielding power. We then introduce small perturbations to the players' strategies to show that the mixed strategy equilibrium where peace is always expected to occur with strictly positive probability is the game's unique Trembling Hand Perfect equilibrium. This result is very instructive since barely noticeable potential mistakes by the decision makers give rise to an equilibrium involving less wasteful activities than in the standard "Guns and Butter" framework. Lastly, allowing for a non-centralized country to confront a centralized one yields intermediate results: either the centralized country always finds it optimal to initiate conflict, or else there exists scope for a mixed strategy equilibrium producing peace with a strictly positive probability.

These neat theoretical predictions need to be confronted to real-world data to convince the sceptics that they are not the pure outcome of a mental and fictious construction. To that end, we use the Correlates of War (COW) database to identify whether the degree of centralization of independent states over the period 1975-2001 influenced the likelihood of bilateral interstate militarized disputes. To address the delicate task of classifying nations according to their degree of centralization, we consider the information flow among the two decision bodies in a country to be higher when the head of the state *and/or* the defense minister is a military official. The empirical investigation produces clear results confirming our theory: dyads featuring one centralized nation face a 80% higher likelihood of experiencing a dispute as compared to a dyad of decentralized countries, while the equivalent figure for dyads of centralized states reaches 136%. Our results are shown to be robust to a host of alternative explanations, including the democratic peace argument and the possibility of the findings being the consequence of the military officers' bias to go to war out of personal considerations.

In the following section we present the model and the theoretical findings. Section 3 contains a de-

³We thank Felix Vardy for this helpful addition to the paper

scription of the data and the empirical methodology which yield the empirical results which are exposed in Section 4. The last section concludes.

2 The model

2.1 The Setting

We consider two countries that share a total territory of worth R , such that country 1 controls a share λ of it, while country 2 has property rights over the remaining territory. Each country's territorial endowment constitutes the unique input in the production of a consumable c^i ($i = \{1, 2\}$), given a unit marginal cost of production. These property rights can be contested by either side by resorting to violence, i.e. by going to war. In each country, a general G^i ($i = \{1, 2\}$) is responsible of the decision to *fight*, or *concede* (i.e. declare war or not). The likelihood that country i wins the war is described by a function $p(w^1, w^2)$ and therefore depends the amounts of guns available in country 1 and 2, respectively denoted a^1 and a^2 . The armament level of a country is decided by its Smith, S^i . Given that the marginal cost of arming is measured as an opportunity cost of foregone production, S^i has to respect his country's budget constraint: $r^i = c^i + a^i$. The function $p(a^1, a^2)$ is assumed to satisfy the following conditions:

$$\mathbf{H. 1.} \quad p(a^i, a^{-i}) = \frac{f(a^i)}{f(a^i) + f(a^{-i})} \quad \text{if } a^i + a^{-i} > 0, \text{ with } f(0) = 0, f(\cdot)' > 0, f(\cdot)'' \leq 0$$

$$\mathbf{H. 2.} \quad (p^1, p^2) = (\lambda, 1 - \lambda) \quad \text{if } a^1 + a^2 = 0$$

We thus assume that a country's fitness is decreasingly increasing in the size of its army, while in the absence of armies ($a^1 = a^2 = 0$), no war can occur.

The countries can be of two kinds, *decentralized* or *centralized*. The Smith and the General are two distinct decision-makers in *decentralized* states, whereas in *centralized* countries all decisions accue to a single decision-maker, the Supreme General, SG^i . The utility function of all decision-makers, i.e. the Smith, the General, and the Supreme General, has the same shape. We denote the utility of a decision-maker in country i by U , and the utility of country 2's decision-makers is represented by V . Under war, a decision-maker in country 1 obtains:

$$U^w = p(a^1, a^2)(R - a^1 - a^2) \tag{1}$$

whereas under peace his utility equals:

$$U^{\bar{w}} = \lambda R - a^1 \tag{2}$$

The timing of the game is sequential. In the first stage of the game, the agents responsible of the resource allocation, i.e. the Smiths in decentralized states, and the Supreme Generals in centralized countries, decide the amount of guns to purchase and the amount of consumables to produce. These decisions are not observed by the opponent. In decentralized states the Smith can communicate to his General his arming strategy, but the flow of information is imperfect. Provided the number of arming strategies is finite (which will actually be the case), General i receives a signal s^i which is correct with probability $1 - \epsilon$, where $\epsilon \in]0, 1[$. The ϵ probability of mistake signals is assumed to be uniformly distributed over the remaining set of arming strategies. In centralized states, since we impose the standard assumption of perfect recall, the Supreme General is aware of his armaments level at subsequent stages of the game.

In the second stage, the agents responsible of the war decisions - the General in decentralized states, and the Supreme General in centralized ones - simultaneously decide whether to attack their foe or not. If either player plays *fight* war ensues.

We solve for both the game's Nash and Trembling Hand Nash Equilibria. Since the game is sequential, we solve it by backward induction.

In the next section we analyze the interaction between two centralized states. Building on this outcome we then consider the confrontation of two non-centralized states, before dealing with the mixed case whereby a centralized state faces a non-centralized one.

2.2 Centralized States

The decision of going to war

Because of assumptions H.1. and H.2., the probability functions, and hence the war payoffs, experience a discontinuity in the weapons' levels in the vicinity of $(a^1, a^2) = (0, 0)$. As a consequence, throughout the paper we denote by σ^i the probability that country i is armed ($a^i > 0$). Moreover, we allow for mixed strategies and accordingly denote by π^i the probability country i attacks country $-i$. From leader SG^1 's perspective, if unarmed he never finds it optimal to declare war. Formally, this reads $\pi^i|_{\sigma^i=0} = 0$. When SG^1 is armed, his expected utility of playing "fight" equals:

$$U^f(\sigma^1, \sigma^2, a^1, a^2)|_{\sigma^1=0} = \sigma^2 U^w(a^1, a^2) + (1 - \sigma^2) U^w(a^1, 0) \quad (3)$$

Where the superscript w stands for the *War* outcome. If, on the other hand, SG^1 plays "concede" his utility is given by:

$$U^c(\sigma^1, \sigma^2, a^1, a^2, \pi^2)|_{\sigma^1=0} = \sigma^2 \pi^2 U^w(a^1, a^2) + \sigma^2 (1 - \pi^2) U^{\bar{w}}(a^1, a^2) + (1 - \sigma^2) U^{\bar{w}}(a^1, 0) \quad (4)$$

With the superscript \bar{w} designating the peaceful outcome. Combining (3) and (4), SG^1 prefers to concede rather than fighting when the following expression is verified:

$$U^{\bar{w}}(a^1, .) - U^w(a^1, a^2) \geq \frac{(1 - \sigma^2)}{\sigma^2(1 - \pi^2)} (U^w(a^1, 0) - U^{\bar{w}}(a^1, .)) \quad (5)$$

The equivalent expression for SG^2 is given by:

$$V^{\bar{w}}(., a^2) - V^w(a^1, a^2) \geq \frac{(1 - \sigma^1)}{\sigma^1(1 - \pi^1)} (V^w(0, a^2) - V^{\bar{w}}(., a^2)) \quad (6)$$

These conditions, combined, yield the following lemma:

Lemma 1. *When two centralized regimes interact in a "Guns and Butter" model and that the arming decisions are private information, for peace to occur it is necessary that either both participants are weaponless, or that both countries arm with certainty.*

Notice that the RHS of both conditions (5) and (6) are always non-negative. Moreover, it is straightforward to show that $U^{\bar{w}}(a^1, .) \leq U^w(a^1, a^2) \Leftrightarrow V^{\bar{w}}(., a^2) \geq V^w(a^1, a^2)$, thus implying that for conditions (5) and (6) to be simultaneously verified it is necessary that *i*) $U^{\bar{w}}(a^1, .) = U^w(a^1, a^2)$ and $V^{\bar{w}}(., a^2) = V^w(a^1, a^2)$, and *ii*) $\sigma^1 = \sigma^2 = 1$.

This lemma may anodnyous but it entails important consequences. If $(\sigma^1, \sigma^2) = (1, 1)$, either $(\pi^1, \pi^2) = (1, 1)$ and war occurs, or else $(\pi^1, \pi^2) < (1, 1)$, and both participants are *completely* indifferent between peace and war. Notice that in such contexts a peaceful equilibrium is in all respects equivalent to a war equilibrium. The intuition behind this result is that whenever both contestants are armed with strictly positive probability,

it must be in the interest of a contestant to launch a war. If both contestants would have been *exactly* indifferent between peace and war for the particular case where $\sigma^1 = \sigma^2 = 1$, the players have no (weakly) dominant strategy thus implying that the decision makers' best response in terms of probability to assign to war is the whole interval $[0, 1]$.

The arms decision

For the arming stage, a foreword to the derivation of the equilibrium is helpful to clarify matters. It is indeed important to underline that our setting gives rise to two arming strategies alone: the hawk strategy of arming in expectation of a conflict, and the dove strategy of not arming in expectation of peace. Hence, unlike the models of Neary (1996), of Jackson and Morelli (2009b), of De Luca and Sekeris (2009), and of Jacobsson (2009), there is no space in the present model for deterrent armaments, i.e. positive guns levels making one's opponent better off under peace than under war. Indeed, the countries' armaments not being observable in the game's second stage, there is no possibility of intimidating the enemy by exhibiting one's strength⁴. As a consequence, either the enemy will actually launch an attack, in which case the optimal response is to arm in expectation of war, or else the enemy refrains from attacking (by choice or by inability) in which case the optimal reaction is either to arm in expectation of oneself playing *fight*, or else to purchase no guns in expectation of a peaceful outcome. We designate the arming strategy that maximizes the war payoffs by the term *hawk* strategy, whereas the (non-)arming strategy in expectation of peace is called the *dove* strategy. The problem at stake for each decision maker is therefore bi-dimensional as he needs to decide (i) how many guns to purchase under the hawkish strategy (a^{ih}), and (ii) which strategy to follow among the hawk and the dove strategy (σ^i).

Given Lemma 1, when deciding their optimal investment in armaments, both contestants know that peace could only result from either both sides being weaponless, or both contestants being armed with certainty and their payoffs from peace and war being equal. From H.1, however, we have that an infinitesimally small investment in guns grants the armed party the total resources under dispute if the Supreme General decides afterwards to attack the opposing country. But if the opponent is expected to be unarmed, such a deviation is always profitable since $\lim_{a^i \rightarrow 0} p(a^i, 0) = 1$. This rules out the possibility of having a peaceful unarmed equilibrium. The other scenario yielding a peaceful outcome requires both contestants to be armed with certainty. If peace occurs with strictly positive probability, however, this implies that *both* contestants attribute a strictly positive probability to peace. As a consequence, it is optimal for both participants to forego arming with a strictly positive probability. But this violates a necessary condition for obtaining peace, thus implying that such equilibria are impossible. We can therefore establish following Proposition:

Proposition 1. *When two centralized states interact in a “Guns and Butter” model, war is the unique outcome.*

Notice that the proposition holds true irrespectively of whether we consider the NE or the THNE. To show this, we first show the unicity of the NE, and then deduce that the outcome is not perturbed by the introduction of trembles. We therefore begin by maximizing the problem of the decision makers. The Supreme General SG^i will choose the weapons that maximize equation (1), i.e. his “hawkish” guns. The first order condition of this maximization problem is given by:

$$U_1^w = p_1(a^1, a^2)(R - a^1 - a^2) - p(a^1, a^2) \geq 0 \quad (7)$$

⁴Had we allowed for information to be revealed between countries, because of the zero-sum structure of the present setting, the deterrence strategy would anyway never be a best response to the opponent's expected guns levels as shown in De Luca and Sekeris (2009).

In the appendix we show that this game always admits a unique equilibrium. Moreover, we show that in unconstrained equilibria $g^{1*} = g^{2*} = g^*$, whereas in the constrained equilibria, the unconstrained country deploys a larger army at equilibrium.

In light of Proposition 1, it is useful to comment the assumption often imposed on Guns and Butter models that in case of indifference between remaining in peace and going to war, the contestants choose peace. This assumption has just been shown to be incompatible with the enemy not observing one's own weapons' level, i.e. with information imperfections. In contexts of perfect information, however, if the contestants are perfectly indifferent between peace and war none of the decisions of playing war or peace weakly dominate each other. This makes the bias in favour of peace *ad hoc* since there *literally* exists an infinity of Nash equilibria among which only one yields "peace". It comes at no surprise, therefore, that a slight perturbation of the initial game - the introduction of trembles - leaves war as the only outcome of the game.

We now turn to the more interesting case where both countries decentralize their arming and fighting decisions.

2.3 Non centralized States

We now consider the case where both countries are decentralized. As explained above, in each country the General receives a signal on the Smith's strategy, but this signal conveys wrong information with strictly positive probability. Since in the present setting the Smiths can have but two strategies, the likelihood that a particular country's General observes the "hawk signal" (resp. dove) when his Smith actually played the dove strategy (resp. hawk) equals $\epsilon \in]0, 1[$. Interestingly, Bagwell (1995) shows that such signals are completely uninformative when restricting the analysis to pure strategies. In our setting mixed strategies will be shown to play an essential role and will therefore not be dismissed. It is nevertheless useful as a first step to impose the pure strategy restriction to clarify matters. Under this assumption, we can establish the following proposition:

Proposition 2. *When two decentralized states interact in a "Guns and Butter" model, and the Smiths imperfectly communicate their arming strategy to their respective General, the game admits two types of pure strategy Nash equilibria: war equilibria with armed contestants, and peace equilibria with weaponless countries.*

The logic of the proof is the same as in Bagwell (1995) and consists in showing that the signals are uninformative if mixed strategies are ruled out by assumption. Assume that the 4-uple $(a^1, a^2, \pi^1(s^1|a^1), \pi^2(s^2|a^2))$ is a pure strategy equilibrium of this game. Define by b^1 General 1's best response function. By the definition of an equilibrium we must have $b^1(s^1(a^1), a^2, \pi^2) = \pi^1$. But this in turn means that for any *realization* of the signal, General 1's best response must be π^1 . Indeed, General 1's optimal reaction to a^1 must be π^1 at equilibrium, even if the realization of s^1 signals a different level of armaments. As a consequence, the signal is disregarded by the General, hence implying that the Smith's best response to $b^1(a^1, a^2, \pi^2)$ must be such that $a^1(a^2(a^1), \pi^1(a^1), \pi^2(a^1)) = a^1$.

This being established, the assertion in Proposition 2 is immediately deduced. Indeed, since the only possible outcomes are peace or war, the equilibrium arming strategies can only be the ones compatible with the outcome, thus dismissing the existence of other equilibria.

Let us as a last step show the existence of these two types of equilibria. Assume w.l.o.g. that $\lambda \geq 1/2$. A (armed) pure strategy Nash equilibrium is such that $(a^1, a^2) = (a^{1h*}, a^{2h*})$, and $\sigma^i = 1$ for at least one General. The equilibrium armament levels are the same as in the centralized case. By the definition of a^{ih} , no Smith has incentives to modify his armaments level given war is expected to occur. On the other hand, for

a unilateral decision of a General to modify the game's outcome, it would be necessary that when only one General plays *fight* at equilibrium, the latter has incentives to modify his action. Either, however, $\lambda > 1/2$, S^2 plays *fight*, and no such deviation is profitable, or else $\lambda = 1/2$ and the Generals are completely indifferent between peace and war. Hence, in either case, no deviation is profitable. It is straightforward to show that the 4-uple $(a^1, a^2, \pi^1, \pi^2) = (0, 0, 0, 0)$ admits no profitable deviation either. The multiplicity of equilibria is a consequence of the Generals' total indifference between playing *fight* and *concede* when the other General plays *fight*. On the other hand, there exists but a single peace equilibrium.

Having proved the existence of the two types of pure strategy equilibria, we now introduce the possibility of playing mixed strategies. The following proposition summarizes the findings:

Proposition 3. *When two decentralized states interact in a “Guns and Butter” model, and the Smiths imperfectly communicate their arming strategy to their respective General, there always exists a mixed strategy Nash equilibrium where both war and peace occur with strictly positive probability, and where the contestants remain weaponless with strictly positive probability. Moreover, this equilibrium is unique.*

When introducing mixed strategies, the pure strategies - of course - survive as degenerate mixed strategies equilibria. The only additional equilibrium that emerges in this context is such that peace is probabilistic for, otherwise, the Smiths' best response would be to play their associated pure strategies thus implying that the Generals' mix would not be a best response. With peace occurring probabilistically, however, the Smiths' equilibrium strategy is necessarily a mix over the *dove* and the *hawk* pure strategies.

To prove uniqueness, it is sufficient to show that all the decision makers' utility functions are quasi-concave in their own decision variable. Consider first the Smiths' arming level. Since $U^w(\cdot)$ is quasi-concave in g^1 , and given that $U^{\bar{w}}(\cdot)$ is linearly decreasing in g^1 , it follows that $\varphi U^w(\cdot) - (1 - \varphi)U^{\bar{w}}(\cdot)$ is quasi-concave in g^1 for any value of φ . Moreover, $U(a^1, a^2, \sigma^1, \sigma^2, \pi^1, \pi^2)$ varies linearly in σ^1 , and in π^1 .

Next, to be able to compare the various equilibria of the game, it is useful to characterize the equilibria. In the arming stage, the Smiths *privately* decide the amount of resources to devote to purchasing weapons, while knowing that the command of the army is in the hands of their uninformed General. The motivations for arming are twofold: on the one hand a Smith will arm in expectation of his General's potential willingness to go to war, while on the other hand there is a need to defend the country in case the rival General was to adopt an offensive stance. We denote by Ψ the probability of having war. We therefore have $\Psi = 1 - (1 - \pi^1)(1 - \pi^2)$. The maximization problem of S^1 is thus given by:

$$\text{Max}_{a^1} \left\{ \Psi \left[\sigma^2 p(a^1, a^2)(R - a^1 - a^2) + (1 - \sigma^2)(R - a^1) \right] + (1 - \Psi)(\lambda R - a^1) \right\} \quad (8)$$

This allows us to (implicitly) derive S^1 's hawkish best response:

$$\Psi \sigma^2 p_1(R - a^1 - a^2) - \Psi \sigma^2 p - (1 - \Psi \sigma^2) = 0 \quad (9)$$

By comparing this FOC to (7), it is obvious that absent the third term in (9) we would obtain exactly the same reaction functions under perfect and imperfect information. This third term constitutes an additional (marginal) cost of arming when peace is the outcome of the game. Because of the utility's quasi-concavity, we have that $\tilde{a}^{1h}(a^2) < a^{1h}(a^2)$. Thus, the hawkish best response of S^1 with decentralized decisions is inferior to the one with centralized decisions, for any a^2 .

This allows us to state the following corollary of Proposition 3:

Corollary 1. *In a “Guns and Butter” model with private information, the scenario with two centralized countries gives rise to equilibria which (weakly) Pareto-dominate the equilibria of the decentralized case if the contestants' territories are not too different ($\lambda \in [\lambda_{low}, \lambda_{high}]$).*

The intuition of this result the proofs of which can be found in the Appendix is straightforward: if property rights' endowments over the total territory are too unequal, then the agents of the smaller country will have incentives in "specializing in fighting" rather than producing. By slightly modifying the standard Guns and Butter framework we have thus reached surprisingly different predictions. We have indeed shown that (potentially Pareto-superior) peaceful equilibria emerge because of the Smiths' inability to *perfectly* communicate their countries' arming strategies to their respective Generals. It could nevertheless be argued that the equilibrium selection problem characterizing our model reduces the scope of this peaceful result since the conflict equilibrium identified in the literature cannot be discarded. The following proposition allows us to overcome the equilibrium selection problem by considering a refinement of the Nash Equilibrium.

Proposition 4. *When two decentralized states interact in a "Guns and Butter" model, and the Smiths imperfectly communicate their arming strategy to their respective General, the unique Trembling Hand Perfect Equilibrium of the game is such that both war and peace occur with strictly positive probability, and the contestants remain weaponless with strictly positive probability.*

To establish this result we first show that the two pure strategy Nash equilibria are not Trembling Hand Perfect, before deducing that the mixed strategy Nash equilibrium must necessarily be the game's unique THPE since such an equilibrium always exists in the present setting. Consider first the peaceful Nash equilibrium. From Smith i 's perspective, given the assumed trembles, the situation is such that all the other decision makers play mixed strategies. As a consequence, with a strictly positive probability Smith $-i$ has played *hawk*, and either or both Generals play *fight*. Playing *dove* with unit probability can therefore not be Smith i 's best response. Similarly, the war pure strategy Nash equilibrium is not Trembling Hand Perfect since peace is expected to occur with strictly positive probability because of the trembles, thus incentivizing the Smiths to forego arming with some strictly positive probability. Lastly, since the the players' strategy space is finite, a mixed strategy equilibrium exists.

Proposition 4 conveys a powerful message since we have just shown that minor information imperfections result in a unique equilibrium where peaceful equilibria may always emerge. The tremble constitute a very convenient way of eliminating unstable equilibria.

Building on the above results, we can now turn to the hybrid scenario where a centralized state interacts with a non-centralized one.

2.4 Centralized vs non-centralized State

The decision of going to war

Assume without loss of generality that country 1 is the decentralized state. The General in country 1 does not know with certainty his country's actual level of military preparedness. General G^1 will prefer to play *concede* instead of *fight*, if the following inequality is verified:

$$\begin{aligned}
U^f(a^1, a^2, \sigma^1, \sigma^2, \pi^2) &= \sigma^1 \sigma^2 U^w(a^1, a^2) + \sigma^2 (1 - \sigma^1) U^w(0, a^2) + (1 - \sigma^2) \sigma^1 U^w(a^1, 0) + (1 - \sigma^1)(1 - \sigma^2) U^{\bar{w}}(0, \cdot) \leq \\
&\sigma^1 \sigma^2 \pi^2 U^w(a^1, a^2) + \sigma^2 (1 - \sigma^1) \pi^2 U^w(0, a^2) + \sigma^1 \sigma^2 (1 - \pi^2) U^{\bar{p}}(a^1, \cdot) + (1 - \sigma^1) \sigma^2 (1 - \pi^2) U^{\bar{p}}(0, \cdot) \\
&+ (1 - \sigma^2) \sigma^1 \pi^2 U^{\bar{p}}(a^1, 0) + (1 - \sigma^1)(1 - \sigma^2) U^{\bar{w}}(0, \cdot) = U^c(a^1, a^2, \sigma^1, \sigma^2, \pi^2)
\end{aligned}$$

Simplifying and rearranging allows us to re-write the expression as:

$$U^{\bar{w}}(a^1, 0) - U^w(a^1, a^2) \geq \frac{1 - \sigma^2}{\sigma^2(1 - \pi^2)} \left(U^w(a^1, 0) - U^{\bar{w}}(a^1, 0) \right) - \frac{1 - \sigma^1}{\sigma^1} U^{\bar{p}}(0, \cdot) \quad (10)$$

On the other hand, for peace to prevail at equilibrium it is equally necessary that the centralized leadership refrains from playing *fight*, which occurs when Condition (6) is verified. As discussed earlier (Section 2.2), for SG^2 not to strictly prefer war to peace, his payoff under peace when armed should be strictly larger than the payoff of war when both contestants are armed. This condition can easily be shown to be fulfilled (violated) for any $\lambda < 1/2$ ($\lambda \geq 1/2$). If $\lambda < 1/2$, peace is therefore the game's outcome with positive probability if the following double condition is satisfied:

$$\frac{(1 - \pi^1)(V^{\bar{w}}(., a^2) - V^w(a^1, a^2))}{V^w(0, a^2) - V^{\bar{w}}(., a^2)} \geq \frac{1 - \sigma^1}{\sigma^1} \geq \frac{1 - \sigma^2}{\sigma^2} \frac{(U^w(a^1, 0) - U^{\bar{w}}(a^1, 0)) - U^{\bar{w}}(a^1, 0) - U^w(a^1, a^2)}{U^{\bar{w}}(0, .)} \quad (11)$$

Since σ^1 and σ^2 are constrained by the interval $[0, 1]$, the two ratios $(1 - \sigma^i)/\sigma^i$ ($i = \{1, 2\}$) are simply constrained to belong to \mathbb{R} . As a consequence, there always exists a pair (σ^1, σ^2) simultaneously satisfying both weak inequalities with equality. Moreover, this pair is such that $\sigma^i \in]0, 1[$ for $i = \{1, 2\}$. Indeed, if $\sigma^1 = 0$ (σ^2), SG^2 (G^1) is always better-off by playing *fight*, while if $\sigma^1 = 1$, since the other decision maker is a centralized state, we have shown in Lemma 1 that peace can only be achieved if $\sigma^2 = 1$ as well. Following an identical reasoning, $\sigma^2 \in]0, 1[$. We can now state the following lemma:

Lemma 2. *When a centralized regime interacts with a decentralized regime in a “Guns and Butter” model and that the arming decisions are private information, there exist no weaponless equilibria.*

The intuition of this result is worth being explored since the same underlying forces drive all this section's results. The Smith in the decentralized country always arms with some strictly positive probability since, if it was ever optimal to be unarmed with unit probability, the centralized regime would anticipate such a move and would accordingly purchase weapons and declare war. Provided there is always some positive probability that country 1 is armed, should SG^2 find it optimal not to purchase guns, G^1 would always have incentives in declaring war. Hence, because the centralized regime is unable to commit not to arm *and* not to attack, arms must be purchased (in expectation) in both countries. While the fully armed situation is the same as in Section 2.2, in the present scenario we also identify a situation where peace is probabilistic. Had the decision makers in country 1 the ability to perfectly communicate, G^1 would *know* whether it would be profitable for his country to launch a war or not, and would accordingly play a pure strategy. This ignorance, however, creates scope for a probabilistic outcome.

For a mixed strategy to emerge at equilibrium in the present setting, it remains to be seen whether it is optimal for S^1 to arm probabilistically. Denoting by Ψ the probability of either, or both participants declaring war, the difference in utilities for country 1's agents between being armed and unarmed can be written as:

$$\Xi = \Psi\sigma^2 U^w(a^1, a^2) + \Psi(1 - \sigma^2)U^w(a^1, 0) + (1 - \Psi)U^{\bar{w}}(a^1, .) - [\Psi\sigma^2 U^w(0, a^2) + (\Psi(1 - \sigma^2) + (1 - \Psi))U^{\bar{w}}(0, .)]$$

For S^1 to be indifferent between his two pure strategies, therefore, we need that $\Xi = 0$. Notice that $\Xi(\Psi = 0) < 0$, Since $U^{\bar{w}}(0, .) > U^{\bar{w}}(a^1, .)$. Moreover, $\Xi(\Psi = 1) > 0$ since $U^w(a^1, 0) > U^{\bar{w}}(0, .)$ as a consequence of $\lambda < 1/2$. There exists a value of Ψ , therefore, making it optimal to arm probabilistically. We can thus claim the next proposition:

Proposition 5. *When a decentralized state interacts with a centralized state in a “Guns and Butter” model with private information, war is inevitable if the centralized state can improve his sharing of the pie through conflict. Otherwise, the unique Trembling Hand Perfect Equilibrium of the game is such that both war and peace occur with strictly positive probability, and the contestants remain weaponless with strictly positive probability.*

This result is obtained exactly as in the proof of Proposition 4.

3 Data and empirical methodology

The self-containment mechanism proposed in this paper relies rests on the breaking down of the decision making process into two separate decision makers who are allowed to communicate in an *almost* perfect manner. While from a theoretical standpoint our argument is perfectly coherent and intuitive, in this section we provide some formal tests of the main theoretical hypothesis. To that end we seek to identify whether the regime type of independent states over the period 1975-2001 influenced the likelihood of bilateral interstate militarized disputes.

The central explanatory variable - the regime type - was given a clear definition in the formal part of the paper. Less obvious, however, is the task of categorizing real-world actors and countries along these lines. To that end, we need to understand to what extent the persons responsible of a country's foreign policy are aware of their army's military preparedness which is a combination of armaments levels, technology, military expertise, intelligence and so forth⁵. According to Peter D. Feaver, a specialist in civil-military relationships, "the military assesses the risk, the civilian judges it" (2003:6). Notice that "civilian" in Feaver's terminology is defined in opposition to the military, meaning that this term is meant to designate the government. Feaver conceptualizes the civilian as the *principal* that has the ultimate word upon the *use* of the military. The military being a professional body, it possesses private information over important issues like tactics and logistics (Fearon, 2003:69). Desch (1999) and Feaver (2003) emphasize that the "civilian" fails in both having perfect knowledge of sensitive military information, and in fully controlling the military. This point is even more relevant in light of the analysis of Jervis (2010) who exposes the problems of commitment between intelligence agencies and their respective governments. Upon this reading, one may be tempted to associate democracies with decentralized regimes, and dictatorships with centralized regimes. Yet, such an approach would prove naive. For, indeed, democratic governments whose leading political figures are military officials centralize the two key military decisions. Hence, while the government remains accountable to the electorate, the informational asymmetries likely to weaken the military capacity of the country are certainly reduced. Commenting on authoritarian regimes, Huntington argues that in "personal" dictatorships, the rulers try to secure the total control of the military (Huntington, 1996). Autocracies, on the other hand, are not immune to military coups (Acemoglu et al., 2010), thus de facto implying that dictatorships may have a decentralized decision making process. Given the above discussion, we shall assume that whenever a military official participates in the highest echelons of the government - as the head of the government in pure military regimes or as a defense minister - the political regime will be categorized as a centralized one. To this end we use the Database of Political Institutions (Beck et al, 2001) which provides worldwide information about the involvement of the military in the government, either as the head of the government or a defense minister, over the 1975-2009 period. Then, according to our theoretical predictions, we should expect centralized states to experience higher probability of a militarized dispute than decentralized states, and this probability should be even higher when considering country pairs with centralized regimes.

To formulate our empirical model, we use a cross sectional time series dataset, where the cross sectional units are country (independent states) pairs. We look at each pair of countries in each year to see whether they engaged in any kind of militarized interstate dispute over the 1975 to 2001 period as coded in the Militarized Interstate Dispute database (version 3) of the Correlates of War 2 project⁶. A first observation is that a significant number of countries are nearly irrelevant for the probability of militarized disputes. These countries have been too weakly militarized and very isolated to be involved in conflicts. We thus decided to drop all countries that for more than 2 years had military-to-total personnel ratio below the 1/4 of the full

⁵Notice that in the modelling part we restrict the country's military preparedness to a single dimension: arming. The essence of the *self-containment* mechanism is captured in a unidimensional framework.

⁶We restrict the time dimension of our sample to 2001 because of data availability of Militarized Interstate Disputes.

country sample median and had no physical contiguity with another independent state. This restricts our sample to 139 countries out of the initial pool of 197 countries⁷. The number of country pairs was limited by the availability of the explanatory variables in the estimated regression, and we ended up using 6490 country pairs. Given the variation in the total number of years available per country, we obtained an average number of years per country pair of 15.4, thus resulting in a final dataset of 99877 observations.

For the purposes of our study, we consider alternative measures of the dependent variable which is a discrete binary variable that indicates whether a militarized interstate dispute occurred. The various gradations of disputes we take into consideration are *i*) the threat to use force, *ii*) the display of force, or *iii*) actual use of force. Thus the measure of conflict used herein is not only restricted to war events but equally includes less violent disputes between states. In our sample a full scale war is rather rare event, constituting only 3.61 percent of all militarized interstate disputes. Most frequently, disputes simple involve the display of force in some form of combat-free military demonstration, as well as simple use of force with no escalation to a full scale war⁸. Since full fledged wars are rare events, we chose to include all types of militarized disputes in our measure of conflict, yet, in sensitivity analysis we examine the robustness of our results when restricting the dependent variable to violent events.

The key explanatory variables in our analysis are the variables *military* and *military both*, which are dummy variables constructed from the Database of Political Institutions (Beck et al., 2001), and take the value of one when *one* or *both* countries in a country pair have a military official as the head of the state or as a defense minister. According to our theoretical findings the coefficients of both these variables must be greater than zero. Moreover, it is important to underline that the *military both* coefficient needs not be larger than the *military* coefficient for our theory to be verified. Indeed, the estimated coefficient of the variable *military both* indicates the deviation in the probability of conflict when the second country in the country pair is also centralized. Thus a positive coefficient reflects the marginal increase in the probability of observing conflict when both countries, instead of only a single one, are centralized states.

The rest of the control variables we included in the analysis are those considered as standard in the literature (see Bennett and Stam, 2004)⁹. Economic interdependence is expected to influence the likelihood of war (Barbieri and Schneider, 1999), and most of the existing empirical literature portrays a negative causal mechanism linking these two variables (see for example Oneal et al., 1997, Oneal and Russett, 1999, Oneal and Russett, 2001). To measure economic interdependence we employ a measure of trade interdependence, *Trade*, which takes a value of zero for those country pairs that have zero bilateral trade, and minus the log of the total bilateral trade over total GDP otherwise. We also employ the variable *Distance* which measures the great circle distance in kilometers between the capital cities of the two states¹⁰. Greater proximity is expected to imply a higher probability of war. Military alliances are expected to affect interstate conflicts by deterring conflict and by encouraging intervention. Yet, Bueno de Mesquita (1981) underlines the possibility that alliances sprawn conflicts among allied nations in a world where the regional balance of power evolves. Moreover, if two or more countries have concluded an agreement that necessitated to be forged by a treaty, one could expect that the potentially belligerent history between these two countries be captured by the

⁷Previous research on the probability of military conflict (e.g. Maoz and Russett, 1993 and Gartzke, 2007) also limit the dataset of country pairs by focusing solely on contiguous (directly or indirectly) country pairs. Given the modern warfare means, however, over the past twenty years a large number of military conflicts have occurred between geographically distant states. Thus our more flexible strategy proves indeed to be less restrictive since we end up excluding fewer country pairs.

⁸The Correlates of War Project has coded the type of militarized interstate incidents into four subcategories, which reflect the threat of force, the display of force and the use of force (see Jones et. al (1996) for more details). Following the existing literature (e.g. Bennett and Stam, 2004) we choose to use a binary variable instead of an ordinal- categorical variable. Robustness checks have been conducted, however, and the results presented in the following section also hold in the case of an ordinal dependent variable. All the results are available from the authors upon request.

⁹See TableA for a list of the definitions of the variables and the data sources.

¹⁰The java program and the coordinates of each capital used were found at <http://www.chemical-ecology.net/java/capitals.htm>

very existence of the need to create an alliance. The latter mechanism would suggest a positive relationship between these two variables. We therefore include the dummy variable *Alliance* which takes the value of one when a formal alliance ties two states based on the Correlates of War Alliance Dataset¹¹. To account for the military capabilities of the two states, we employ the measure *power* which is constructed as the ratio of the maximal military capability in a dyad over the dyad's total military capability. For the computation of *power* we rely on the national military capability score of the COW project¹².

Following Diehl (1983), to account for spiralling effects of mutual fear and arms escalation, we introduce the dummy variable *Arms Race* which takes the value of one when the two states' military armaments experience a rapid build up, indicating an escalation of hostility between them. We catalogize as a rapid armament cases where the three-year moving average of constant dollar military expenditure growth (taken from the Correlates of War Dataset) is larger than 8 percent for *both* states (Oneal et al. 1996).

The Democratic Peace thesis has attracted a lot of attention in the political science profession (Maoz and Russett, 1993; Gartzke, 1998, and Gartzke, 2007, and the references therein). According to this argument that dates back to Immanuel Kant, non-democracies have a high tendency to fight each other, whereas democracies tend to abstain from doing so. Moreover, the data supports the fact that there is a greater tendency for democratic regimes to be at war with non-democracies than with democracies (Maoz and Abdolali, 1989). A common characteristic among the plethora of arguments that have been proposed for explaining this empirical regularity, is the incentives of democratic and autocratic rulers are intrinsically different, thus implying that the *regime type* constitutes a good explanatory variable for interstate wars (Morgan and Campbell 1991; Levy 1994; Schultz 1998; Bueno de Mesquita et al. 1999; Levy and Razin 2004; Jackson and Morelli 2007; Conconi et al. 2010). We therefore introduce three variables *Democracy High*, *Democracy Low*, and *Democracy Pair*. The two former variables are defined as the maximum, and the minimum measures of the Polity IV score among the two countries, thus giving a sense of the democratic and autocratic bounds of any pair. The combined measure *Democracy Pair* is constructed such that it is increasing in the level of aggregate democracy in the pair¹³. Moreover, to account for sudden internal political changes that may result in leaders going to war in order to safeguard power (Levy, 1988), we introduce the dummy variable *Violence* which takes the unit value whenever a regime (either democratic or non-democratic) comes to an abrupt end according to the Polity IV dataset (i.e. whenever the polity variable takes the value of -66, -77, -88).

Economic factors may also influence the propensity of states to engage in conflict. On the one hand, economic development increases the opportunity cost of conflict, and consequently lowers the probability of engaging in a military conflict. On the other hand poor countries seldom possess the military power necessary to engage in a military contest with other states. To account for these issues, we introduce the variables *GDP per capita Low* and *GDP per capita High* which correspond, respectively, to the lowest and highest logarithm of the GDP per capita in the country pair, as well as the variables *Growth low* and *Growth High* which measure the lowest and highest growth rates of GDP per capita in the country pair¹⁴.

To capture the regional variability in interstate conflict (e.g. Lemke, 2002), we introduce regional dummies for each state in the pair for the regions of South and North America, Africa, Middle East, Asia and Europe. Finally, to account for the variability of the world economic activity, political leadership, and international system polarity, which are all very important for the period under consideration (1975-2000), we

¹¹see Small and Singer, 1969.

¹²The national material capability score is constructed as a weighted average of the a state's share of total system population, urban population, military personnel and military expenditure (see Singer et al. 1990)

¹³*Democracy Pair* is given by the ratio $\frac{\text{democracy high} + \text{democracy low}}{\text{democracy high} - \text{democracy low} + 1}$ and therefore spans from -20 (at the limit) for the most autocratic pair, to +20 (at the limit) for the most democratic pair.

¹⁴All variables were taken from Penn World Tables version 6.3

introduce fixed time effects in the estimated equation¹⁵.

The econometric model under consideration has the following specification:

$$\Pr[\text{war}_{ij,t} = 1] = F(b_1\text{military}_{ij,t} + b_2\text{military_both}_{ij,t} + \text{Controls}_{ij,t}'c + \lambda_t + d_{ij,t}) \quad (12)$$

the probability that the state dyad ij will be involved in a military conflict at period t is determined by the density function F . We assume that F is the logistic function, and thus estimate a logit model. Notice, however, that we examine the sensitivity of our results under the assumption that F is the normal density function (i.e. the probit model).

4 Results

Table 2 presents the main results. In column 1 a conditional logit is estimated, which is the main model of our analysis. The first panel presents the estimated coefficients and the t-statistics (in brackets), whereas the second panel presents the odds ratio. These results confirm the theoretical predictions since they indicate that dyads where one country centralizes the arming and fighting decisions tend to have a higher probability of an armed conflict, with this probability being higher when both states in the dyad are centralized. The estimated odds ratio also suggests that this effect is quantitatively not negligible: states with a military officer in the head of the state or in the ministry of defense have 80% higher probability of an armed conflict compared to states where there is no involvement of the military in the government. Moreover when the other state also has a military officer in the government the probability of an armed conflict is 56.7% higher, thus implying that a dyad featuring two centralized governments is more than twice more likely of being at war as compared to a dyad with two decentralized states.

Regarding the other explanatory variables, *trade* is statistically significant at the 1 per cent level of statistical significance, and the respective odds ratio reveals that a one percent decline in the amount of trade between the two states results into a 3.5% higher probability of conflict. Moreover, consistently with conventional wisdom, the *Distance* coefficient is negative and highly statistically significant, thus suggesting that contingent states are more likely to engage in military disputes.

Table 1 reveals that a larger difference in military capabilities between the two states, as captured by the variable *power*, is associated with a lower probability of war. This finding would tend to support the Power Transition theory (Organski 1958, Organski and Kugler 1980) as opposed to the Balance of Power theory (Morgenthau 1960), in a debate in the political science literature that is still waging on. The coefficients on *Democracy High*, *Democracy Low*, and *Democracy Pair* are consistent with the existence of a “Democratic Peace”. Our results suggest that countries that face an internal conflict have a lower probability of conflict. Stated otherwise, when two countries are facing a long standing latent dispute, the confrontation is more likely to escalate into a military conflict when the domestic political legitimacy of the governments goes unchallenged (Bennett and Stam 2004). Lastly, the coefficient of the variable *Arms Race* is always highly insignificant, and changes signs across specifications.

With respect to the economic variables, the coefficients of *GDP per capita Low* and *GDP per capita High* are consistent with both theories linking income levels to the incidence of conflicts. On the one hand, the view that a higher opportunity cost of war is associated with lower probabilities of conflict is confirmed

¹⁵Ideally we should include both time and dyad fixed effects in the estimated equation. However there is no estimator for a fixed effects limited dependent variable model with both time and country effects. Moreover opting for the alternative estimation featuring only dyad effects would result into throwing away more than 95% of our sample as the fixed effects model drops all units that never conflict. To make matters worse the model would be misspecified since we take time effects to be important determinants for the probability of conflict. Then if we have already included in the regression all the factors that explain conflict in each state pair it would be preferable to omit the dyad fixed effects (which would turn out insignificant) and introduce only the time fixed effects.

by the positive coefficient of *GDP per capita High*, even though the coefficient is (barely) statistically insignificant. On the other hand, poor states are more prone to engage in a military contest when their income rises, thus confirming the thesis that poor actors may be disciplined because of budget constraints.

The *Alliance* coefficient may appear perplexing at first view since our empirical predictions point at a highly significant positive coefficient, and the odds ratio reveals that “allied” countries are 3.5 times more likely to be at war. Yet, these findings are in accordance with Bueno de Mesquita’s (1981) intuition that alliances are often concluded in fragile and volatile environments.

In the remaining columns in Table 1, we explore the validity of our results by estimating various specifications. In columns 2–4, we present, a Logit model with no time effects (column 2), a Logit model with time dummies (i.e. unconditional Fixed Effects model- column 3), and a Random Effects Logit model (column 4). In Column 5 we show the results of an Ordered Logit with Fixed Effects, where the dependent variable is an ordinal variable with the level of militarized incidents being categorized into four subcategories: a) the threat of force, b) the display of force and c) the use of force, and d) war. Finally a probit model (column 6) is presented. As one can observe, all the results of the initial regression remain unchanged, thus implying that our conclusions are robust to the specification of the model.

In Table 2 a series of sensitivity analyses is performed. All estimations are based on the Logit Fixed Effects model (as in column 1 of Table 1). We first re-estimate the model after excluding country pairs that may be outliers in our relationship. Specifically in column (1) we exclude all dyads where at least one state belongs to NATO and in column (2) we exclude from the sample the United States. The purposes of this truncation of the sample is to exclude the major military power for the time-period under consideration. In column (3) we exclude from the sample countries that experience internal conflict. Interestingly, all the results of the main specification remain unchanged.

One possible criticism to our approach is that when military officials are involved in the political decision-making process, we may observe a higher probability of conflict due to the fact that military officers are biased in favor of war, either for ideological reasons, or else due to rent-seeking motivations of the military. In either of these cases, however, one should expect the bias of the military for war to be less pronounced in democratic regimes, where the electorate constrains the behaviour of such biased governments. To test this assumption we interact the variables *military* and *military both* with a dummy variable that takes the value of one when the polity score of both countries in the dyad is greater than zero. Then we re estimate the main equation adding these two interaction variables and test their joint statistical significance. Column (4) presents these results. One can see that there is no significant change on the other estimated coefficients. Moreover the joint chi-square test of the hypothesis that the interaction effect of *military* and *military both* is different across democracies and non-democracies cannot be accepted at the 10% level of statistical significance ($\chi^2 = 4.37$).

Another potential explanation for the higher probability of conflict when the military participates in the government is the fact that nations that forecast an imminent military confrontation assign military officers as defense ministers or as head of the state in order to increase the country’s military effectiveness in the upcoming conflict¹⁶. To account for this possibility we re-estimate the main equation using lagged values for the main variables of interest, *military* and *military both*. The results are presented in column (5). Once again, we obtain no significant differences to our previous results.

Finally in column (6) we estimate our main regressions while considering a more restrictive measure of conflict: cases only featuring the threat to use force are no longer considered to be instances of conflict¹⁷.

¹⁶Notice that this explanation does not totally contradict our argument, for, indeed, our theoretical prediction stresses *both* the higher capacity of a centralized government to defend the country’s interests if a war was to occur, *and* the higher probability of a centralized country going to war. Hence our main hypothesis is consistent with either story where the military officials occupy key political positions for the above-stated reasons or for other ones.

¹⁷We consider the dependent variable to take the value of one, when the variable HostLev of the Correlates of War Database takes a

As one can see in Table 2, the probability of interstate military confrontation (display or use of force) is significantly higher when there is military involvement in the government.

5 Conclusion

In this paper we propose a novel mechanism for potentially conflictive parties to credibly commit not to divert productive resources to appropriative activities, and thereby not to get trapped in inefficient conflicts. When the arming and fighting decisions are assigned to distinct decision makers, i.e. a Smith and a General, the amounts of weapons purchased by the Smith are private information. In a situation of perfect information, war would have been unavoidable because the inability of contestants to commit not to arm implies that at equilibrium weapons are unavoidably produced, and in zero-sum games settings it is always in the interest of one player to launch a war. If the transmission of information by the Smith to the General is not completely immune to mistakes, however, the latter cannot dismiss the possibility that the former arms in expectation of peace when in fact he is preparing for war. The General is therefore more reluctant to declare war as compared to a perfect information scenario. On the other hand, however, a General that would otherwise have sought to achieve peace (under perfect information) will turn out to adopt a more aggressive stance because of the possibility that the opponent is defenceless. Despite this second effect, there is a strictly positive probability that peace prevails when the flow of information is imperfect. This constitutes the first major contribution of this paper: decentralizing arming and fighting decisions produces peaceful outcomes when war would otherwise have occurred. From this finding stems a second one which is economically more relevant. In expectation of peaceful outcomes, the Smiths will forego from arming with a strictly positive probability. Moreover, if a Smith does arm, the amounts of guns purchased will be lower than under a centralized decision-making setting since the opponent is expected not to be armed with a positive probability. We thus conclude that the prospect of peaceful outcomes enables the Smiths to reduce the waste of resources in arms investments by a double token: (i) the arms are less likely to be used, thus it is optimal to acquire fewer guns, and (ii) since the rival reduces his military preparedness, it is equally optimal to downsize one's own army. Notice that throughout this paper we make the assumption that war is a zero-sum game to have a benchmark model where war is inevitable. The commitment mechanism identified in this setting is nevertheless directly extendable. One can anticipate that this commitment device is likely to generate peaceful outcomes even in such settings as in Jackson and Morelli (2007) where war is conceptualized as a positive sum game.

The theoretical analysis was restricted to a particular class of games which is widely validated by conflict scholars. It is nevertheless essential to understand that the essence of the commitment mechanism identified in this paper extends to alternative settings. *Self-Containment* consists in credibly committing not to fully abide to the arms race rules by delegating to an independent body part of one's own decisions. It bears emphasis that this mechanism is rooted in the inability of the distinct decision makers to perfectly communicate. Thus, contrary to most of the existing contributions in the literature on conflicts, informational imperfections can have a salvaging effect in our setting. Indeed, rather than hampering potential peaceful bargains, informational asymmetries allow the players to commit not to arm, and hence not to attack each other.

According to our findings, while two centralized states are the most likely to go to war, the probability of having war in the intermediate scenario involving a centralized and a decentralized state is higher than when both contestants are decentralized. Equipped with these theoretical predictions, we embarked on the task of confronting our findings with reality. To that end we sought to determine whether having a military official

value greater than 3, which corresponds to display of force, use of force and war.

as the head of the government (in purely military regimes) or as defense minister increased the propensity of nations of getting involved in militarized incidents. We ran our conditional logit regression on a sample of dyads over the 1975-2001 period, and show that having a centralized state in a dyad increases the likelihood of conflict by 80%, while when both nations have military officers occupying key political positions, the likelihood of observing militarized incidents more than doubles as compared to a dyad composed of decentralized governments. Our results were found to be robust to a host of alternative specifications. Most importantly, perhaps, by interacting the degree of political centralization with a dummy variable for democratic regimes, we show that our results are not driven by intrinsic preferences of self-regarding military officers to go to war. Hence, our empirical analysis provides convincing evidence that the channel through which states with politically relevant military officers are more bellicuous is informational. Alternatively, countries with highly separated political and military spheres tend to be more peaceful because of the failure of political and military decision-makers to perfectly anticipate each other's moves. Decentralized countries manage to credibly commit to *self-contain* their bellicosity because of informational imperfections.

A Appendix

Existence:

To establish the quasi-concavity of the players' utility in their own action, we look at the problem from country 1's perspective (the reasoning applies to country 2). The second order derivative of U^w w.r.t. a^1 is given by:

$$U_{11}^w = p_{11}(a^1, a^2)(R - a^1 - a^2) - 2p_1(a^1, a^2)$$

To obtain that $U_{11}^w < 0$ when $a^2 > 0$ it is thus sufficient to show that $p_{11} < 0$. Computing this expression yields:

$$p_{11} = \frac{F''(a^1)F(a^2)(F(a^1) + F(a^2)) - 2(F'(a^1))^2 F(a^2)}{(F(a^1) + F(a^2))^3} < 0$$

When, on the other hand, $a^2 = 0$, quasi-concavity follows from the fact that $p(a^1, 0) = 1 > \lambda$ for any $a^1 > 1$.

Because of the discontinuity of the players' utility in their decision variable in the vicinity of $(0, 0)$, existence could be jeopardized. To establish existence despite this discontinuity, it is sufficient to show that $a^1(a^2) \neq 0, \forall a^2$. We have already shown in section 2 of the paper that $a^1(0) > 0$. To prove existence, it is therefore sufficient that $U_1^w(0, a^2) > 0, \forall a^2 > 0$. Replacing $a^1 = 0$ in the F.O.C. of SG^1 yields:

$$U_1^w = p_1(0, a^2)(R - a^2)$$

And this expression is necessarily positive.

Unicity

To show unicity, we first derive the equilibrium values of armaments. At an interior equilibrium, (7) is satisfied with equality, and the equivalent holds true for L^2 . Using these conditions together yields the following equilibrium condition:

$$\frac{p_1(a^{1*}, a^{2*})}{p(a^{1*}, a^{2*})} = -\frac{p_2(a^{1*}, a^{2*})}{1 - p(a^{1*}, a^{2*})} \Leftrightarrow \frac{f'(a^{1*})}{f(a^{1*})} = \frac{f'(a^{2*})}{f(a^{2*})} \Rightarrow a^{1*} = a^{2*} = a^* \quad (\text{A-1})$$

with the last implication being a direct consequence of the concavity of function $f(\cdot)$.

Assume the equilibrium is not unique. Then there exists some other equilibrium pair of armaments $(a^{1'}, a^{2'})$, such that $a^{1'} = a^{2'} = a'$. Assume w.l.o.g. that $a' > a^*$. Rewriting the F.O.C. and replacing by the equilibrium levels of weapons we have that:

$$p_1(a^*, a^*)(R - 2a^*) = 1/2 = p_1(a', a')(R - 2a')$$

For these inequalities to hold, since $a' > a^*$, we need that $p_1(a', a') > p_1(a^*, a^*)$. Replacing in the previous inequality for the first derivative of $p(\cdot)$ yields:

$$\frac{1}{4F(a')} > \frac{1}{4F(a^*)} \Leftrightarrow F(a^*) > F(a')$$

And this last inequality violates $a' > a^*$.

If the equilibrium is not interior, it is straightforward to show it is also unique. Assume w.l.o.g. that $\lambda > 1/2$. We first show that if some country is budget constrained, it is necessarily the smaller one. Indeed, suppose this is not the case. Assume therefore that $a^{1*} = \lambda R > a^{2*}$. Combining $U_1^w(\lambda R, a^2) > 0$ with $V_1^w(\lambda R, a^2) = 0$, allow us to obtain:

$$\frac{p_2(\lambda R, a^2)}{1-p} < \frac{p_1(\lambda R, a^2)}{p} \Rightarrow a^1 < a^2$$

But this last inequality cannot be true since $a^1 = \lambda R > (1-\lambda)R > a^2$. On the other hand, if SG^2 is budget constrained, we conclude that $a^2 < a^1$ which violates no condition. The single-valuedness of $a^1(a^2)$ guarantees the uniqueness of such equilibria.

Proof of Corollary 1

To show this result notice first that in the fully symmetric scenario ($\lambda = 1/2$), the private information scenario (weakly) Pareto dominates the perfect information scenario. Indeed, since the Smiths' reaction functions produce less guns when expecting the other players to play mixed strategies than under the war equilibrium, at the mixed strategy equilibrium both Smiths arm less than in the war equilibrium. Moreover, the (unique) mixed strategy equilibrium in the symmetric case is such that the same decision variables across the two countries take the same values, thus implying that the expected probability of winning a potential war equals $1/2$ for both countries. Imagine this is false, and that there exists an equilibrium described by the 6-uple $(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, \tilde{\sigma}^1, \tilde{\sigma}^2)$, such that $\tilde{\sigma}^1 \neq \tilde{\sigma}^2$. Denote the associated equilibrium probability of having a war by Ψ . Next, by the definition of a mixed strategy equilibrium, we have $U(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, 0, \tilde{\sigma}^2) = U(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, 1, \tilde{\sigma}^2)$. Given, however, that $\tilde{\sigma}^1 \neq \tilde{\sigma}^2$, it follows that $U(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, 0, \tilde{\sigma}^2) \neq V(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, \tilde{\sigma}^1, 0)$. Assume, w.l.o.g. that the former is larger to the latter. Writing the utilities as a function of the arming probabilities alone, we can thus deduce the following inequality:

$$\Psi U^w(0, \tilde{\sigma}^2) + (1-\Psi)U^{\bar{w}}(0, \tilde{\sigma}^2) > \Psi V^w(\tilde{\sigma}^1, 0) + (1-\Psi)V^{\bar{w}}(\tilde{\sigma}^1, 0)$$

Since the utility of a weaponless contestant facing an armed one is nil, this inequality reduces to $\lambda > 1/2$, which violates symmetry. Since mixed strategy equilibria necessitate that $\sigma^1 = \sigma^2$, to prove uniqueness it is sufficient to show that there cannot exist two distinct mixed strategy equilibria involving different probabilities of observing war. Indeed, imagine that two such equilibria exist, and that $\tilde{\Psi} > \hat{\Psi}$. Since the likelihood of conflict is higher under the former equilibrium, it is easy to show that the equilibrium amounts of weapons are larger under that equilibrium such that $\tilde{a}^{1*} = \tilde{a}^{2*} > \hat{a}^{1*} = \hat{a}^{2*}$. We equally know that $U(0, \tilde{\sigma}^2) = U(1, \tilde{\sigma}^2)$, which, after replacing and re-writing reads $\tilde{\Psi}\tilde{a}^{1*} = (1-\tilde{\Psi})U^w(1, \tilde{\sigma}^2)$. Since $\tilde{\Psi} > \hat{\Psi}$, and $\tilde{a}^{1*} > \hat{a}^{1*}$, at the alternative equilibrium the LHS of the analogous expression must be smaller than $\tilde{\Psi}\tilde{a}^{1*}$. Moreover, for the same reason, the RHS should be larger, i.e. $(1-\hat{\Psi})U^w(1, \hat{\sigma}^2) > (1-\tilde{\Psi})U^w(1, \tilde{\sigma}^2)$, thus implying that the equality cannot be verified. Since $\tilde{\sigma}^1 = \tilde{\sigma}^2$, it is straightforward to show that this implies $U^w(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, \tilde{\sigma}^1, \tilde{\sigma}^2) = V^w(\tilde{a}^1, \tilde{a}^2, \tilde{\pi}^1, \tilde{\pi}^2, \tilde{\sigma}^1, \tilde{\sigma}^2)$, as a consequence of which $\tilde{a}^1 = \tilde{a}^2$ and $\tilde{\pi}^1 = \tilde{\pi}^2$. We therefore conclude that the mixed strategy equilibrium Pareto dominates the war equilibrium since both equilibria yield the same expected winning probabilities, while under the former one less resources are wasted in arming. As for the peaceful equilibrium, it Pareto dominates the two other equilibria, since $\lambda = p^* = 1/2$, while no resources are devoted to armaments.

Define by $\bar{\lambda}$ the value of λ above which Smith 2 would be budget constrained in the war equilibrium. When $\lambda = \bar{\lambda}$ then, at the war equilibrium $a^{2*} = (1-\bar{\lambda})R$. Define similarly $\underline{\lambda}$ as the minimal value of λ below which the analogous condition would hold for Smith 1. For $\lambda \in [\underline{\lambda}, \bar{\lambda}]$, the war equilibrium is the same as in

the symmetric case and rewards the players with payoffs $R/2 - a^*$, with a^* implicitly defined in Condition (7). In $\lambda = \underline{\lambda}$, the peace equilibrium is preferred to the war equilibrium by both players if $U^{\bar{w}}(\underline{\lambda}) - U^w(\underline{\lambda}) > 0$, which, replacing by the above expressions and rearranging yields $\underline{\lambda} > 1/4$. Similarly, at $\lambda = \bar{\lambda}$, agents in country 2 are better off under peace than under war if $\bar{\lambda} < 3/4$. If $a^{w*} < 1/4$, then $\lambda_{low} = 1/4$, and $\lambda_{high} = 3/4$. To establish this we still need to show that for both $\lambda \in [0, \underline{\lambda}]$, and $\lambda \in [\bar{\lambda}, 1]$, at least one agent prefers war to peace. Take any $\lambda' < 1/4$. An agent in country 1 will prefer peace to war if $U^{\bar{w}}(\lambda') - U^w(\lambda') > 0$, which, after simplifying, can be written as $\lambda' R + a^2(\lambda' R) > R/2$. Because $a_1^2(\cdot) \gtrless 0 \Leftrightarrow a^2 \gtrless a^{118}$, for any $a^1 < 1/4$ we necessarily have that $a^2 < 1/4$, thus implying that war is preferred to peace by country 1's agents. A symmetric reasoning applies to $\lambda' > \bar{\lambda}$. If $a^{w*} \geq 1/4$, we equally need to show that λ_{low} exists. Since $a^2(a^1)$ is monotonically increasing in a^1 for any $a^1 < a^*$, it is sufficient to show that the inequality $\lambda R + a^2(\lambda R) < R/2$ holds for some $\lambda < 1/2$. But this has been shown to be true for any $a^1 < 1/4$.

¹⁸Applying the implicit functions theorem on condition 7 allows us to obtain $a_i^1 = -\frac{p_{12}(R-a^1-a^2)-p_1-p_2}{p_{11}(R-a^1-a^2)-2p_1}$. The denominator is always negative, while the sign of the numerator can be shown to be given by the difference $(a^1 - a^2)$.

	Definition	Source
War (dependent variable)	Dummy equal to 1 if Militarized Interstate Dispute is coded 2 or above	Correlates of War Militarized Interstate Disputes dataset
Trade	Minus log of bilateral trade flows between the two countries over the joint GDP	IMF Trade Statistics
Military	Dummy equal to one when one country has a military official as Head of their government or as a defense minister	Beck et al (2010)
Military both	Dummy equal to one when both countries have a military official as Head of their government or as a defense minister	Beck et al (2010)
Democracy both	$(\text{democracy high} + \text{democracy low}) / (\text{democracy high} - \text{democracy low} + 1)$	Polity IV
democracy High	The maximum of the Polity 2 score in the country pair	Polity IV
democracy low	The minimum of the Polity 2 score in the country pair	Polity IV
Distance	Great circle distances in km between capitals of the two countries	http://www.chemical-ecology.net/java/capitals.htm
Alliance	Dummy equal to 1 if both countries have a formal alliance	Correlates of War Alliance Dataset
Arms Race	Dummy equal to 1 if both countries have experienced for three years an increase of more than 8% in their total defense spending	Correlates of War National Material Capabilities dataset
Violence	Dummy equal to 1 if polity in at least one state in the dyad is equal to -66, -77, -88	Polity IV
Power	The maximum of the Composite Index National Capabilities score (CINC) in the dyad divided by the total CINC score	Correlates of War National Material Capabilities dataset
GDP per capita low	The minimum of the real GDP per capita in the dyad	Penn World Tables
GDP per capita high	The maximum of the real GDP per capita in the dyad	Penn World Tables
growth high	The maximum of real growth in GDP in the country dyad	Penn World Tables
growth low	The minimum of real growth in GDP in the country dyad	Penn World Tables

Table 2 - Logit and Probit Regressions for the Incidence of Bilateral Wars: The Role of Military Officials' Presence in the Government's High Ranks

Dep Variable	(1)		(2)		(3)		(4)		(5)		(6)	
	war		war		war		war		hostlev		war	
	Conditional		Cross		Logit with time		Random Effects		Ordered		Probit	
	Logit		Section		dummies		Logit		Logit		Probit	
Trade	-0.035*** (-6.280)	0.965	-0.034*** (-6.080)	0.966	-0.036*** (-6.287)	0.965	-0.035*** (-6.156)	0.966	-0.034*** (-6.198)	0.966	-0.013*** (-6.048)	
Military	0.588** (2.255)	1.800	0.588** (2.328)	1.801	0.589** (2.255)	1.802	0.588*** (4.205)	1.780	0.577** (2.299)	1.780	0.233** (2.395)	
Military Both	0.449** (2.130)	1.567	0.436** (2.096)	1.547	0.451** (2.135)	1.571	0.444*** (3.139)	1.572	0.452** (2.144)	1.572	0.174** (2.333)	
Democracy Pair	-0.057*** (-3.180)	0.945	-0.061*** (-3.483)	0.941	-0.057*** (-3.180)	0.945	-0.058*** (-3.915)	0.942	-0.060*** (-3.380)	0.942	-0.027*** (-3.752)	
Democracy High	0.056*** (2.826)	1.058	0.061*** (3.193)	1.062	0.056*** (2.825)	1.058	0.058*** (4.125)	1.062	0.060*** (3.113)	1.062	0.021*** (3.238)	
democracy Low	0.005 (0.385)	1.005	0.013 (1.042)	1.014	0.005 (0.384)	1.005	0.008 (0.562)	1.014	0.014 (1.110)	1.014	0.007 (1.452)	
Distance	-0.659*** (-17.336)	0.517	-0.659*** (-17.294)	0.517	-0.660*** (-17.327)	0.517	-0.660*** (-18.629)	0.516	-0.661*** (-17.515)	0.516	-0.220*** (-14.975)	
Alliance	0.930*** (6.200)	2.533	0.895*** (6.243)	2.448	0.931*** (6.200)	2.538	0.919*** (5.842)	2.439	0.892*** (5.950)	2.439	0.365*** (7.602)	
Violence	-0.710** (-2.249)	0.492	-0.717** (-2.256)	0.488	-0.712** (-2.250)	0.491	-0.714** (-2.443)	0.489	-0.715** (-2.251)	0.489	-0.264** (-2.212)	
Arms Race	0.107 (0.786)	1.113	-0.067 (-0.489)	0.935	0.107 (0.786)	1.113	0.044 (0.329)	0.943	-0.059 (-0.432)	0.943	-0.038 (-0.731)	
Power	-1.077*** (-3.735)	0.341	-1.018*** (-3.602)	0.361	-1.079*** (-3.735)	0.340	-1.058*** (-2.986)	0.357	-1.031*** (-3.669)	0.357	-0.372*** (-3.397)	
GDP per capita Low	0.104* (1.788)	1.110	0.114* (1.914)	1.121	0.105* (1.794)	1.110	0.108 (1.380)	1.118	0.112* (1.827)	1.118	0.047** (2.055)	
GDP per capita High	-0.116 (-1.539)	0.890	-0.108 (-1.388)	0.897	-0.117 (-1.537)	0.890	-0.114 (-1.436)	0.886	-0.121 (-1.562)	0.886	-0.039 (-1.380)	
Growth High	0.020 (1.579)	1.020	0.022 (1.605)	1.022	0.020 (1.579)	1.020	0.021*** (2.680)	1.022	0.022 (1.566)	1.022	0.008 (1.595)	
Growth Low	-0.022*** (-2.938)	0.978	-0.016** (-2.307)	0.984	-0.022*** (-2.933)	0.978	-0.020** (-2.083)	0.984	-0.016** (-2.258)	0.984	-0.007*** (-2.680)	
Constant			-4.346*** (-4.595)		-4.474*** (-4.870)		-4.302*** (-4.879)				-2.372*** (-7.314)	
Log-Likelihood	-1947.314		-2046.057		-2005.922		-2035.634		-2374.789		-2064.783	
obs	99877		99877		99877		99877		99877		99877	
Country-Pairs	6490		6490		6490		6490		6490		6490	
Likelihood ratio test	f(1) 1122.38		1111.43		1191.70		309.93		1114.22		1073.98	
McFadden-R2	0.21		0.20		0.21				0.18		0.20	

Clustered t statistics in the parenthesis. Second column denotes odds ratio. *, **, *** denotes statistical significance at 10%, 5%, 1% level of statistical. The second panel in each column is the odds ratio

Table 3 - Regressions for the Incidence of Bilateral Wars: Robustness Checks

	(1) war	(2) war	(3) war	(4) war	(5) war	(6) war2					
	Excluding NATO Country Pairs	Excluding the USA	Excluding countries that experience internal conflict	Different effect of military on democracies	Lagged military and military both	different definition of war (hostlev>=3)					
Trade	-0.036*** (-6.021)	0.964	-0.041*** (-6.954)	0.960	-0.038*** (-6.798)	0.962	-0.036*** (-6.094)				
Military	0.586** (2.173)	1.796	0.559** (2.176)	1.748	0.614** (2.363)	1.848	0.374 (1.422)	1.454 (1.959)	0.567** (2.134)		
Democracy*military											
Military Both	0.454** (2.208)	1.574	0.532** (2.389)	1.702	0.388* (1.731)	1.474	0.495** (2.369)	1.641	0.482** (2.261)		
Democracy*military both							-0.116 (-0.396)	0.891			
Military (-1)								0.632** (2.389)	1.880		
Military both (-1)								0.503** (2.409)	1.654		
Democracy Pair	-0.036** (-1.974)	0.964	-0.038** (-1.963)	0.962	-0.061*** (-3.271)	0.941	-0.051*** (-3.074)	0.950	-0.064*** (-3.354)	0.938	-0.056*** (-3.139)
Democracy High	0.048** (2.381)	1.049	0.036 (1.580)	1.036	0.058*** (2.830)	1.060	0.055*** (2.752)	1.056	0.061*** (2.686)	1.063	0.056*** (2.859)
democracy Low	-0.000 (-0.027)	1.000	0.010 (0.845)	1.010	0.008 (0.582)	1.008	-0.023 (-0.971)	0.977	0.008 (0.604)	1.008	0.006 (0.425)
Distance	-0.639*** (-16.510)	0.528	-0.717*** (-16.340)	0.488	-0.655*** (-18.910)	0.520	-0.666*** (-16.902)	0.514	-0.691*** (-18.256)	0.501	-0.657*** (-17.341)
Alliance	1.006*** (4.279)	2.734	0.875*** (5.722)	2.399	0.955*** (6.356)	2.599	0.965*** (5.942)	2.626	0.908*** (5.368)	2.479	0.943*** (6.315)
Violence	-0.727** (-2.267)	0.484	-0.813** (-2.326)	0.444			-0.690** (-2.121)	0.501	-0.655** (-2.122)	0.519	-0.703** (-2.192)
Arms Race	0.054 (0.382)	1.056	0.145 (1.087)	1.156	0.086 (0.590)	1.090	0.098 (0.726)	1.103	0.163 (1.236)	1.177	0.123 (0.884)
Power	-1.179*** (-4.031)	0.307	-1.323*** (-3.760)	0.266	-1.140*** (-3.973)	0.320	-1.093*** (-3.720)	0.335	-1.179*** (-4.491)	0.308	-1.059*** (-3.491)
GDP per capita Low	0.127** (2.217)	1.135	0.158** (2.402)	1.172	0.121** (2.034)	1.128	0.112** (2.008)	1.119	0.129** (2.364)	1.138	0.101* (1.666)
GDP per capita High	-0.119 (-1.498)	0.888	-0.216** (-2.520)	0.806	-0.105 (-1.349)	0.900	-0.119 (-1.564)	0.888	-0.098 (-1.283)	0.907	-0.111 (-1.452)
Growth High	0.019 (1.416)	1.019	0.016 (1.165)	1.016	0.021 (1.237)	1.021	0.020 (1.568)	1.021	0.021 (1.612)	1.022	0.021* (1.747)
Growth Low	-0.020** (-2.541)	0.980	-0.017** (-2.263)	0.983	-0.022*** (-2.828)	0.978	-0.022*** (-2.892)	0.978	-0.025*** (-3.058)	0.976	-0.023*** (-2.939)
Log-Likelihood	-1872.175		-1709.057		-1875.592		-1943.543		-1769.979		-1928.712
obs	97913		97860		95218		99877		91662		99877
Country-Pairs	6374		6413		6378		6490		6490		6490
Likelihood ratio test(fi	1066.58		1160.47		1084.22		1129.92		1102.33		1106.80
McFadden-R2	0.21		0.24		0.21		0.21		0.23		0.21
F-chow							4.369301				

Clustered t statistics in the parenthesis. Second column denotes odds ratio. *, **, *** denotes statistical significance at 10%, 5%, 1% level of statistical. The second panel in each column is the odds ratio

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