War and Wealth*

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Abstract

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1 Introduction

The rich history of war provides evidence of its devastating consequences and of the wide variety of circumstances that lead to it.[1] While there is much that we know about wars, there is still much to be learned about how the choices to go to war differ across countries and circumstances, and in particular how this relates to economic situations and political regimes. Although religious and ethnic conflicts have played key roles in many wars, balance of power, territorial disputes, expansion of territory, and access to key resources or wealth are often either involved or the primary driving force behind wars.[2] In this paper, we build a simple model of war that builds on these more political and economic incentives.

We propose a simple model of war, aiming to make several contributions. First, the model allows us to examine the relationship between the political structure of countries and their incentives to go to war and ability to bargain to avoid a war. Second, in our model it is possible for two countries to go to war even though they both have complete information about the relative likelihood of winning, and even though they could bargain and make payments to avoid war, and war burns resources. Third, the model allows us to analyze what the role of bargaining and transfers are in avoiding war. In particular, we examine which countries will be willing to make transfers to avoid a war, when such transfers will be sufficient to avoid a war, and how this depends on the ability of countries to sign binding treaties.[3]

Our model of war is simple in its structure. Two countries are faced with a possible war, and each know the probability of their winning given their respective wealth levels. If a war ensues, there is a cost to each country of waging war, and then the victor claims a portion of the loser's wealth. The incentives of each country thus depend on the costs, the potential spoils, and the probability that each will win.[4] If either country wishes to go to war then war

[1] See for example Blainey (1973) and Kaiser (1990).

[2] ...

[3] By transfers we do not refer to explicit monetary transfers only (like the purchase of Alaska, Louisiana, or the conceived purchase of Cuba, discussed in Luard (????)); we also refer to transfers of territory, control over seas, and even implicit transfers of wealth and control linked to the marriages between royal families across Europe up to the end of the 19th century.

[4] Historians of economic thought characterize such a mercantilist view as a zero-sum game among country leaders for a finite and fixed amount of resources. Foreign policy and international relations are fields where the mercantilist view (or the realist view, as they call it in IR) is still one of the prevailing interpretations. For us, it is just a reasonable simplification of country leaders' motivations, without any ideological judgement. In fact, in international relations the realist view is generally at odds with a democratic peace view, whereas our approach is "reconciliatory", because we will show that when a country's decision maker varies with the political regime, rather than being the State like in the pure realist approach, the results of the democratic

ensues. Having analyzed the basic incentives to go to war, we then examine the incentives of countries to offer to make (or receive) some transfer in order to forgo a war. In some cases such bargaining will avoid a war, and in others it will not. We characterize when such bargaining avoids a war and when war is inevitable.

The way in which we tie the analysis back to political structure is crude but powerful. In particular, we model a country's decisions through the eyes of the pivotal decision-maker in the society. In a totalitarian regime, this is simply the ruler. In an oligarchy, this is the pivotal oligarch, depending on the rules by which decisions are made. In a pure democracy, this is the median voter. In an indirect democracy, this may be an elected official or officials. We characterize differences in countries by differences in these pivotal agents.[5] A decision to go to war will depend on the relative costs and benefits that the pivotal agent expects from a war. If the agent has little at risk, but much to gain, then war is more likely. In contrast, when the agent has much at risk relative to potential benefits, then the pivotal agent would like to avoid a war.

One plausible (but clearly only approximate) interpretation of the relative benefits to costs of a war relates to the political structure of the country. That is, a plausible measure of how democratic the country is, is the ratio between the share of benefits and the share of costs deriving from a decision for it's pivotal decision maker. A high benefit/cost share ratio for the pivotal agent could stem from a less democratic political regime, since the decision of a small group benefits them relative to the rest of the population and they do not bear as large a share of the costs.

We should emphasize that our model also provides a new explanation for the observation of the democratic peace literature (according to which two democracies rarely go to war). Postulating that in the purest democracy the benefit/cost ratio for the pivotal agent is unity, we can show that (i) in the absence of transfers at most one of two pure democracies will want to go to war, and (ii) if binding treaties can be written, then two pure democracies can always reach an agreement over transfers that will avoid a war. We also show how the democratic peace result hinges on ability to write binding treaties, as when no commitment is possible, the possibility of war between democracies re-emerges.

We close with a dynamic extension of the model, where we discuss the evolution of the political structure of countries through war.

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peace literature can be rationalized from a mercantilist/realist perspective.

[5] See Bueno de Mesquita et al. (2003) on the empirical relevance of measures of democracy similar to the simple one proposed in our model.

1.1 Relation to the Literature

Bruce Bueno de Mesquita (1981) is the main reference for explanations of war based on the cost/benefit calculations by countries. However, his approach does not consider, and is not robust to, the introduction of bargaining and transfers. The basic way in which our approach differs from previous cost/benefit analyses of war is that we view countries as governed by some decision maker(s), who have incentives that can differ from the country's overall incentives. That is, we introduce a (very crude) model of the political process, and this effectively introduces an agency problem between the pivotal agent's incentives and the welfare of a country. The pivotal agent, may have more to gain and less to lose than the average citizen. Bueno de Mesquita et al. (2003) analyze the important variation across countries in terms of inclusiveness of the so called "selectorate", and their perspective is the closest to ours in terms of our measure of democracy. Our model can be viewed as incorporating in a simple manner the ideas discussed in Bueno de Mesquita et al (2003) into the basic structure of cost/benefit models like Bueno de Mesquita (1981), and the immediate benefit of this incorporation is that we can have in the same model *both* a neorealist theory of war based on complete information *and* a neorealist explanation of the fact that democracies tend not to go to war with one another if transfers are available.

One suggested way to reconcile rationality with the fact that wars happen, is to view international relations as interactions under anarchy, i.e., interactions among agents in a Hobbesian state of nature without any law enforcement (see e.g. Waltz 1959). A Coase-Theorem logic would suggest that if property rights are well defined (and each Nation has property right over it's territory) then war should be avoided and replaced by some less wasteful bargaining outcome. Of course, the Hobbesian view is really that property rights are not well-defined, and one country can take the "property" of another by force. Our model can be thought of as adding the ability to make transfers to such a view, and then understanding if and when they can help countries to avoid a war, and how this depends on political incentives. Countries can still take resources by force, but the ability of one to costless give something to another can dramatically affect incentives.

Other explanations of wars invoke miscalculations or errors due to lack of information or to different priors about relative power (see e.g. Blainey (1973) and Gartzke (1999)). As argued by Fearon (1995), once we allow for bargaining and communication, these explanations are consistent if there are strategic incentives to hide (or not to reveal) information. For example, as demonstrated in Fearon (1997) among others, two countries can engage in a signaling game of various kinds, and with a pooling equilibrium war can occur. Again, our model differs from this perspective in suggesting how the political structure and incentives of countries can lead to decisions to wage war even with complete information, given that the decision makers may often have more to gain than lose.[6]

Two alternative constraints that could make a war an equilibrium phenomenon even when players can bargain and communicate, are commitment constraints and indivisibilities. For instance, some authors have argued that indivisibilities, often determined by politics itself, restrict so much the space of possible agreements to become one of the most important causes of war (see Kirshner 2000). Our model is completely complementary to this is that we allow for any transfers to be made, and still find wars. On the other hand, the commitment constraints can still be important in determining whether war can be avoided via transfers, and we deal with them in the paper. However, as we will see below, the kind of commitment problem we identify is different from those identified in the previous literature.

Two "dynamic" theories of war are the so called "preemptive war" theory (see e.g. Jervis (1976)) and "preventive war" theory (see e.g. Taylor 1954). The preemptive war theory can be summarized by the observation that there could be a first strike advantage, so that the probability of winning the war is higher than p or (1-p) for country a or b respectively if a or b moves first. If this first strike advantage is large enough then war can be explained. [7] Preventative wars, as argued by Taylor (1954) account for many of the wars among great powers between 1848 and 1918. This type of argument represents a kind of commitment problem: The reason for not finding an agreement is that a country cannot commit not to

[6] It is one of our main points that war can happen in equilibrium even with complete information. However, one could extend our model to include incomplete information (and have that be the catalyst for war, rather than distorted incentives of decision makers), and still conduct similar analyses in terms of characterizing how transfers help avoid war. In terms of our model below, the miscalculations about relative power could be represented by having both countries believe that they can win with probabilities that sum to more than 1. The easiest way to introduce asymmetric information in the model would instead be to have the relative costs and benefits to the decision makers be private information (countries don't know the true willingness to fight of an opponent).

[7] The preemptive war theory is not to be confused with the spiral phenomenon that had already been noted in Schelling (1960), then further analyzed in Jervis (1976) and (1978): the game between two contenders who have to decide whether to engage or not in an arms race is represented as a stag-hunt game, in which each player prefers to arm only if the other does so. Baliga and Sjöström (2003) rigorously prove that even if there is an infinitesimally small belief that the opponent is someone who would arm no matter what, a spiral of mutual distrust can arise and lead to an arms race with probability 1 (in the absence of communication). However, even though there is some evidence that arms races can be determined by a spiral of mutual distrust rather than by rational ex-ante motivations, in this paper we ignore the spiral theories henceforth because our main focus is on the explanation of wars for given military power and complete information. When it comes to explanations of wars the spiral theory finds many supporters only concerning World War I, but for most other major wars there seems to be a consensus that they cannot be explained by the spiral theory.

propose a more favorable share of the surplus of peace in the future when it's probability of winning will be hire. But the opponent considers the probabilities of today, and so decides that it is better to go to war today than to wait and then be exploited in the future. So a country B here is going to war against A at time t to prevent being threatened by a stronger country A in the future. Of course, if country A could commit not to change the terms of the agreement signed at time t, both could be better off. Beside the preventative war argument, a second type of commitment problem can also raise the chance of war. Two countries may well prefer in a static model some transfer of territory over a war, but if such a transfer of territory then changes forever the relative powers, and the relatively advantaged country cannot commit to use the additional power given from the new territory in the future, then war can occur. This is the type of commitment problem closest to the one we model.[8] However, the type of commitment problem we describe is more directly related to the possibility to commit to avoid repeating a threat immediately after a transfer has been made, and hence it is a type of commitment problem that can even be explained in a static model, and even with myopic agents. We do not claim that this type of commitment problem is more important than the others, and we believe that these dynamic explanations of war are important factors, but we want to find static explanations of war in the simplest possible model, eliminating all sorts of complexities related to asymmetric information, different beliefs, or even forward looking motivations, so that the basic model can also be extended to study a different type of dynamics, namely the evolutionary dynamics of political regimes.

Finally, let us mention that the literature on conflict has identified two paradoxes (see e.g. Sanchez 2005): the *Hicks* paradox which refers to the inability of two players not to bargain to avoid war in general; and the *uneven contenders paradox* (Clausewitz (1832)) which refers to cases in which one small or weak country doesn't concede even though it should. Our model explains why neither of them is really a paradox. In our model wars can occur even when bargaining and commitment are possible, as long as the political regimes are not both completely democratic; and it is possible to have a war when two countries are very different in wealth, therefore showing that there is no uneven contenders paradox.

2 A Materialistic Model of War

We focus on wars between two countries in complete isolation. We denote the countries by i and j. We return to the case of dynamics and more countries below.

[8] In the forward looking version of our dynamic model we conjecture that the frequency of war is higher than in the myopic model, and the explanation is related to the preventative war argument.

Let w_i denote the total wealth of country i.

We model the technology of war in a simple way. If countries i and j go to war against each other, country i prevails with probability $p_i(w_i, w_j)$, which is increasing in w_i and decreasing in w_j. When the wealth levels are clear, we let p_{ij} denote $p_i(w_i, w_j)$. The probability that country j prevails is $]_{ji} = 1 - p_{ij}$. This simple form ignores the possibility of a stalemate or any gradation of outcome, but still captures the essence of war necessary to understand the incentives to go to war.

Note that it is possible that $p_i(w_i, w_j) \neq 1/2$ when $w_i = w_j$. This allows, for instance, i to have some geographic, population, or technological advantage or disadvantage.

In terms of the consequences of a war, we model the costs and benefits as follows. Regardless of winning or losing, a war costs a country a fraction C of its wealth. In addition to this cost of a war, if a country loses then it loses a fraction P of its wealth to the other country.[9] So after a war against country j, country i's wealth is $w_i(1 - C - P)$ if it loses and $w_i(1 - C) + Pw_j$ if it wins.

When two countries meet, they each decide whether to go to war and if either decides to go to war then a war occurs. As part of the decision process they may be able to make transfers of resources or territory, or to make other concessions. In order to derive a benchmark, we first examine the case where no transfers are possible and then return to consider the importance of transfers.

2.1 War Decisions Without Transfers

Let a_j denote the fraction of w_j controlled by the agent who is pivotal in the decisions of country j. The fraction of the spoils of war that the pivotal agent might control can differ from the fraction of the wealth that they hold, especially in non-democratic regimes or in situations where there might be other sorts of benefits from war (for instance, to a pivotal military leader). The fraction of the spoils of war obtained by the pivotal agent is a'_j.

Thus, the pivotal agent of a country j expects the following payoff from going to war against country i:

$$p_{ji}(a_j(1 - C)w_j + a'_j P w_i) + (1 - p_{ji})(1 - C - P)a_j w_j.$$

Country j's pivotal agent then wishes to go to war if and only if

$$(1 - C - P)a_j w_j + p_{ji} P(a_j w_j + a'_j w_i) > a_j w_j.$$

[9] We could also add fixed costs (independent of wealth), but that would add little to the analysis.

Let $R_j = \frac{a'_j}{a_j}$ denote the benefit/cost ratio for the pivotal agent. We use R_j as an operational measure of the level of democracy of the political regime of country j. Again, we stress that we interpret a country with high R_j as "less democratic" (or "more dictatorial") than a country with a lower R_j, and we use the term *pure democracies* to refer to situations where $R_j = 1$.[10]

Letting $w_{ij} = \frac{w_i}{w_j}$, the condition for a country j to wish to go to war simplifies to

$$p_{ji}(1 + R_j w_{ij}) > 1 + \frac{C}{P}. \tag{1}$$

We note some intuitive comparative statics.

The "tendency" of j to want to go to war (as measured in the range of parameter values where j wants to go to war)

- is increasing in R_j and P, and decreasing in C.
- depends only on the ratio of C/P and not on the absolute levels of either C or P.
- depends only on R_j and not on the absolute levels of either a_j or a'_j.

The comparative statics in w_i and w_j are ambiguous, as these wealths enter directly in w_{ij}, but also enter through p_{ji}. For instance as w_j increases, p_{ji} increases, but w_{ij} decreases. Which of these two effects dominates depends on the technology of war as captured in p_{ji}. Denoting by $dp_{ji}/dw_{ij} \leq 0$ the derivative of the probability of winning with respect to w_{ij},[11] the tendency to go to war of country j against country i increases in w_{ij} if and only if

$$-\frac{dp_{ji}/dw_{ij}}{p_{ji}} \leq \frac{R_j}{1 + R_j w_{ij}}.$$

Example **1** ***Proportional Probability of Winning***

If the probability of winning is $p_{ji} = \frac{w_j}{w_j + w_i}$, then (1) can be rewritten as

$$\frac{1 + R_j w_{ij}}{1 + w_{ij}} > 1 + \frac{C}{P}, \tag{2}$$

[10] We realize that there may be totalitarian regimes for which $R_j = 1$ and democracies where $R_j > 1$. We use the term nevertheless, since we are abstracting from all the other governance and institutional differences between democracies and non- democracies.

[11] The arguments of the p function are only w_i, w_j, so this is an abuse of notation, where we are considering changes where we decrease w_j and increase w_i simultaneously.

which is satisfied if and only if R_j is large enough.

Note that in this setting, a pure democracy $R_j = 1$ never wishes to go to war.

Note also that if $R_j > 1$, then the tendency for j to want to go to war is increasing in w_{ij}. To see this, note that the derivative of the left hand side with respect to w_{ij} is $(R_j - 1)/(1 + w_{ij})^2 > 0$.

2.2 A Characterization of the Incentives for War in the Absence of Transfers

There are three cases that can arise when two countries meet:

(w1) Neither country wishes to go to war.

(w2) One country wishes to go to war.

(w3) Both countries wish to go to war.

In case (w1), there is no war, and transfers would be irrelevant. In case (w3), there is a war and no transfers could possibly avoid it. The only situation where one country might be willing to make transfers that could induce the other country to avoid a war come in case (w2).

We first characterize the regions (w1) and (w3), and then we focus on (w2), where the availability of transfers could make a difference, as this will be the important benchmark for analyzing transfers.

PROPOSITION **1** No Transfers. *Consider any fixed w_i, w_j and p_{ij}.*

(I) If $R_i = R_j = 1$, then at most one country wishes to go to war regardless of the other parameters.

(II) Fixing any ratio $\frac{C}{P}$, if R_i and R_j are both sufficiently large, then both countries wish to go to war.

(III) Fixing any R_i and R_j, if $\frac{C}{P}$ is large enough, then neither country wishes to go to war.

All proofs appear in the appendix.

We note that for fixed $R_i > 1$, $R_j > 1$ and $\frac{C}{P}$, whether or not one or both countries wish to go to war depends on the technology p_{ij} and the wealth levels in ways that may not be purely monotone. This can be seen in (11) below.

Corollary **1** *There exist no parameter values for which two pure democracies both want to go to war with each other.*

2.3 Transfers to Avoid a War: the Commitment Case

We now focus on situations where in the absence of any transfers one country would like to go to war but the other would not; that is, case (w2) from above.

Here we study the impact of transfers. We are interested in identifying when it is that transfers will avoid a war. That is, we would like to know when is it that

(A) in the absence of transfers j wants to go to war with i,

(B) i prefers to pay $t_{ij} > 0$ to j rather than going to war, and

(C) j would prefer to have peace and a transfer t_{ij} to going to war.

We start with the case the countries can commit to peace conditional on the transfer t_{ij}. This is a situation where the countries can sign some (internationally) enforceable treaty so that they will not go to war conditional on the transfer. In the absence of such enforceability or commitment, it could be that i makes the transfer to j and then j invades anyway. We deal with the case of no commitment in the next section.

Assume henceforth, without loss of generality that we are in case (w2) so that j wishes to go to war while i does not.

Proposition **2** *4 A transfer can be made that will avoid a war when*

$$\frac{C}{P} \geq \frac{(1-p_{ji})(R_iR_j-1)}{1+R_jw_{ij}} \tag{3}$$

Here the comparative statics are very simple: this condition is more likely to be satisfied when

- $\frac{C}{P}$ is larger,
- R_i is smaller,
- p_{ji} is larger, and
- w_{ij} is larger (holding p_{ji} fixed).[12]

[12]When w_{ij} increases, the direct effect is unambiguous: the wealthier is i compared to j, the lower is the RHS of (3). This is because i can afford larger transfers. However, the total effect can go either way, depending on the size of the negative effect of w_{ij} on p_{ji}.

The effect of R_j is ambiguous.

Before using (3) and it's comparative statics to characterize the effect of transfers, we note a simple and sharp result.

Proposition **3** [Democratic Peace] *If $R_i = R_j = 1$, transfers under commitment always avoid a war. In other words, two pure democracies will never go to war if they can make transfers to each other and the receiver of a transfer can commit not to go to war after receiving the transfer.*

Proposition 3 identifies a new explanation for the observation that democracies rarely go to war. Most of the explanations of this fact in the literature concern internal checks and balances within a democracy, whereas here we simply note that two democracies never go to war because they can always find some transfer (perhaps bargaining under the threat of war) that makes it irrational to go to war.

We say that *transfers avoid a war* if both (9) and (3) are satisfied, so that a war would occur if transfers were not possible, but a war would be avoided if transfers are possible. We rewrite (9) as

$$p_{ji}(1 + R_j w_{ij}) - 1 > \frac{C}{P}$$

Combining this with (3) we get the following condition:

$$p_{ji}(1 + R_j w_{ij}) - 1 > \frac{C}{P} > \frac{(1 - p_{ji})(R_i R_j - 1)}{(1 + R_j w_{ij})}. \tag{4}$$

The first thing to note is that a decrease in R_i increases the range where more transfers help to avoid a war, since it helps in the second inequality and it does not matter for the first. In other words:

Remark **1** *The more democratic a country that is being challenged, the more likely it is that transfers help avoid a war.*

Note in particular that if $p_{ji} = \frac{1}{2}$ no matter what w_{ij} is – a case where a war is a pure lottery independent of relative wealths – (4) implies that there exists a range of values of $\frac{C}{P}$ such that transfers help avoid war if and only if

$$R_i < R_j w_{ij}^2.$$

So in this case it is very clear that transfers help the most when R_i is small, R_j is large, and/or w_{ij} is large. In other words:

Proposition 4 *Consider a benchmark case where the probability of winning a war is 1/2 for any relative wealth levels.*

If $\frac{R_i}{R_j} > w_{ij}^2$, then there are no transfers that can avoid war, regardless of $\frac{C}{P}$.

The range of $\frac{C}{P}$ for which transfers can help avoid a war is larger for lower R_i, higher R_j, and higher w_{ij}.

Next, consider again the general case in which p_{ji} varies with the relative wealths, but now let us consider a technological change that exogenously favors one country in a war; that is, consider a change in p_{ji} holding all else constant. It is easy to see that extent to which transfers are helpful in avoiding a war is increasing in p_{ji}, in the sense that an increase in p_{ji} enlarges the range of values of $\frac{C}{P}$ for which both inequalities in (4) hold. Thus, if p_{ji} was an exogenous parameter, one could conclude that transfers are more likely to avoid war when the challenger is more powerful, relatively more dictatorial, and/or poorer (still in relative terms. [13]

2.4 The no-commitment case

Let us now suppose that a country cannot commit to avoid a war if it receives transfers. It is still possible that transfers can help avoid a war, as transfers can change the wealths of the two countries so as to make it no longer in one country's interest to invade the other.

In the case of no commitment, a transfer t_{ij} makes it so that j does not want to go to war after having received the transfer if

$$(1 - C - P)(a_j w_j + a'_j t_{ij}) + p'_{ji} P(a_j w_j + a'_j t_{ij} + a'_j(w_i - t_{ij})) \leq a_j w_j + a'_j t_{ij}. \tag{5}$$

where $p'_{ji} = p_{ji}(w_j + t_{ij}, w_i - t_{ij})$. This can be rewritten as

$$p'_{ji} P(w_j + R_j w_i) \leq (C + P)(w_j + R_j t_{ij}). \tag{6}$$

Note that the only differences between this and the expression in (12) are that on the left hand side p_{ji} changes to $p'_{ji} > p_{ji}$ and that on the right hand side $R_j t_{ij}$ changes to $(C + P)R_j t_{ij}$. This makes it clear (given $C + P \leq 1$) that if t_{ij} avoids a war in the no commitment case, then it will also avoid a war in the commitment case. It is also clear that reverse need not be true.[14]

[13] Given the effect of wealth levels on p_{ji} in general, the last comparative statics could in principle be reversed.

[14] In the extreme case in which $C + P = 1$, which is when a country losing a war loses the entire wealth and disappears, the no commitment case differs from the commitment case only if the probability of winning is sensitive to the additional wealth coming from the transfer. If p_{ji} is constant, no difference.

Interestingly, the no commitment case has the following effect. There are some transfers $t_{ij} > 0$ for which (5) is not satisfied, and yet (5) is satisfied for t'_{ij} where $t_{ij} > t'_{ij} > 0$. Thus, it is possible that too high a transfer will lead to war while a lower transfer will avoid a war. This can be true in a case where a lower t_{ij} leads to a low enough probability that j wins the war. Larger transfers can lead the country making the transfers to be more vulnerable in terms of being more likely to lose a war, and thus higher transfers can end up leading to a war that lower transfers might have averted.

Example **2** *Smaller Transfers Avoid a War*

Let $R_i = 1$, $R_j = 4$, $w_i = w_j = 1$, $C = \frac{1}{10}$ and $P = \frac{1}{10}$. Have $p_{ij}(w, w) = \frac{1}{2}$.

Note that in this case (9) is satisfied, so initially j wishes to go to war with i.

From (14), we estimate that i would be willing to make a maximal transfer of $\bar{t}_{ij} = 1/10$ to avoid war.

In the case of commitment, we can then check that this would avoid war, as (12) is then satisfied.

Let us set $p_{ji}(6/10, 4/10) = 3/4$. Thus, if a transfer of $\bar{t}_{ij} = 1/10$ is made, then j would still wish to go to war after the transfer as (6) is not satisfied, and so the transfer would not avoid a war.

However, consider a smaller transfer of $t = \frac{3}{40}$. Suppose that $p_{ji}(23/40, 17/40) = 1/2 + \varepsilon$. For small enough ε, (6) is satisfied and so this smaller t avoids a war!

This means that we can no longer adopt the method of the last section using the maximal possible transfer that a country is willing to make to avoid a war. Without specifying the p_{ij} function, one cannot determine which transfers will avoid a war.

Nevertheless, we do know that

- Transfers can still avoid a war (as we see in Example 2);
- The set of parameter values where transfers avoid a war is a subset of the commitment case;
- The set of parameters for which war is avoided is larger as $\frac{C}{P}$ is larger;
- The set of parameters for which war is avoided is larger as R_i is smaller.

The fact that smaller R_i helps avoid war is due to the fact that this results in an increase in the set of transfers that i is willing to make, and $\frac{C}{P}$ increasing helps make both countries wish to avoid a war.

The effects of R_j and w_i, w_j are ambiguous.

3 Dynamics

Our analysis up to this point has only considered a static setting where two countries decide on whether to go to war with each other. More generally, we might be interested in how a world of countries is likely to evolve.

The most basic and important aspect that dynamics introduces is that as countries get richer, their incentives change. As a country j has won past wars, three things happen. First, its wealth increases, and so the w_{ij}'s it faces will decrease. This in turn has a second effect which is that p_{ji} increases. Third, as more wealth is acquired, the pivotal agent's percentage share of the wealth increases and so R_j decreases. To see this, note that before a war the agent's share is a_j. After the war, if the country wins, the agent's share is

$$\frac{a_j(1-C)w_j + a_j' P w_i}{(1-C)w_j + Pw_i}. \tag{7}$$

If $a_j' > a_j$, then this new share is larger than a_j. Thus, the new R_j is a_j' over this new share, and so as a country keeps winning wars, R_j will decrease.

Let us examine the implications of these changes over time. We know from (1) that a country will want to go to war (without consideration of transfers) if

$$p_{ji} > \frac{1+\frac{C}{P}}{1+R_j w_{ij}}. \tag{8}$$

As we see from above, if a country has become wealthier through the winning of past wars, then the right hand side of this expression will have increased as both R_j and w_{ij} will have decreased (if we are holding the wealth of a given opponent constant). On the other hand, the left hand side will also go up as p_{ji} increases.

While we cannot say what the short-term effects of this are, we can say that a country will not wish to go on going to war for too long. This follows from noting that p_{ji} is bounded above by 1, while w_{ij} can go to 0. As a country becomes much wealthier than other countries, it no longer desires to go to war as the right hand side of (8) will converge to $1 + \frac{C}{P}$, while the left hand side is bounded above by 1. Essentially, even if the country is sure to win the war, it does not wish to go to war because the costs outweigh the spoils of war against a much smaller country.[15]

Interestingly, depending on the technology of war, as one country becomes much wealthier it may no longer wish to go to war, but it may become an attractive target for smaller

[15] It might be more reasonable to presume that the costs of going to war against a much smaller country are small. However, if the costs of going to war have any lower bound, then the conclusion will still hold.

countries, since they may have much to gain and little to lose. Whether or not this is the case depends on how fast p_{ji} increases in w_j.

What does this suggest about the dynamics of war? Provided that as w_{ji} becomes large, p_{ji} goes to 1, countries of substantially different sizes will no longer wish to go to war. So, wars will only occur (if at all) between countries of similar sizes. Over time, some countries must get larger and others smaller, until some country becomes large enough that it will no longer go to war with others.

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4 Appendix: Proofs

Proof of Proposition 1: From (1), it follows that in the absence of transfers, country j wishes to go to war with country i if and only if

$$p_{ji} > \frac{1+\frac{C}{P}}{1+R_j w_{ij}}. \tag{9}$$

Similarly, country i wishes to go to war with country j if and only if

$$1-p_{ji} > \frac{1+\frac{C}{P}}{1+R_i w_{ji}}. \tag{10}$$

Part (III) follows directly from (9) and (10), as both right hand sides are increasing in $\frac{C}{P}$.

Next, note that from (9) and (10) it follows that both countries want to go to war if and only if

$$1-\frac{1+\frac{C}{P}}{1+R_i w_{ji}} > p_{ji} > \frac{1+\frac{C}{P}}{1+R_j w_{ij}}. \tag{11}$$

It is clear that if $R_i = R_j = 1$ (the case of two pure democracies) then inequalities (11) require that

$$1-\frac{1+\frac{C}{P}}{1+w_{ji}} > \frac{1+\frac{C}{P}}{1+w_{ij}}.$$

To see this is impossible, rewrite the above inequality as

$$1+w_{ij}-\frac{1+\frac{C}{P}}{w_{ji}} > 1+\frac{C}{P}.$$

This simplifies to

$$-w_{ij}\frac{C}{P} > \frac{C}{P},$$

which is clearly impossible. This proves (I).

The proof of (II) derives from the following observation: the left hand side of (11) converges to 1 as R_i gets large and the right hand side of (11) converges to 0 as R_j gets large. ∎

Proof of Proposition 4: As j wishes to go to war but i does not, (9) holds but (10) does not. The condition that needs to be satisfied for country j to no longer wish to go to war against i if offers $t_{ij} > 0$ is

$$(1-C-P)a_j w_j + p_{ji}P(a_j w_j + a_j' w_i) \leq a_j w_j + a_j' t_{ij}.$$

This simplifies to

$$p_{ji}P(w_j + R_j w_i) \leq (C+P)w_j + R_j t_{ij} \tag{12}$$

Similarly, the condition for i to be willing to make a transfer $t_{ij} > 0$ to avoid a war is

$$(1 - p_{ji})P(w_i + R_i w_j) \leq (C+P)w_i - t_{ij} \tag{13}$$

Note that we assume that the pivotal agent in country j gets the same proportion (a'_j) of t_{ij} as they would if it were a spoil of war, and the pivotal agent in country i pays the same proportion (a_i) of t_{ij} as it risks of its wealth in a war.

Let $\bar{t}_{ij}$ be the transfer that makes country i (who wishes to avoid war) indifferent between going to war and paying such a transfer, i.e., the transfer that makes (13) hold as equality. In other words, $\bar{t}_{ij} > 0$ is the maximum transfer that i is willing to make in order to avoid the war. Then

$$\bar{t}_{ij} = (C+P)w_i - (1 - p_{ji})P(w_i + R_i w_j) \tag{14}$$

Substituting (14) in (12), a transfer can be made so that country j no longer wishes to go to war if

$$p_{ji}P(w_j + R_j w_i) \leq (C+P)w_j + R_j(C+P)w_i - R_j(1 - p_{ji})P(w_i + R_i w_j).$$

This can be rewritten as 3. ▮

Proof of Proposition 3: Given corollary (1), we know that when two pure democracies meet, the situation without transfers is either (w1) or (w2). If it is (w1) we are done. If it is (w2), then assume without loss of generality that j is the one who wants to go to war and i is the one who does not. We have established above that in this case the availability of transfers eliminates the incentive of j to go to war if (3) holds. Thus, the result follows, noting that the RHS of (3) is 0 with two pure democracies. ▮