The Geography of Inter-State Resource Wars*

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April 16, 2012

Abstract

We establish a theoretical as well as empirical framework to assess the role of resource endowments and their geographic location for inter-State conflict. The main predictions of the theory are that conflict tends to be more likely when at least one country has natural resources; when the resources in the resource-endowed country are closer to the border; and, in the case where both countries have natural resources, when the resources are located asymmetrically vis-a-vis the border. We test these predictions on a novel dataset featuring oilfield distances from bilateral borders. The empirical analysis confirms that the presence and location of oil are significant predictors of inter-State conflicts after WW2.

*We wish to thank Johannes Boehm, Patrick Luescher and Cyrus Farsian for excellent research assistance. Helpful comments from Luis Corchon, Tom Cunningham, Joan Maria Esteban, Erik Gartzke, Sebnem Kalemli-Ozcan, Hannes Mueller, Peter Neary, Costantino Pischedda, Jack Snyder, Mathias Thoenig, Andew Wood, Fabrizio Zilibotti, and conference and seminar participants in Barcelona, Munich, Oxford, Harvard and Zurich are gratefully acknowledged. The usual disclaimer applies.

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1 Introduction

Natural riches have often be identified as triggers for war in the public debate and in the historical literature (e.g. Bakeless, 1921; Wright, 1942; Westing, 1986; Klare 2002; Kaldor, Karl, and Said, 2007).[1] The contemporary consciousness is well aware, of course, of the alleged role of natural resources in the Iran-Iraq war, Iraq's invasion of Kuwait, and the Falklands war. But the historical and political science literatures have identified a role for control over resources in dozens of cases of wars and (often militarized) border disputes, such as those between Bolivia and Peru (Chaco War, oil, though subsequently not found), Nigeria and Cameroon (Bakassi peninsula, oil, see Price, 2005), Ecuador and Peru (Cordillera del Condor, oil and other minerals, Franco, 1997), Argentina and Uruguay (Rio de la Plata, minerals, Kocs, 1995), Algeria and Morocco (Western Sahara, phosphate and possibly oil, BBC 2011, Kocs, 1995), Argentina and Chile (Beagle Channel, fisheries and oil, Carter center, 2010), China and Vietnam (Paracel Islands, oil, Anderson, 1999), Bolivia, Chile, and Peru (War of the Pacific, minerals and sea access, Carter Center, 2010).[2]

However, to the best of our knowledge there is no systematic formal and empirical analysis on this topic that takes into account the *location* of natural resources. In this paper we develop a simple two-country model of territorial war that allows us to obtain a mapping from the geographical distribution of natural resources to the likelihood of conflict. The general prediction of the model is that *asymmetries in endowments and location* of natural resources are potentially important determinants of territorial conflict.

Each of the two countries in our model may or may not have a resource deposit (henceforth oil, for short). The one(s) that have oil have the oil at a particular distance from the bilateral border. Each country may unilaterally initiate a war. We model war as the stochastic draw of a new border, which may lead one of the two countries to capture some

[1] Cf. also the discussion in De Soysa, Gartzke, and Lie (2009), and Acemoglu et al. (2011).

[2] Other examples of (militarized) border disputes over areas (thought to be) rich in oil and other resources include Guyana-Suriname, Nicaragua-Honduras, Guinea-Gabon, Chad-Libya, Bangladesh-Myanmar, Oman-Saudi Arabia, Algeria-Tunisia, Eritrea-Yemen, Guyana-Venezuela, Congo-Gabon, Equatorial Guinea-Gabon, Greece-Turkey, Colombia-Venezuela, Southern and Northern Sudan (cf. Mandel, 1980; McLaughlin Mitchell and Prins, 1999; Carter Center, 2010).

of the other country's territory. If an oil field is located in the captured area, the control over the oil field shifts as well.

Each country has both potential territorial reasons to seek a conflict, including to capture the other country's oil well, and non-territorial ones. Compared to the situation where neither country has oil, we show that the appearance of oil in one country tends to increase the likelihood of conflict. In particular, the heightened incentive of the resource-less country to seek conflict to capture the other's oil, tends to dominate the reduced incentive of the resource-rich country, which fears losing the oil. Similarly, ceteris paribus the likelihood of conflict increases with the proximity of the oil to the border, as once again as the oil moves towards the border the incentive of the oil-less country to fight increases more than the reduced incentive for the oil-rich one. Finally, when both countries have oil the key geographic determinant of conflict is the oil fields' asymmetric location: the more asymmetrically distributed the oil fields are vis-a-vis then border the more likely it is that two oil-rich countries will enter into a conflict.

While our theory applies to any type of resource endowment, our empirical work focuses on oil. We test the model's predictions using a novel dataset which, for each country pair with a common border, records the minimum distance of oil wells in each of the two countries from the international border. The model has predictions for the probability of war depending on whether one, both, or neither country has oil; and, when oil is present, on its distance from the border. We find that indeed having oil in one or both countries of a dyad increases the dispute risk relative to the baseline scenario of no oil, and this effect is stronger the more asymmetrically the oil is distributed, i.e. when one country has oil close to the border and the other country no oil or oil very far from the bilateral border.

Several streams of the existing literature are relevant for our research question. Most theoretical papers on war onset in political science and economics take the motives for war, i.e. potential gains from an attack for a country, as given. The objective is typically to study why it is not possible to prevent costly fighting with successful bargaining and transfers. Fearon (1995), Powell (2006) and Jackson and Morelli (2007) highlight, respectively, imperfect information, commitment problems and agency problems as potential sources of bargaining failure in a dispute over a "cake" of a fixed value for given fighting costs.[3] In other words, these papers focus on how motives for war can translate in the onset of fighting, but do not study what factors can result in powerful motives for war in the first place. Our approach is complementary: We assume that bargaining is not able to prevent fighting, e.g. due to commitment problems, but we study how the presence and location of natural resources affect the motives for war.

The paper is thus closer to other contributions that have focused on factors that enhance the incentives to engage in conflict. On this, the literature so far has emphasized the role of trade (e.g., Polachek, 1980; Skaperdas and Syropoulos, 2001; Martin, Mayer and Thoenig, 2008), domestic institutions (e.g., Maoz and Russett, 1993; Conconi, Sahuguet, and Zanardi, 2010), development (e.g., Gartzke, 2007; Gartzke and Rohner, 2011), and stocks of weapons (Chassang and Padró i Miquel, 2010). Natural resources have received surprisingly little systematic attention as potential explanations for the break out of inter-state conflict. Acemoglu et al. (2011) build a dynamic theory of trade and war between a resource rich and a resource poor country. But their focus is on the interaction between extraction decisions and conflict, and they do not look at geography. The models are therefore complementary. Empirically, there is a small statistical literature in International Relations that finds that oil rich countries are more likely to be involved in interstate disputes (De Soysa, Gartzke, and Lie, 2009, Colgan, 2010), but these contributions do not provide formal models, nor take resource location into account.

There are two papers in the literature that have focused on geographical features of natural resources, but in the context of civil conflict. Morelli and Rohner (2011) study the role of the distribution of natural resources within a country, interacted with the distribution and concentration of ethnic groups, for the likelihood of civil wars. Esteban, Morelli and Rohner (2011) study the impact of natural resources on the probability of civilian mass killings. Clearly, borders become salient in inter-State wars, whereas for civil wars and civilian mass killings what matters is the concentration of ethnic groups in the areas where natural resources are located, independently of the distance from the country

[3] See also Jackson and Morelli (2010) for an updated survey.

borders.

The remainder of the paper is organized as follows. In Section 2 a simple model of inter-state conflict is constructed, Section 3 carries out the empirical analysis, and Section 4 concludes. Appendix A describes all data in detail, while Appendix B presents an extended version of our model with endogenous fighting efforts.

2 The Model

2.1 The Setup

2.1.1 Assumptions

The world has a linear geography, with space ordered continuously from $-\infty$ to $+\infty$. In this world there are two countries, A and B. Country A initially controls the $[-\infty, 0]$ region of the world, while country B controls $[0, +\infty]$. Each country has a resource point (say an oil field) somewhere in the region that it controls. Hence, the geographic coordinates of the two resource points are two points on the real line, one negative and one positive. We call these points G_A and G_B, respectively. These resource points generate resource flows R_A and R_B, respectively. For simplicity the Rs can take only two values, $R_A, R_B \in \{0, \bar{R}\}$, where $\bar{R} > 0$. Without further loss of generality we normalize $\bar{R}$ to be equal to 1.[4]

The two countries play a game with two possible outcomes: war and peace. If a conflict has occurred, there is a new post-conflict boundary, Z. Intuitively, if $Z > 0$ country A has won the war and occupied a segment Z of country B. If $Z < 0$ country B has won. We make the following assumptions on Z.

Assumption 1 *Z is a continuous random variable with domain $\mathbb{R}$, density f, cumulative distribution function F, and mean $\bar{Z}$.*

In sum, the innovation of the model is to see war as a random draw of a new border

[4] As we discuss in Section 2.2.4 it is easy to generate comparative static predictions with respect to changes in R_A and R_B (and hence, implicitly, with respect to changes in oil prices). But data limitations and identification issues prevent us from testing these predictions.

between two countries: this makes the model suitable for the study of territorial wars. Note that the mean $\bar{Z}$ can be interpreted as an index of relative strength of the two countries. If $\bar{Z} > 0$ a potential war is expected to result in territorial gains for country A (the more so the larger $\bar{Z}$), so country A can be said to be stronger. If $\bar{Z} < 0$ country B is stronger.[5]

We assume that each country's objective function is increasing in three terms. First, it is increasing in territorial size, which in our model is equivalent to the measure of the real line it controls. For example, if it controls more territory it has more agricultural land to exploit. Or, if the population is distributed uniformly on the land, it has more people to tax. Second, it is increasing in the natural resources located in the territory it controls. In particular, we assume that the country within which the oil field is situated (at the end of the game) receives the resource stream from the oil. Hence, *ceteris paribus* a country would like to maximize the number of oil fields it controls. Finally, there is an additional cost or benefit from conflict, b_i, $i = A, B$. b_i will often be negative, reflecting war casualties and destruction. But it could also occasionally be positive, reflecting the fact that sometimes countries have very compelling ideological or political reasons to fight wars.

This discussion results in the following payoff functions. If there has been a war

$$
\begin{aligned}
U_A^W &= Z + R_A I(Z > G_A) + R_B I(Z > G_B) + b_A, \\
U_B^W &= -Z + R_A I(Z < G_A) + R_B I(Z < G_B) + b_B.
\end{aligned}
$$

U_i^W is the payoff for country i after a war, and $I(\cdot)$ is the indicator function. The first term in each expression is the size of the territory conquered or lost (Z for country A and $-Z$ for country B). The second and third terms are the oil wells controlled after the war. For example, country A has hung on its well if the new border is "to the right" of it, and similarly it has conquered B's oil if the new border is to the right of it. The last term is the non-territorial costs or benefits from war. Note that implicitly (and for simplicity) we

[5] For simplicity, we treat $\bar{Z}$ as an exogenous parameter. The important qualitative results would remain unchanged if we endogenized $\bar{Z}$ using a standard contest success function approach. However, in order to maintain analytical tractability strong functional form assumptions would be required. The results are available from the authors upon request.

assume that countries are risk neutral.

The payoff functions under peace are simply

$$\begin{aligned} U_A^P &= R_A, \\ U_B^P &= R_B, \end{aligned}$$

as by definition there is no border change (and hence also no change in property rights over the oil fields) in case of peace. Similarly, we have (implicitly) defined b as a net benefit of conflict so there is no such term in case of peace.[6]

We assume that the b_is are random variables:

Assumption 2 *b_i, $i = A, B$ is a continuous random variable defined on $\mathbb{R}$, with density h and cumulative distribution function H. Further, $h(b)/h(-b) < H(b)/H(-b)$ for $b > 0$.*

The main reason to make b_i a random variable is that otherwise the model would have deterministic predictions on whether a pair of countries with given geography G_A and G_B should have a conflict or not. Since many other factors beyond G_A and G_B determine conflict outcomes such a deterministic representation would be counter-factual. For simplicity we have implicitly assumed that the distribution H is the same for both countries (though the two draws of b_i are independent). We discuss relaxing this assumption below.

The last statement in the assumption is a mild "regularity condition," and it will be satisfied in empirically relevant cases. In particular, it is natural to suppose that $h(x)$ is single-peaked, and that it peaks at a negative value of b, since, as discussed, most of the time the net non-territorial costs of violent conflicts (deaths and destruction) exceed the benefits. Then the condition will be satisfied if (but not only if) either h is symmetric or H is log-concave. The vast majority of distributions defined on $\mathbb{R}$ are either symmetric or log-concave (or both). Note also that the assumption also implies $h(b)/h(-b) > H(b)/H(-b)$ for $b < 0$.

[6] Our payoff functions implicitly assume that the value of the oil fields is the same in case of war or without. It would be fairly trivial to allow for some losses in the value of the oil in case of conflict. For example we could assume that conquered oil only delivers δR to the conqueror, with $\delta \in (0, 1]$. The statements of our propositions would become slightly messier, but the qualitative predictions would be unchanged.

The timing and actions of the model are as follows. First, each country i draws a benefit of war b_i, $i = A, B$. Then each country decides whether or not to declare war, and does so to maximize expected payoffs. If at least one country declares war, wars ensues. In case of war, nature draws the new boundary, Z. Then payoffs are collected.

2.2 Analysis

2.2.1 When neither country has oil

Let us start with the baseline case where $R_A = R_B = 0$. After observing the realization of the non-territorial gain from conflict, the expected payoff from war for country A is

$$E\left(U_A^W\right) = \bar{Z} + b_A.$$

Country A will prefer peace if $\bar{Z} + b_A \leq 0$. Similarly country B will prefer peace if $-\bar{Z} + b_B \leq 0$. Then the probability of observing peace in any given period between A and B is

$$P_0 = H(-\bar{Z})H(\bar{Z}), \tag{1}$$

where P_0 denotes the probability of peace when $R_A = R_B = 0$. Note that because of assumption 2, P_0 is increasing in the symmetry of relative strength, i.e., decreasing in $\left|\bar{Z}\right|$.

2.2.2 When only one country has oil

Without loss of generality we assume that the oil is in country A: $R_A = 1$ and $R_B = 0$. Then

$$E\left(U_A^W\right) = \bar{Z} + 1 - F(G_A) + b_A,$$

so country A prefers peace if $\bar{Z} + 1 - F(G_A) + b_A \leq 1$, or

$$b_A \leq F(G_A) - \bar{Z},$$

or the territorial and non-territorial benefits from war $b_A + \bar{Z}$ are dominated by the risk of losing the oil, $F(G_A)$. Note that (i) country A is less likely to declare war when it has oil, relative to when neither country does; (ii) this greater reluctance is increasing in the proximity of the oil to the border; (iii) in the limit, when the oil is infinitely far from the border, the likelihood of country A declaring war converges to the likelihood when neither country has oil.

Country B prefers peace if $F(G_A) + b_B - \bar{Z} \leq 0$, or

$$b_B \leq -\left[F(G_A) - \bar{Z}\right].$$

Here the potential benefits of conflict in terms of nonterritorial gains and captured natural resources $b_B + F(G_A)$ are weighed against the expected territorial loss $\bar{Z}$. Note that the oil-poor country is more likely to declare war if the oil is close to the border. Also, the oil-poor country is more likely to declare war than when neither country has oil.

The probability of peace is

$$P_1(G_A) = H(-x_1)H(x_1), \tag{2}$$

where $P_1(G_A)$ is the probability of peace when only one country has oil, in location G_A, and

$$x_1 \equiv F(G_A) - \bar{Z}.$$

Using our assumptions, we get the following predictions.

Proposition 1

(i) $P_1(G_A) \leq P_0$ *if and only if* $F(G_A) \geq 2\bar{Z}$.

(ii) $\partial P_1(G_A)/\partial G_A \leq 0$ *if and only if* $F(G_A) \geq \bar{Z}$

(iii) $\lim_{G_A \to -\infty} P_1(G_A) = P_0$

Proof: Parts (i) and (ii) of the proposition use the fact the function $H(-x)H(x)$ is symmetric around 0, increasing for $x < 0$ and decreasing for $x > 0$. This implies that $P_1 < P_0$ if and only if $|x_1| > |\bar{Z}|$, which translates in the statement in part (i). We also have $\partial x_1/\partial G_A > 0$, so $\partial P_1/\partial G_A < 0$ if $\partial P_1/\partial x_1 < 0$, or $x_1 > 0$. This translates into the statement in part (ii). Part (iii) is immediately true by inspection.

Corollary

If $\bar{Z} \leq 0$ *(the two countries have equal strength or the country with oil is weaker) then (i)* $P_1(G_A) \leq P_0$ *and (ii)* $\partial P_1(G_A)/\partial G_A \leq 0$.

The corollary follows from the fact that when $\bar{Z} \leq 0$ the conditions for parts (i) and (ii) of Proposition 1 are met.

Part (i) of the proposition (and corollary) establishes the conditions under which conflict is more likely when one country has oil than when neither country does. In particular, whenever oil is in the weaker country ($\bar{Z} \leq 0$), the likelihood of conflict is higher than when neither country has oil. When oil is in the stronger country, the likelihood of conflict is higher than when neither country has oil as long as the difference in strength is not too large.

Part (ii) establishes the conditions under which the probability of conflict increases as the oil moves closer to the border. This is always true when the weaker country has the oil. When the stronger country has the oil a movement of the oil towards the border increases the chances of conflict as long as the difference in strength is not too large.

Part (iii) says that the case where the oil is infinitely far from the border is observationally equivalent to the case where neither country has oil.

The intuition for these results is fairly straightforward. A discovery of oil in one country has opposite effects on each country's incentives to go to war. The country which found the oil becomes less likely to wish to get into a conflict because it has more to lose, while the other country has an additional potential prize from going to war. Both of these incentives and disincentives become more powerful as the oil moves towards the border. The proposition signs the relative strength of these opposing forces, as a function of the relative strength of the two countries and the location of the oil.

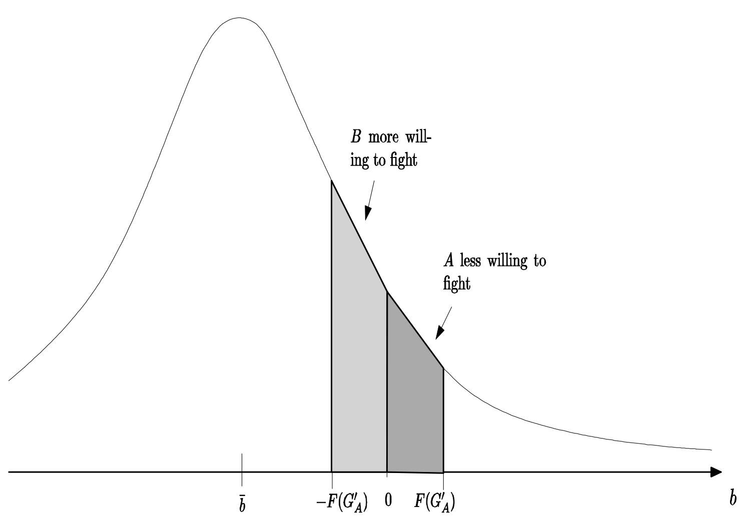

Figure 1: Effect of oil presence and location on incentives to fight

To see why in most cases the appearance of oil in one country and its movement towards the border increase the likelihood of conflict it is useful to begin with the case $\bar{Z} = 0$, i.e. the two countries are equally strong. Refer then to Figure 1. The bell-shaped curve is the function $h(b)$, assumed to be symmetric in this particular picture. Imagine an initial situation where neither country has oil. In this case country A (B) prefers peace if $b_A \leq 0$ ($b_B \leq 0$), so the area under the h curve and to the left of 0 represents the probability that either country prefers peace. Now suppose that oil appears in country A, at location G'_A. Country A prefers peace if $b_A \leq F(G'_A)$ and country B prefers peace if $b_B \leq -F(G'_A)$. Hence, relative to the no-oil case, country A's desire for peace increases by the shaded area between 0 and $F(G'_A)$, while country B's preference for peace decreases by the shaded area between $-F(G'_A)$ and 0. It is immediately apparent that the latter effect dominates, giving rise to part (i) of the proposition and corollary. To see part (ii), just imagine a further increase in G_A to $G''_A > G'_A$ (not drawn): one can immediately see that the further change has similarly asymmetric effects on the two countries incentives for conflict.

Why do the incentives of the oil-less country dominate? Because under our assumptions the oil-less country is the one that is more prone to seek conflict. Since country B has the additional inducement of capturing the oil to seek conflict, a disproportionate fractions of the wars between country A and country B will be initiated by country B. Therefore a given increase in incentive for country B has a disproportionate effect on the frequency on conflict relative to an equal reduction in incentive for country A.

This last point also clarifies the role of the conditioning statements in Proposition 1. Begin with the condition for part (ii) $F(G_A) \geq \bar{Z}$. In general, one would expect the oil-less country to initiate a disproportionate fraction of conflicts. But when $F(G_A) < \bar{Z}$ country A is an expected winner from the territorial component of the conflict even though it is the oil-rich country. In particular, the expected territorial gains $\bar{Z}$ are so large that they more than compensate for the expected loss of oil, $F(G_A)$. Thus, the condition for part (ii) is not met when it is the oil-rich country that initiates a disproportionate fraction of conflicts, and it is therefore the disincentive effect on this country that dominates when then oil moves towards the border.

The interpretation of the condition in (i), $F(G_A) \geq 2\bar{Z}$ is similar. Once again the condition can only fail if A is initially stronger ($\bar{Z} > 0$). In this case, without oil A's incentives initially account for a disproportionate share of the conflicts between A and B, and if $F(G_A)$ is low (oil far from the border) this continues to be true after A acquires oil, resulting in a lower likelihood of conflict. Conflict increases if the oil is sufficiently close to the border that A turns from typical aggressor into typical defender, and B becomes more aggressive than A was before the discovery. For the latter condition to be satisfied it is necessary that B's incentive to fight after the discovery, $F(G_A) - \bar{Z}$, exceeds A's incentive before, $\bar{Z}$.

2.2.3 When both countries have oil

If we have $R_A = R_B = 1$, then country A chooses peace if

$$2 - F(G_A) - F(G_B) + b_A + \bar{Z} \leq 1.$$

Note that A is more likely to declare war than when it is the only one to have oil. Also notice that an increase in G_A (own-oil closer to the border) as well as an increase in G_B (foreign oil further from the border), reduce country A's willingness to fight.

Country B prefers peace if

$$F(G_A) + F(G_B) + b_B - \bar{Z} \leq 1,$$

i.e. it is less likely to declare war than when only country A has oil. Increases in G_A and in G_B increase B's propensity to fight.

The probability of peace is now

$$P_2(G_A, G_B) = H(-x_2)H(x_2), \tag{3}$$

where $P_2(G_A, G_B)$ is the probability of peace when both countries have oil, at locations G_A and G_B respectively, and

$$x_2 \equiv 1 - F(G_A) - F(G_B) + \bar{Z}.$$

We then obtain the following predictions:

Proposition 2

(i) $P_2(G_A, G_B) \leq P_0$ *if and only if* $1 - F(G_A) - F(G_B) \geq \max\left[0, -2\bar{Z}\right]$ *or* $1 - F(G_A) - F(G_B) \leq \min\left[0, -2\bar{Z}\right]$.[7]

[7] A less compact but more reader-friendly version of this condition is

$$\bar{Z} \geq 0 \text{ and } 1 - F(G_A) - F(G_B) \notin \left(-2\bar{Z}, 0\right)$$

(ii) $P_2(G_A, G_B) \leq P_1(G_A)$ *if and only if* $F(G_A) \leq \bar{Z}$ *or* $F(G_A) \geq \bar{Z}$ *and* $1 - F(G_B) \geq 2\left[F(G_A) - \bar{Z}\right]$.

(iii) $\partial P_2(G_A, G_B)/\partial G_A \leq 0$ *if and only if* $1 - F(G_A) - F(G_B) \leq -\bar{Z}$.

(iv) $\lim_{G_A \to -\infty, G_B \to \infty} P_2(G_A, G_B) = P_0$; $\lim_{G_B \to \infty} P_2(G_A, G_B) = P_1(G_A)$.

The proof follows the same logic as the proof of Proposition 1 and is thus omitted.

Corollary

If $\bar{Z} = 0$ *(the two countries have equal strength) then*

(i) $P_2(G_A, G_B) \leq P_0$ *for any* G_A, G_B.

(ii) $P_2(G_A, G_B) \leq P_1(G_A)$ *if and only if* $1 - F(G_B) \geq 2F(G_A)$.

(iii) $\partial P_2(G_A, G_B)/\partial G_A \leq 0$ *if and only if* $1 - F(G_A) - F(G_B) \leq 0$.

Part (i) of the proposition and corollary tell us when two countries both having oil are more likely to experience a conflict than two countries both not having oil. The understand the conditions we can use a line of reasoning now familiar from Proposition 1. To fix ideas suppose $\bar{Z} > 0$, so that country A is stronger and accounts for most conflicts when oil is not present. When the two countries find oil, A continues to be the more "aggressive" country if $\bar{Z} + [1 - F(G_B)] - F(G_A) > 0$, i.e. if it continues to be the one that reaps greater territorial benefits. Then conflict is more likely if A's incentives for conflict have strengthened, or $\bar{Z} + [1 - F(G_B)] - F(G_A) > \bar{Z}$, which is the first condition in Part (i). If instead $\bar{Z} + [1 - F(G_B)] - F(G_A) < 0$ the oil discoveries turn B into the more aggressive country, and leads to more conflict if B's post-discovery incentives are stronger than A's pre-discovery ones, or $F(G_A) - \bar{Z} - [1 - F(G_B)] > \bar{Z}$, which is the second condition. The corollary says that these conditions are always satisfied when the two countries are equally strong. This is because if the countries are equally strong oil always makes one country more aggressive, and this is enough to trigger more conflicts. In this sense under our assumptions the mere presence of oil is always a threat to peace.

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or

$$\bar{Z} \leq 0 \text{ and } 1 - F(G_A) - F(G_B) \notin \left(0, -2\bar{Z}\right)$$

Note that the conditions for part (i) say that oil causes more conflicts either when $1 - F(G_A) - F(G_B)$ is smaller than a nonpositive threshold or larger than a positive one, i.e. when it is large in absolute value. Now the absolute value of $1-F(G_A)-F(G_B)$ can be interpreted as a measure of asymmetry in the location of the oil: it is maximal when one country has oil on the border and the other has oil infinitely far from the border. Hence, part (i) of the proposition says that war is more likely when both rather than neither country have oil if oil endowments are located sufficiently asymmetrically.

Part (ii) compares the situation when both countries have oil to the situation when only country A has oil. It says that if the country with oil was originally the more aggressive one ($F(G_A) \leq \bar{Z}$), then a discovery in the less aggressive country will always lead to more conflict. If instead country A was initially the typical defender, a discovery in the aggressor country will only lead to more conflict if it makes country A more aggressive than B was. This happens if $\bar{Z} + 1 - F(G_B) - F(G_A) > -\bar{Z} + F(G_A)$, which is the condition in the proposition.

Part (iii) looks at the marginal effect of moving oil towards the border in one country, while leaving the other country's oil location unchanged. The condition in the proposition is immediately recognizable as the one where the country whose oil is not moving is the typical aggressor, and it is thus by now not surprising that under this condition a movement of the oil towards the border leads to more conflict.

A crucial implication of part (iii) is that when both countries have oil changes in distance that increase the *asymmetry* of oil locations tend to increase conflict. To see this begin with the case $\bar{Z} = 0$ and assume that F is symmetric. By part (iii) a movement of A's oil closer to the border increases the chances of war if and only if $1 - F(G_B) \leq F(G_A)$. If F is symmetric this condition is equivalent to saying that B's oil is further from the border than A's oil. Hence an increase in G_A is a movement away from symmetry. The intuition is similar to introducing oil in one country when neither country has oil: breaking symmetry induces one of the two countries to become more aggressive relative to the symmetric situation.

In the more general case we can expect that on average the country whose oil is further from the border is the more aggressive one. Hence, a movement of the other country's oil towards the border (move away from symmetry) will make conflict even more frequent, while a movement of the other country's away from the border (movement towards symmetry) will reduce the incentives for conflict of the more aggressive country, leading to a decline in the incidence of conflict. These are some of the key predictions we test in the empirical part of the paper.

Part (iv) shows that there is an isomorphism between the situation when neither country has oil and both countries have oil infinitely far from the border, as well as when one country has oil and both countries have oil but one country's oil is infinitely far from the border.

2.2.4 Discussion

The key modelling choice we have made is to think of international wars as potentially border-changing events. The long (and very incomplete) list of examples of territorial wars and militarized border disputes in the Introduction supports this assumption. The International Relations literature provides further systematic evidence. Kocs (1995) has found that between 1945 and 1987 86% of all full-blown international wars were between neighboring states, and that in 72% of wars between contiguous states unresolved disputes over territory in the border area have been crucial drivers. The unstable nature of borders is well recognized. According to Anderson (1999) about a quarter of land borders and some two-thirds of maritime borders are unstable or need to be settled. Tir et al. (1998) identify, following restrictive criteria, 817 territorial changes between 1816 and 1996. More to the point, many of these border changes are the result of international conflicts. According to Tir et al. (1998) and Tir (2003) 27% of all territorial changes between 1816 and 1996 involve full-blown military conflict, and 47% of territorial transfers involve some level of violence. Weede (1973: 87) concludes that "the history of war and peace is largely identical with the history of territorial changes as results of war and causes of the next war".

The data described in the next section supports the existing evidence. In our panel of country pairs 0.4% of all observations feature border changes (corresponding to 90 cases of border change). Yet, conditional on the two countries being in conflict with each other, the incidence of border changes goes up to 7.4%. In other words the probability of a border change increases 19-fold in case of war.[8] In the appendix we reinforce the message from these simple calculations by confirming that conflict remains a significant predictor of border changes after controlling for time and country fixed effects.

Having said that, it is also important to stress that the model emphatically does not predict that *all* conflicts will be associated with border changes. All of our results and calculations still go through if the distribution of Z has a mass point at 0. Indeed, a significant mass point at 0 appears likely in light of the figures above. Of course a mass point at 0 is entirely consistent with a non-zero expected value of Z.[9]

The assumption that the b_A and b_B are drawn from identical distributions could easily be relaxed. For example, a natural extension would be to assume that b_A (b_B) is positively (negatively) related to $\bar{Z}$, i.e. that the country that expects the largest territorial benefits also expects the largest non-territorial ones (or to pay a less devastating non-territorial cost for the war). A tractable special case of this is to assume that the country-specific distributions h_A and h_B each satisfy assumption 2, and only differ in their means $\bar{b}_A$ and $\bar{b}_B$, with $0 > \bar{b}_A > \bar{b}_B$ if $\bar{Z} > 0$ and $\bar{b}_A < \bar{b}_B < 0$ otherwise.[10] Under these assumptions all our propositions still hold qualitatively, though the quantitative conditions need modification.[11]

With our assumption that $R \in \{0, 1\}$ we have normalized all non-zero oil endowments. It is trivial to relax this assumption to look at the effects of changes in R_A and R_B.

[8] Conversely, while only 6% of observed country pairs are in conflict, 30% of country pairs experiencing a border change are in conflict.

[9] The discussion so far assumes that f is the true distribution of post-conflict border locations Z. Strictly speaking, f is the distribution used by the decision-makers in the two countries, so the discussion essentially assumes that policymakers have correct beliefs about the distribution of outcomes in case of war. Anecdotal observation suggests that overoptimism is often a factor in war and peace decisions, so our guess is that the objective numbers cited above are probably lower bounds on the probabilities assigned by leaders to their chances of moving the border in case of war.

[10] Hence, if $\omega = \bar{b}_i - \bar{b}_j$, then $h_i(b + \omega) = h_j(b)$.

[11] Take our headline result in part (ii) of Proposition 1. The condition under which a movement of the oil towards the border reduces the likelihood of peace is now that $F(G_A) - \bar{Z} > \xi$. The threshold ξ is implicitly defined by the equation

$$\frac{h_A(\xi)}{h_B(-\xi)} = \frac{H_A(\xi)}{H_B(-\xi)}.$$

In particular, an increase in R_A has identical qualitative effects of a movement of A's oil towards the border, while an increase in R_B is akin to a move of B's oil towards the border. Our propositions can therefore readily be reinterpreted in terms of changes in quantities. Unfortunately, testing these predictions would require data on oilfield-level endowments that we have no access to. Potentially, predictions for changes in the Rs might be tested using variation in oil prices, as an oil price increase is an equi-proportional increase in both R_A and R_B. For example, for the case where only one country has oil, our theory would predict that increases in oil prices tend to lead to an increase in the likelihood of conflict. However, ample anecdotal evidence suggests that short-term oil prices are very responsive to conflicts involving oil-producing countries, so it would be very difficult to sort out a credible causal path from oil prices to conflict. Another issue is that what matters for war should be the long-term oil price: it is not clear that current oil prices are good forecasts of long-run ones.

On a somewhat related point, it is important to stress that we have not assumed that relative strength $\bar{Z}$ is uncorrelated with oil endowments. Having oil could confer military advantages, implying a positive (negative) correlation between $\bar{Z}$ and R_A (R_B). This possibility does not affect any of the statements in our propositions. However, it does affect the frequency with which the conditioning statements in the propositions are likely to be satisfied. The most relevant case is when only one country has oil. In this case, this country's concern with losing the oil should conflict occur is potentially balanced out by being the strongest in the pair, lending some potential ambiguity to some of the empirical predictions of our model.

To address this ambiguity, we make three observations. First, while the fact of having oil may have some ambiguous implications through opposing effects on strength and motive, the geographical location of the oil should only matter through motive. Oil will increase resources for fighting irrespective of its location, but the risk of losing it will be more severe if the oil is near the border. Hence, our predictions concerning the effect of oil location on conflict – which are the focus for our most distinctive empirical results – should be unaffected by the strength argument. Second, to the extent that oil endowments are a source of strength, it is overall endowments that should matter, not endowments in any specific oil field. Hence, in our empirical work we can control for the overall effect by conditioning on each country's overall oil production or reserves. Third, the whole premise that oil should make a country militarily stronger may be somewhat dubious, as a large literature argues that there is a "resource curse" which lower incomes in oil-rich countries (see Ross, 2012, for a very comprehensive overview.)

3 Empirical Implementation

In this section we shall assess the empirical relevance of the predictions of the model. In what follows we shall describe the data, the method and the results.

3.1 Data and Empirical Strategy

We have constructed a panel dataset with as unit of observation a country pair in a given year, e.g. US-Canada in 1960. The dataset covers the years 1946-2008, and includes all 606 pairs of countries contained in the "Correlates of War" (2010) country list and meeting the standard minimum "direct contiguity" criterion of the "Correlates of War Direct Contiguity Data" (Stinnett et al., 2002), i.e. sharing a border or being separated by not more than 400 miles of water.

All variables are described in detail in the Data Appendix, which also contains Table 5 with summary descriptive statistics. Two dependent variables of inter-state disputes are used. The main dependent variable, "Hostility", is a dummy variable that takes a value of 1 when a country pair year has disputes of hostility levels 4 ("use of force") and 5 ("war") according to the Dyadic Militarized Interstate Disputes Dataset of Maoz (2004), which is a dyadic update of the "Correlates of War" (2010) data on Militarized Interstate Disputes. About 5.7% of all dyad-years are coded as having such a major dispute.

For robustness checks, we use a second dispute variable, that focuses on full-blown inter-state wars only. The variable "War" is based on the same raw data as "Hostility", but takes a value of 1 when hostility level 5 ("war") is reached, and 0 otherwise. "War" is defined as follows in the Correlates of War project: "Inter-state war must involve sustained combat, involving organized armed forces, resulting in a minimum of 1,000 battle-related combatant fatalities within a twelve month period" (Correlates of War, 2010). In 0.4% of all dyad-years there is full-blown war.[12,13]

Our main independent variables are measures of distance of oil fields from the joint dyadic border. We have used as starting point the CShapes dataset of Weidmann, Kuse and Gleditsch (2010). This contains historically accurate geo-referenced borders for every country and year. The dataset accounts for border changes over time, both the ones originating from state creation and split-ups, and those arising from border adjustments. Their border adjustment information is based on Tir et al. (1998). Using Geographical Information System (GIS) software, ArcGIS, we merge this data on country borders with the time varying and geo-referenced dataset on the location of petroleum fields (PETRO-DATA) from Lujala, Rod and Thieme (2007). Using ArcGIS we have then computed the minimum distance of the closest oil field to a given bilateral border.

The main independent variables capture the parameters of our model. "Ind. One Oil" is a dummy variable taking the value of 1 when only one country in the pair has oil. Similarly, "Ind. Both Oil" takes a value of 1 if both countries of the pair have oil, and 0 otherwise. The omitted baseline category hence is the case where none of the countries in the dyad has oil. "Dist. Oil * Ind. One Oil" is the product of the "one oil" dummy with the distance of the oil from the border.[14] Similarly, "Min. Dist. Oil * Ind. Both Oil" is the product of the "both oil" dummy and the minimum of the distances of the oil from the border in the two countries. Analogously, "Max. Dist. Oil * Ind. Both Oil" captures G_j the distance from the border in the country whose oil is further from the border. Note that

[12] The dataset from Maoz (2004) only runs until 2001. As alternative data on full-blown wars is readily available, we update the "War" variable using the UCDP/PRIO Armed Conflict Dataset (Uppsala Conflict Data Program, 2011).

[13] An alternative approach, perhaps even closer to the predictions of our model, might have been to investigate data which identifies the aggressor in a bilateral conflict. However, in many cases clearly identifying the aggressor is very difficult (Gowa, 1999). Furthermore, any data set in which the aggressor is mechanically identified as the party that "opened fired" or declared war first would be suspicious, as in many cases such actions have a pre-emptive or self-defensive connotation.

[14] In the main specifications, all the distance variables are normalized to lie between 0 and 1 to reduce their range. This monotonic rescaling is explained in the Data Appendix. In robustness checks we display the results for alternative re-scaling or crude unscaled distances.

an increase in "Min. Dist. Oil * Ind. Both Oil" is a movement towards symmetry, while an increase in "Max. Dist. Oil * Ind. Both Oil" is a movement away from symmetry.

We control in most specifications for country fixed effects and annual time dummies and include several control variables for both countries of the dyad. Following the standard approach in the literature for studying country pairs, we construct maximum and minimum variables for all controls. To illustrate, suppose that in a country pair the larger country has a population of 50 million people, and the smaller one of 10 million people. Hence, the maximum population variable for this dyad-year would take a value of 50 million, while the minimum population variable would take a value of 10 million. We construct such minimum and maximum variables for surface, population, GDP per capita, democracy scores, and fighting capabilities. In addition we control for last period's hostility level in the same dyad, bilateral trade / GDP, membership of the same defensive alliance, and for two dummies on civil war incidence in the countries of the dyad. In robustness checks also several variables on the amounts of oil production and reserves are included. All variables are explained in detail in Appendix A, where also summary descriptive statistics are provided in Table 5.

In most specifications we run linear probability models, but consider alternative estimators in robustness checks. In all regressions we allow robust standard errors to be clustered at the dyad level.

3.2 Results

Let us start with Figure 2 that simply presents the stylized fact of an unconditional cross-sectional correlation between the minimum distance of oil in any of the two countries from the dyadic border and the percentage of years since World War II that there has been "Hostility" between the two countries.[15] The correlation coefficient is -.11 (p-value: 0.01).

This crude correlation could of course be driven by unobserved heterogeneity and omitted variables. To investigate the relationship in more depth we shall now perform a regres-

[15] Note that for visual convenience we have trimmed both axes, removing the 1% outliers with highest levels on the axes.

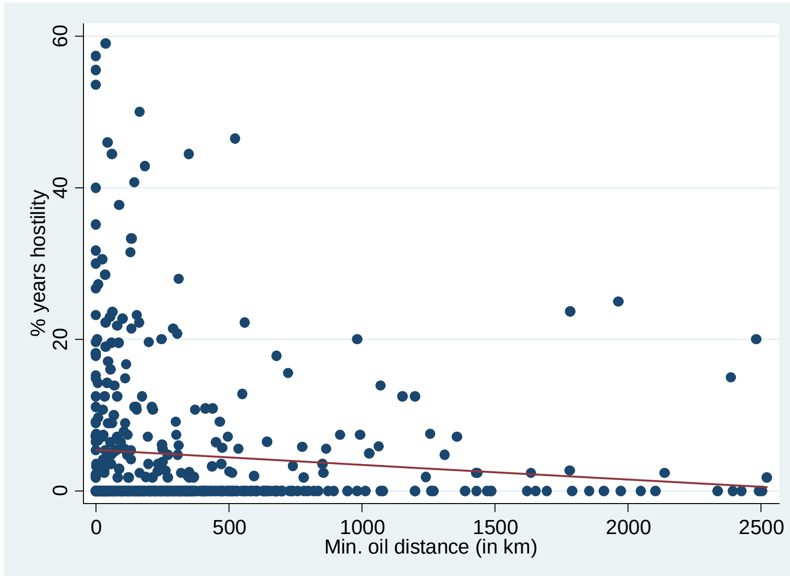

Figure 2: Unconditional correlation between minimum oil distance and hostility

sion analysis. Table 1 displays the baseline regressions for the main dependent variable, Hostility. In the first three columns we use all petrol fields to construct our main variables, while in columns 4-6 we only use offshore petrol, and in columns 7-9 only onshore petrol. In column 1 we include the five main parameters of our model, together with unreported annual time dummies and minimum and maximum surface measures, but neither country fixed effects nor additional controls. All main variables have the correct sign, but some are imprecisely estimated, probably due to unobserved heterogeneity on the country level. Therefore, we include fixed effect for both countries of the dyad in column 2. This would for example account for some countries being generally more bellicose than others. This leads indeed to more precise estimates, and our key variables are all significant at the 1% level. As predicted by the model a country pair with one or both countries having petrol is significantly more prone to inter-state disputes than a dyad with no petrol whatsoever (which is the omitted category). Further, the oil distance from the frontier matters. While in a country pair with only one country producing oil the dispute risk is increased by 9.7 percentage points when the oil field is right at the dyadic border, the effect on hostilities becomes almost zero when oil is very far from the border. Similarly, also when both countries have oil the dispute-inducing effect of petrol completely vanishes when oil is increasingly far from the border.

In our preferred specification of column 3, we add various controls, which somewhat reduces the coefficients of the key variables, but they remain sizeable and significant at the 1% level. Columns 4-6 are mirror images of columns 1-3 but only include offshore oil, while columns 7-9 do the same analysis for onshore oil. The pattern is very similar for offshore and onshore oil.

Note that our results are quantitatively sizeable. As shown in Figure 3, while the baseline risk of inter-state dispute is 5.7 percentage points for a country pair with all average characteristics, a dyad without any oil whatsoever would have a dispute risk of about 3.7 percentage points. In contrast, a country pair with only one country having oil right at the border would have a risk of 10.8 percentage points, which is more than three times the risk of an oil-free dyad. Interestingly, a dyad with only one country having oil, but the oil being located at 3/4 of maximum distance from the border would have a risk of 4.8 percentage points. A country pair with oil in both countries and one country having oil at the border and the other one at maximum distance would also have high risk of inter-state disputes (9.2 percentage points), while a dyad with both countries having oil at intermediate distance (i.e. the distance index being at 0.5) would feature a conflict risk of 4.6 percentage points.

	Dependent variable: Hostility								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ind. 1 Petrol	0.044	0.097***	0.071***	0.101*	0.176***	0.117***	0.060	0.121***	0.105***
	(0.031)	(0.029)	(0.023)	(0.053)	(0.047)	(0.029)	(0.045)	(0.039)	(0.034)
Dist.Petrol*I1	-0.043	-0.093***	-0.080***	-0.115**	-0.160***	-0.107***	-0.079*	-0.136***	-0.113***
	(0.032)	(0.026)	(0.020)	(0.055)	(0.046)	(0.028)	(0.045)	(0.038)	(0.033)
Ind. 2 Petrol	0.044**	0.079***	0.046**	0.027	0.132***	0.085***	0.027	0.081***	0.043
	(0.021)	(0.029)	(0.023)	(0.030)	(0.036)	(0.028)	(0.025)	(0.031)	(0.027)
Min.Dist.Petrol*I2	-0.084**	-0.109***	-0.084***	-0.089*	-0.103**	-0.050*	-0.109***	-0.124***	-0.116***
	(0.038)	(0.031)	(0.026)	(0.046)	(0.050)	(0.027)	(0.041)	(0.033)	(0.028)
Max.Dist.Petrol*I2	0.028	0.012	0.009	0.048	-0.003	-0.022	0.061	0.042	0.047
	(0.042)	(0.031)	(0.027)	(0.064)	(0.063)	(0.037)	(0.045)	(0.034)	(0.030)
Type Petrol	All	All	All	Offshore	Offshore	Offshore	Onshore	Onshore	Onshore
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Add. Controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	19962	19962	11401	19962	19962	11401	19962	19962	11401
R-squared	0.020	0.147	0.253	0.021	0.147	0.250	0.022	0.148	0.254

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2001. OLS regressions with intercept in all columns. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. All independent variables are taken as first lag. All specifications control for minimum and maximum surface and annual time dummies (not displayed). In addition, columns 2, 3, 5, 6, 8, and 9 include country fixed effects for each country of the dyad. In addition, columns 3, 6, and 9 include the following set of unreported control variables: Minimum population, maximum population, minimum GDP per capita, maximum GDP per capita, minimum democracy score, maximum democracy score, minimum capabilities, maximum capabilities, dummy for one country having civil war, dummy for both countries having civil war, bilateral trade / GDP, defensive pact, and last period's hostility level in the dyad.

Table 1: Baseline results for Hostility

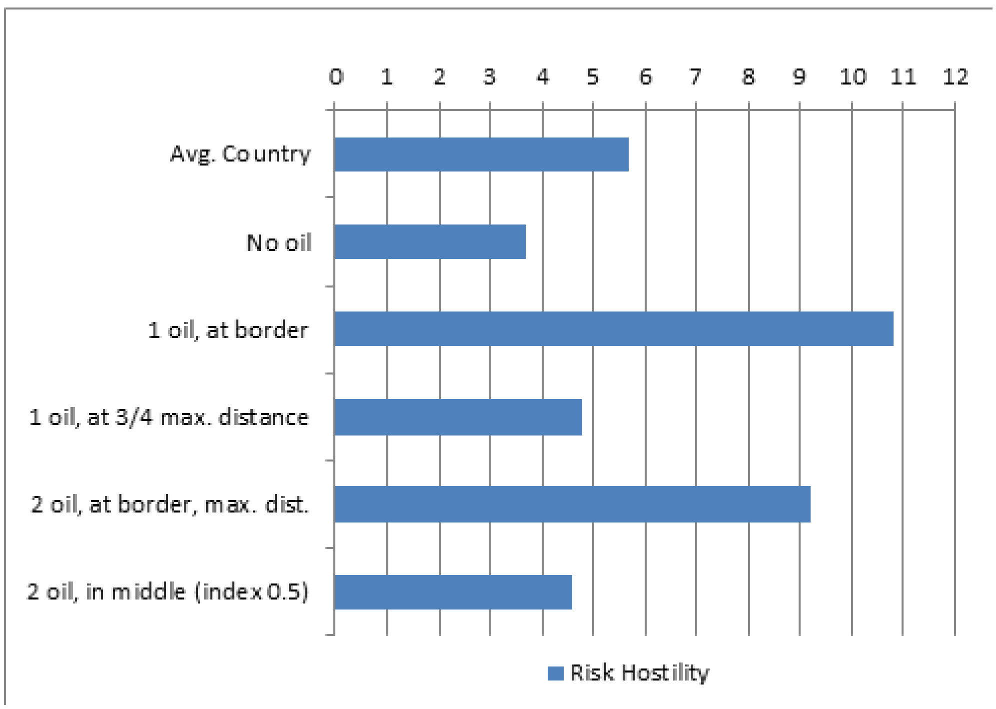

Figure 3: Quantitative Effects

	Dependent variable: War								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ind. 1 Petrol	0.014	0.022**	0.004*	0.036**	0.043***	0.013***	0.019	0.032**	0.004
	(0.012)	(0.010)	(0.002)	(0.018)	(0.015)	(0.004)	(0.018)	(0.015)	(0.002)
Dist.Petrol*I1	-0.012	-0.018*	-0.002	-0.037**	-0.044***	-0.013***	-0.019	-0.028*	-0.003
	(0.013)	(0.010)	(0.001)	(0.018)	(0.016)	(0.004)	(0.019)	(0.015)	(0.002)
Ind. 2 Petrol	0.010**	0.014**	0.006**	-0.003*	0.009	0.003	0.009*	0.022***	0.005*
	(0.005)	(0.006)	(0.003)	(0.002)	(0.006)	(0.002)	(0.005)	(0.006)	(0.003)
Min.Dist.Petrol*I2	-0.004	-0.008	-0.007**	-0.001	0.008	-0.001	-0.005	-0.008*	-0.007**
	(0.006)	(0.005)	(0.003)	(0.004)	(0.006)	(0.001)	(0.006)	(0.004)	(0.003)
Max.Dist.Petrol*I2	-0.005	-0.007	0.002	0.003	-0.020**	-0.001	-0.005	-0.008	0.002
	(0.007)	(0.006)	(0.003)	(0.004)	(0.009)	(0.002)	(0.008)	(0.006)	(0.003)
Type Petrol	All	All	All	Offshore	Offshore	Offshore	Onshore	Onshore	Onshore
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Add. Controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	23768	23768	11401	23768	23768	11401	23768	23768	11401
R-squared	0.007	0.075	0.480	0.013	0.079	0.480	0.007	0.075	0.480

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2008. OLS regressions with intercept in all columns. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. All independent variables are taken as first lag. All specifications control for minimum and maximum surface and annual time dummies (not displayed). In addition, columns 2, 3, 5, 6, 8, and 9 include country fixed effects for each country of the dyad. In addition, columns 3, 6, and 9 include the following set of unreported control variables: Minimum population, maximum population, minimum GDP per capita, maximum GDP per capita, minimum democracy score, maximum democracy score, minimum capabilities, maximum capabilities, dummy for one country having civil war, dummy for both countries having civil war, bilateral trade / GDP, defensive pact, and last period's war level in the dyad.

Table 2: Baseline results for War

Table 2 runs exactly the same regressions as in Table 1, but using as dependent variable "War", which covers only full-blown wars, instead of our main dependent variable, "Hostility", which also covers militarized disputes with use of force that do not degenerate into full-blown war. The results are similar for this alternative dependent variable, although the statistical significance levels of the main variables are usually somewhat lower. This is hardly surprising, given that there is much less variability of the dependent variable, due to the low baseline risk of interstate wars (0.4 percentage points). Note that while the size of the coefficients is smaller in these regressions, their quantitative importance remains very substantial relative to the low baseline risk of interstate war.

To assess the robustness of our results, Table 3 presents variants of our preferred specification of column 3 of Table 1. In column 1 of Table 3 we re-scale the distance of oil fields from the dyad border using a plain natural log function instead of the usual function ranging from 0 to 1 that is used in the baseline specification, while in column 2 we use the raw oil distance in 100 kilometers. The results of columns 2 and 3 are very similar to the ones of the benchmark regression.

In columns 3, 4 and 5 we do not run a linear probability model like in the benchmark, but use logit, probit and rare events logit (ReLogit)[16] estimators, respectively. The results are again very similar to our benchmark. To reduce further unobserved heterogeneity, we restrict in column 6 the sample to country pairs where one or both of the countries have petrol (hence dropping all country pairs without any oil). In column 7 we restrict the sample further to country pairs where only one country has oil, and in column 8 to country pairs where both countries have oil. The results of the benchmark continue to hold in these restricted samples.

[16] The rare events logit (ReLogit) estimator is from Tomz, King, and Zeng (2003), and adjusts the estimation for the fact that the dependent variable takes much more often a value of 0 than of 1. The ReLogit estimator is not designed for the inclusion of fixed effects and for robust standard errors. Hence, we remove all fixed effects and use standard errors without the robust option, but still clustered at the dyad level.

	Dependent variable: Hostility							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ind. 1 Petrol	0.058**	0.030**	3.448***	1.413***	0.344			
	(0.026)	(0.014)	(1.039)	(0.469)	(0.451)			
Dist.Petrol*I1	-0.005***	-0.005***	-4.225***	-1.818***	-0.934**	-0.073***	-0.050**	
	(0.002)	(0.001)	(0.917)	(0.424)	(0.473)	(0.021)	(0.021)	
Ind. 2 Petrol	0.050*	0.047**	1.322*	0.483	0.423	-0.020		
	(0.026)	(0.021)	(0.768)	(0.342)	(0.321)	(0.023)		
Min.Dist.Petrol*I2	-0.004***	-0.010**	-2.248***	-1.101***	-1.233**	-0.085***		-0.076***
	(0.002)	(0.004)	(0.469)	(0.243)	(0.479)	(0.026)		(0.027)
Max.Dist.Petrol*I2	-0.001	-0.004**	0.010	0.060	-0.144	0.011		-0.007
	(0.002)	(0.002)	(0.496)	(0.264)	(0.475)	(0.026)		(0.028)
Sample	All	All	All	All	All	Only I1, I2	Only I1	Only I2
Estimator	OLS	OLS	Logit	Probit	ReLogit	OLS	OLS	OLS
Country FE and TE	Yes	Yes	Yes	Yes	NO	Yes	Yes	Yes
Scale distances	Nat.log.	in 100 km	Standard	Standard	Standard	Standard	Standard	Standard
Observations	11401	11401	8939	8939	11277	10122	3737	6385
R-squared	0.249	0.254	0.350	0.348	0.205	0.269	0.311	0.286

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2001. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. The petrol variables are constructed using all petrol fields (onshore and offshore). All independent variables are taken as first lag. All specifications control for intercept, minimum and maximum surface, minimum population, maximum population, minimum GDP per capita, maximum GDP per capita, minimum democracy score, maximum democracy score, minimum capabilities, maximum capabilities, dummy for one country having civil war, dummy for both countries having civil war, bilateral trade / GDP, defensive pact, and last period's hostility level in the dyad. All columns, with the exception of the ReLogit regression in column 5, also include country fixed effects and annual time dummies.

Table 3: Robustness with respect to Estimator and Sample

In Table 4 we perform further robustness checks with respect to the total amount of oil in a given country pair. In columns 1-3 we add various measures of petrol richness for the more and the less abundant country. We can see that for the main variables the only one that loses significance in most columns is the indicator function taking a value of one if both countries have oil. This is unsurprising, as it is the measure that is most strongly correlated with overall abundance measures. In column 4 we construct the level of oil production for the country with petrol fields closer to the border and for the one further away. While our main variables remain significant these additional petrol quantity measures do not play a large role, being at best borderline significant and having a very small coefficient size. This is consistent with the view that mostly resource *location* rather than *quantity* matters. In column 5 we include interaction terms for all main variables with the corresponding oil amounts produced. Again, while our main variables remain statistically significant and quantitatively important, the interaction terms are small and usually insignificant.

As a further check on the mechanism described in the theoretical model we have also asked the question whether oil, and oil distance from the border, has some predictive power for border changes. We do not expect the results to be a string as for war, because as discussed in Section 2.2.4 the model is entirely consistent with probability distributions for the post-war border location that have a significant mass-point at the original position. And, indeed, we know from the data that many wars do not lead to (measurable) border changes. Still, it is interesting to see if petrol has some predictive power for border changes. The results are presented in the Appendix, where we first display in Table 6 the relationship between conflict and border changes, which is positive and significant. Then, we include Table 7, which uses the same specification as in Tables 1 and 2, but with a dummy for border change as dependent variable. Remarkably, the presence and location of the oil have broadly similar effects on border changes as they have on conflict, though the coefficients are, not surprisingly, less consistently significant.

4 Conclusions

In this paper we have studied the effect of natural resource location on the risk of inter-state conflict. In particular, we have built a simple model that predicts the risk of inter-state

	Dependent variable: Hostility				
	(1)	(2)	(3)	(4)	(5)
Ind. 1 Petrol	0.087***	-0.021	0.084***	0.074***	0.079***
	(0.029)	(0.091)	(0.029)	(0.028)	(0.028)
Dist.Petrol*I1	-0.103***	-0.101***	-0.101***	-0.088***	-0.093***
	(0.026)	(0.026)	(0.026)	(0.025)	(0.025)
Ind. 2 Petrol	0.037	-0.177	0.029	0.039	0.053*
	(0.032)	(0.176)	(0.032)	(0.030)	(0.031)
Min.Dist.Petrol*I2	-0.072***	-0.093***	-0.073***	-0.068***	-0.074***
	(0.021)	(0.023)	(0.020)	(0.021)	(0.022)
Max.Dist.Petrol*I2	-0.002	0.014	0.003	-0.008	-0.013
	(0.023)	(0.023)	(0.021)	(0.023)	(0.022)
Oil prod.(max)	-0.000*				
	(0.000)				
Oil prod.(min)	-0.000				
	(0.000)				
Oil res.(max)		-0.000			
		(0.000)			
Oil res.(min)		0.001			
		(0.001)			
Oil/GDP(max)			-0.036		
			(0.028)		
Oil/GDP(min)			-0.062		
			(0.043)		
Oil pr.(further)				0.000	
				(0.000)	
Oil pr.(closer)				-0.000*	
				(0.000)	
I1*Oil pr.(closer)					-0.000
					(0.001)
Dist.Petrol*I1*Oil pr.(closer)					0.000
					(0.001)
I2*Oil pr.(closer)					-0.000***
					(0.000)
I2*Oil pr.(further)					-0.000
					(0.000)
Min.Dist.Petrol*I2*Oil pr.(closer)					0.000**
					(0.000)
Max.Dist.Petrol*I2*Oil pr.(further)					-0.000
					(0.000)
Country FE, TE, all controls	Yes	Yes	Yes	Yes	Yes
Observations	9331	6206	8991	9698	9698
R-squared	0.248	0.257	0.242	0.238	0.239

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2001. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. The petrol variables are constructed using all petrol fields (onshore and offshore). All independent variables are taken as first lag. OLS with intercept in all columns. All specifications control for minimum surface, maximum surface, minimum population, maximum population, minimum GDP per capita, maximum GDP per capita, minimum democracy score, maximum democracy score, minimum capabilities, maximum capabilities, dummy for one country having civil war, dummy for both countries having civil war, bilateral trade / GDP, defensive pact, and last period's hostility level in the dyad, country fixed effects and annual time dummies.

Table 4: Robustness with respect to oil quantities

disputes to be largest in the presence of natural resource *asymmetry*. The most dangerous situations are the ones where only one country of the dyad has oil, and in particular when the oil is close to the border, or similar in a dyad of two oil producers when one has its oil fields close to the frontier and the other one far away from it. The logic is intuitive: The country with no oil or oil far from the border is very keen to engage in war, as it may have much to win, but very little to lose. In contrast, the country with oil wells situated in proximity to the bilateral frontier is reluctant to conflict that has large expected costs. We show in a simple framework where both countries have the power to start a war that the first effect dominates, and that therefore asymmetry and not only absolute petrol abundance fuels the risk of conflict.

In the second part of the paper we test these predictions empirically. In a dyad-year panel with a battery of controls and country fixed effects and annual time dummies we find that indeed asymmetry matters. In fact, country pairs with oil are only found to have a larger risk of inter-state conflict if the oil location is asymmetric, while symmetric distances of oil fields from the border and the general lack of oil close to the border make even larger oil producers not more likely to engage in interstate dispute than dyads without oil. However, in the most risky constellations where one country has oil close to the border and the other one no oil or oil far away from the frontier the baseline risk of inter-state conflict can more than triple. The results are robust for alternative dependent variables, specifications, estimators, samples and ways of constructing the main oil distance measures.

While this paper has proposed a new theory of inter-state conflict, it has several limitations. The theoretical framework is static, while several potential mechanisms could be driven by dynamic considerations. Hence, we plan in future work to build a dynamic model of the geography of interstate wars. Further, while we are the first paper that has computed variables of minimum distances of oil fields from bilateral borders, we will aim in future research for putting together more precise data on oil fields that also includes the amounts produced and aim for broadening the analysis to other natural resources than petrol.

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Appendix A: Data

This appendix describes the variables used in section 3 and provides summary descriptive statistics in Table 5. In terms of dependent variables, "Hostility" and "War" are explained in detail in subsection 3.1. The third dependent variable used in Appendix B is the following:

"Territorial Change": Dummy variable taking a value of 1 if there has been a territorial change in a given dyad year. From Tir et al. (1998), version 4.01 obtained from http://www.correlatesofwar.org/.

In terms of independent variables, all variables starting with "Maximum" correspond to the values of this variable for the country in the dyad with higher values of this variable. "Minimum" is used analogously.[17]

All oil variables have been constructed in the following way: Using Geographical Information System (GIS) software, ArcGIS, we have merged the geo-referenced and time-varying CShapes dataset of Weidmann, Kuse and Gleditsch (2010) on country borders with the time varying and geo-referenced dataset on the location of petroleum fields (PETRODATA) from Lujala, Rod and Thieme (2007) Using ArcGIS we have then computed the minimum distance of the closest oil field to a given bilateral border. Unless noted otherwise, distances are re-scaled using the following formula: distance index=1-exp(-(distance in km/(100000))). This monotonic transformation guarantees that we obtain a distance measure ranging between 0 and 1, and that a larger weight is put on a given absolute distance increase if the oil field is close to the border.[18]

"Ind. One Oil": Dummy variable that takes a value of 1 if only a single country in the dyad has oil, and 0 otherwise.

"Ind. Both Oil": Dummy that takes a value of 1 if both countries of a dyad have oil, and 0 otherwise.

[17] For illustration, if, say, country A has a Polity score of 3, and country B a Polity score of 7, then "Minimum Polity Score" would take a value of 3, and "Maximum Polity Score" a value of 7 for this dyad.

[18] For example, an increase of oil distance from 0 to 50 kilometers would lead to a stronger increase in this distance index than an increase from 1000 kilometers to 1050 kilometers.

*"Dist. Oil * Ind. One Oil"*: Distance of nearest oil field from the border in the case where only one country has oil.

*"Dist. Oil * Ind. Both Oil":* Distance from border when both countries have oil.

"Surface": In Square kilometers. From World Bank (2009).

"*Population":* In Thousands. From Heston, Summers, and Aten (2009).

"GDP per Capita": Real Gross Domestic Product per Capita, Current Price National Accounts at PPPs. From Heston, Summers, and Aten (2009).

"*Polity Score":* Democracy scores ranging from -10 (strongly autocratic) to +10 (strongly democratic). From Polity IV (2009).

"Capabilities": Capability scores from Correlates of War (2010).

"CW1": Dummy taking a value of 1 if there is a civil war in one country of the dyad, and 0 otherwise. Constructed using data from Uppsala Conflict Data Program (2011).

"CW2": Dummy taking a value of 1 if there is a civil war in both countries of the dyad, and 0 otherwise. Constructed using data from Uppsala Conflict Data Program (2011).

"Bilateral trade /GDP": Sum of total bilateral trade between the two countries of the dyad divided by the sum of their total GDPs. Bilateral trade data from Barbieri and Keshk (2012), GDP data from Heston, Summers, and Aten (2009).

"Defensive pact": Dummy taking a value of 1 if the countries of the dyad are together in a defense pact, and 0 otherwise. From Correlates of War (2010).

"Oil production": In million tones. From British Petroleum (2009).

"Oil reserves": In 1000 million barrels. From British Petroleum (2009).

"*Oil production/GDP":* Total value of current oil production / GDP. Production quantities and prices from British Petroleum (2009), corresponding GDP in current prices from World Bank (2009).

Appendix B: Evidence on Border Changes

Variable	Obs	Mean	Std. Dev.	Min	Max
Hostility	20564	0.0574305	0.2326689	0	1
War	24387	0.0044286	0.0664015	0	1
Territorial change	24387	0.0036905	0.0606385	0	1
Ind. 1 Oil	24387	0.3297659	0.4701376	0	1
Dist.Oil*I1	24387	0.2739667	0.4194668	0	1
Ind. 2 Oil	24387	0.5484479	0.4976575	0	1
Min.Dist.Oil*I2	24387	0.2758145	0.3920748	0	1
Max.Dist.Oil*I2	24387	0.360698	0.4383344	0	1
Surface (min)	24366	366134.6	906894.1	1.95	9632030
Surface (max)	24366	2294903	4146068	340	1.71E+07
Pop. (min)	20418	9458.731	17790.53	16.866	234694
Pop. (max)	20418	54522.26	117102.3	64.025	1129866
GDPpc (min)	18075	4128.787	5710.022	88.47964	57259.23
GDPpc (max)	18075	8070.147	9460.969	117.8336	104707.5
Democracy (min)	20055	-2.663725	7.115371	-10	10
Democracy (max)	20055	2.835403	7.242276	-10	10
Capabilities (min)	20489	0.0032423	0.0099355	0	0.176526
Capabilities (max)	20489	0.0221372	0.0429604	3.00E-06	0.363988
CW1	24387	0.263009	0.4402763	0	1
CW2	24387	0.0405544	0.1972596	0	1
Bilat. Trade / GDP	17201	0.002920	0.007120	0	0.120824
Defensive pact	19948	0.3889112	0.4875153	0	1
Oil prod.(max)	18854	53.7746	108.8133	0	569.5
Oil prod.(min)	18854	5.316527	23.89532	0	498.7
Oil res.(max)	13965	17.58999	46.05685	0	264.3
Oil res.(min)	13965	2.042521	12.07888	0	138.4
Oil/GDP(max)	17907	0.1036509	0.1868859	0	1.213318
Oil/GDP(min)	17907	0.0232266	0.0925642	0	1.036548

Table 5: Descriptive Statistics

	(1)	(2)	(3)	(4)
	Dependent variable: Territorial Change			
Hostility	0.018***		0.015***	
	(0.006)		(0.004)	
War		0.070***		0.064***
		(0.022)		(0.020)
Country FE	No	No	Yes	Yes
Observations	20564	24387	20564	24387
R-squared	0.013	0.014	0.033	0.031

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2008. OLS regressions with intercept in all columns. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. All specifications control for annual time dummies (not displayed).

Table 6: Conflict and Border Changes

	Dependent variable: Territorial change								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ind. 1 Petrol	0.002	0.008***	0.005	0.014**	0.020***	0.024**	0.002	0.007**	0.005
	(0.001)	(0.003)	(0.003)	(0.007)	(0.007)	(0.011)	(0.002)	(0.003)	(0.004)
Dist.Petrol*I1	-0.001	-0.004	-0.004	-0.016**	-0.021***	-0.023**	-0.002	-0.003	-0.003
	(0.002)	(0.002)	(0.003)	(0.007)	(0.007)	(0.009)	(0.002)	(0.003)	(0.004)
Ind. 2 Petrol	0.007***	0.017***	0.008*	0.006	0.012**	0.007	0.006***	0.015***	0.008
	(0.002)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.002)	(0.005)	(0.006)
Min.Dist.Petrol*I2	-0.001	-0.003	-0.001	0.002	0.000	-0.003	-0.005	-0.006*	-0.001
	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.004)	(0.003)	(0.004)
Max.Dist.Petrol*I2	-0.005	-0.008***	-0.006	-0.008	-0.011*	0.001	-0.001	-0.004	-0.006
	(0.004)	(0.003)	(0.005)	(0.006)	(0.006)	(0.003)	(0.004)	(0.003)	(0.006)
Type Petrol	All	All	All	Offshore	Offshore	Offshore	Onshore	Onshore	Onshore
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Add. Controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	23768	23768	11401	23768	23768	11401	23768	23768	11401
R-squared	0.011	0.027	0.035	0.012	0.028	0.037	0.011	0.027	0.034

Note: The unit of observation is a country pair in a given year. The sample covers all direct contiguous country pairs of the Correlates of War list and the years 1946-2008. OLS regressions with intercept in all columns. Significance levels *** p<0.01, ** p<0.05, * p<0.1. In all columns robust standard errors clustered at the dyad level in parenthesis. All independent variables are taken as first lag. All specifications control for minimum and maximum surface and annual time dummies (not displayed). In addition, columns 2, 3, 5, 6, 8, and 9 include country fixed effects for each country of the dyad. In addition, columns 3, 6, and 9 include the following set of unreported control variables: Minimum population, maximum population, minimum GDP per capita, maximum GDP per capita, minimum democracy score, maximum democracy score, minimum capabilities, maximum capabilities, dummy for one country having civil war, dummy for both countries having civil war, bilateral trade / GDP, defensive pact, and last period's territorial change in the dyad.

Table 7: Petrol Location and Border Changes