Web Appendix to
Detecting Illegal Arms Trade

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1 Modeling competition among arms producing firms

We use a model of Cournot competition with barriers to entry to model the arms production. In the first stage of period t, the potential entrants observe the realization of the state –Embargo or not Embargo–, and then decide to enter or not enter the market. The firms that enter pay a fixed cost K to sell arms in the Embargo state. This cost does not apply to sales in the Non-Embargo state. In the second stage of period t, the N_t firms that entered the market observe the demand realization α_t and choose production levels q_t in a Cournot game. We rule out repeated game strategies and assume that, in each time period t, firms play a static equilibrium.

We consider two types of firms with identical demand and identical (linear) production costs $c(q_t) = cq_t$, with $c > 0$, but different legal and reputational cost K. For the high-cost firms H, the legal and reputational cost K^H is high enough that these firms do not sell arms in the Embargo state. For the low-cost firms L, instead, the cost is zero ($K^L = 0$).[1] We also assume that, due to barriers to entry, only a fixed number of firms can enter the market: at most N^H firms of the high-cost type and at most N^L firms of the low-cost type. We first analyze the competition in the second stage, and then characterize the entry decision in the first stage.

Competition. We consider symmetric equilibria in the second stage of period t where all firms choose the same quantity q_t. Hence, aggregate supply Q_t in period t is equal to $N_t q_t$. The aggregate demand function for the market is $\alpha_t D(P_t)$ where α_t is a demand shift capturing shifts in demand due to changes in conflict. We write the equilibrium inverse demand function $P_t = P[N_t q_t/\alpha_t]$. We assume that P is twice-differentiable, with $P'(.) < 0$ and $P''(.) \leq 0$, and $\lim_{Q\to\infty} P(Q) < c < P(0)$.

[1] This is a simplifying assumption. More generally, we can allow the cost of entry K^L to be positive, but smaller than K^H. This would not affect our main Predictions as long as the entry cost is smaller than the expected profits under embargo $E\pi_E^L$.

The assumption $P'(.) < 0$ is simply a requirement that demand curves be downward-sloping. The other assumptions guarantee the existence and the uniqueness of the solution to the profit-maximization problem in the second stage.

Let $\bar{q}_t$ be the average production level of the $N-1$ competitors, then the second-stage maximization problem for the firm is

$$\max_{q_t} \Pi(q_t|\alpha_t, N_t) = P\left[\frac{(N_t-1)\bar{q}_t + q_t}{\alpha_t}\right] q_t - cq_t.$$

The first order condition for each firm in a symmetric equilibrium is:

$$P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{q_t^*}{\alpha_t} + P\left[\frac{N_t q_t^*}{\alpha_t}\right] - c = 0. \tag{1}$$

For a given α_t and N_t, equation (1) has one and only one solution q_t^*. This follows because the left-hand-side of equation (1) is decreasing in q_t^*, is positive for $q_t^* = 0$, and is negative in the limit as $q_t^* \to \infty$. Given a solution q_t^*, we define the equilibrium profits $\Pi^*(\alpha_t, N_t) = \Pi(q_t^*|\alpha_t, N_t)$.

We now derive the comparative statics of the equilibrium profits $\Pi^*(\alpha_t, N_t)$ with respect to demand shifts α_t and with respect to the number of firms N_t. First, we consider the impact of an increase in demand α_t for given N_t. In a similar set-up, DellaVigna and Pollet (2007) show that, with constant marginal cost, production increases proportionally with the demand shift: $\partial q_t^*(\alpha_t)/\partial\alpha_t = q_t^*(\alpha_t)/\alpha_t$. Using this property, we solve for the derivative of equilibrium profits $\Pi^*(\alpha_t, N_t)$ with respect to the demand shift α_t:

$$\begin{aligned}\frac{d\Pi^*(\alpha_t, N_t)}{d\alpha_t} &= P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\left(\frac{\partial q_t^*}{\partial\alpha_t} - \frac{q_t^*}{\alpha_t}\right)\left(\frac{N_t q_t^*}{\alpha_t}\right) + \left(P\left[\frac{N_t q_t^*}{\alpha_t}\right] - c\right)\frac{\partial q_t^*}{\partial\alpha_t} = \\ &= \left(P\left[\frac{N_t q_t^*}{\alpha_t}\right] - c\right)\frac{q_t^*}{\alpha_t} = \frac{\Pi^*(\alpha_t, N_t)}{\alpha_t},\end{aligned} \tag{2}$$

where in the second step we used the property $\partial q_t^*(\alpha_t)/\partial\alpha_t = q_t^*(\alpha_t)/\alpha_t$ and in the third step we substituted the definition of $\Pi^*(\alpha_t, N_t)$. Hence, the derivative of profits with respect to a demand shift α_t is increasing in the level of profits $\Pi^*(\alpha_t, N_t)$, a property we use below.

Similarly, we can derive the comparative statics of the profits with respect to the number of firms N_t, for a given α_t. We provide bounds on the response of q_t^* to changes in N_t: $-q_t^*/N < \partial q_t^*/\partial N_t < 0$. As the number of firms increases, the production of each firm decreases ($\partial q_t^*/\partial N_t < 0$), but not so much that total production $N_t q_t^*$ may fall ($\partial q_t^*/\partial N_t > -q_t^*/N_t$). (The response of total production to an increase in q_t^* is $\partial(N_t q_t^*(N_t))/\partial N_t = N_t[\partial q_t^*/\partial N_t + q_t^*/N_t]$).

Claim. For a given α_t, $-q_t^*/N < \partial q_t^*/\partial N_t < 0$ holds.

Proof. In the unique equilibrium, condition (1) must hold. We can then use the implicit function theorem to obtain $\partial q_t^*/\partial N_t$. We obtain:.

$$\frac{\partial q_t^*}{\partial N_t} = -\frac{q_t^*}{N_t}\frac{P''\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{q_t^*}{\alpha_t^2} + P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{1}{\alpha_t}}{P''\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{q_t^*}{\alpha_t^2} + P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{1}{N_t\alpha_t} + P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\frac{1}{\alpha_t}},$$

where we have collected q_t^* in the numerator and N_t in the denominator. The condition $\partial q_t^*/\partial N_t < 0$ follows given $P'' < 0$ and $P' < 0$. The condition $\partial q_t^*/\partial N_t > -q_t^*/N$ follows since the second fraction is smaller than 1. **Q.E.D.**

Using this Claim, we establish that equilibrium profits $\Pi^*(\alpha_t, N_t)$ are a decreasing function of the number of firms N_t, a property we use below:

$$\frac{d\Pi^*(\alpha_t, N_t)}{dN_t} = P'\left[\frac{N_t q_t^*}{\alpha_t}\right]\left(\frac{\partial q_t^*}{\partial N_t} + \frac{q_t^*}{N_t}\right)\left(\frac{N_t q_t^*}{\alpha_t}\right) + \left(P\left[\frac{N_t q_t^*}{\alpha_t}\right] - c\right)\frac{\partial q_t^*}{\partial N_t} < 0. \tag{3}$$

The inequality follows since both terms in expression (3) are negative, the first because $\partial q_t^*/\partial N_t > -q_t^*/N_t$ and the second because $\partial q_t^*/\partial N_t < 0$.

Entry. Going back to the first stage of period t, we consider the entry decision. In the non-Embargo state, there are no fixed costs of entry. If all firms enter, that is, $N_t = N^H + N^L$, the firms earn expected profits $E\pi_N = \int \Pi^*\left(\alpha_t, N^H + N^L\right) dF_N(\alpha)$. We assume $E\pi_N \geq 0$, that is, firms earn non-negative profit in the case of full entry. This implies full entry: $N_t^* = N^H + N^L$. The profits $E\pi_N$ are the same for high- and low-cost firms.

In the Embargo state, instead, the entry costs differ across the two types of firms. We assume that the cost K^H is high enough to deter entry of high-cost firms, that is, $K^H > E\pi_E = \int \Pi^*\left(\alpha_t, N^L\right) dF_E(\alpha)$. The high-cost firms, hence, earn zero profits in the Embargo state: $E\pi_E^H = 0$. The low-cost firms, instead, face no costs of entry, and find it optimal to enter, that is, $N_t^* = N^L$. The profits $E\pi_E^L$ under Embargo are higher than the profits under Non-Embargo $E\pi_N$ for two reasons: (i) the demand for arms α_t in the Embargo state first-order stochastically dominates the demand for arms in the Non-Embargo state; (ii) entry N_t in the Embargo state is lower than in the Non-Embargo state. Since higher demand α_t and lower entry N_t both raise profits, $E\pi_E^L > E\pi_N$ follows.

This identifies the parameters $E\pi_E$ and $E\pi_N$. To obtain the parameters $\pi_N'(\alpha_t)$ and $\pi_E'(\alpha_t)$, we use expression (2). In the case of Non-Embargo, we obtain $\pi_N^{L\prime}(\alpha_t) = \pi_N^{H\prime}(\alpha_t) = \pi_N(\alpha_t)/\alpha_t > 0$: both types of firms have an equal and positive derivative of profits with respect to demand shifts. In the case of Embargo, the high-cost firms do not produce ($\pi_E^{H\prime}(\alpha_t) = 0$), while the low-cost firms produce and earn profits: $\pi_E^{L\prime}(\alpha_t) = \pi_E(\alpha_t)/\alpha_t$. Given $\pi_E(\alpha_t) > \pi_N(\alpha_t)$, it follows that $\pi_E^{L\prime}(\alpha_t) > \pi_N^{L\prime}(\alpha_t)$ for all α_t. Hence, the profits for low-cost companies are more responsive to demand shifts under an embargo than outside of an embargo.

2 Data and Additional empirical results

Measures of Cost of Embargo Violation. In addition to the two benchmark measures described in the text (corruption and arms transparency), we describe here five additional measures.

As an alternative measure of corruption, we use the index of *Control of corruption* (CC) proposed

by Kaufmann, Kraay and Mastruzzi (2006) for the years from 1994 to 2004. This index captures 'the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests' (Kaufmann et al. (2006), p.4). Compared to the CPI index, the CC index is estimated from a larger number of data sources and only uses data for the current year (as opposed to the current year and two previous years as the CPI). As for the CPI index, we use a time-average to form an above-the-median indicator and a continuous standardized measure.

We also identify the countries that did not belong to the OECD in 1985. Membership in an international organization is likely to raise the reputational costs of violating international rules on arms embargo.

We use the measure of press freedom provided by *Freedom House* for the years 1994-2004. Countries with a less free press are less likely to monitor illegal transactions conducted by companies head-quartered in their country. We average the measure across the years and define an indicator for below-median press freedom and standardize the continuous variable.

An additional measure, also produced by *Transparency International*, is the *Bribe Payers Index* (BPI). This index ranks the top 30 exporting countries according to their propensity to bribe abroad, and is constructed from the opinions of business executives. We use the most accurate and comprehensive definition of the index, that is the 2006 BPI.[2] While the CPI measures the likelihood that firms corrupt officials in their own countries (e.g., to obtain licenses), the BPI captures the likelihood that firms bribe the officials of importing countries (either the conflict countries or some third, transit country). Unfortunately, the BPI index covers only a subset of the countries in our sample. We define a discrete and continuous variable using the same methodology as for the corruption variable.

Finally, we use the self-dealing index of Djankov et al. (2006) as a measure of protection of small shareholders. In countries where small shareholders have fewer control rights (high self-dealing), they are also less likely to have access to information about illegal behavior by the managers. We define a discrete and continuous variable of high self-dealing.

In Table A3 in the Web Appendix we list separately the companies in OECD markets and non-OECD markets, and we indicate whether the countries where the companies are head-quartered belong to countries with low cost of embargo violation according to the measures above.

Robustness Checks. In Table 5 of the Web Appendix we present robustness checks: (i) we add per-capita GDP of the country producing arms as an additional control (also interacted with the embargo measures), and show that the effect of the corruption measure is not affected by a control for the income diferences (Column 1); (ii) we account differently for the time difference

[2]We do not average this measure with the previous years because the measure for 2006 is not comparable with the measure for the previous years.

between the country of the event and the stock market where the company is traded by shifting dates with a time difference of more than 8 hours, leaving hte results unaffected (Column 2); (iii) we examine the role of time-series correlation and show that the standard errors are somewhat smaller when we cluster by company (Column 3); (iv) we adopt a more conservative approach to deal with stale price series and drop all company-year observations with fewer than 230 days with non-stale returns; the results are unaffected (Column 4); (v) using the two-day abnormal returns $e_{i,t}^{(0,1)}$ (instead of $e_{i,t}^{(-1,1)}$) reduces the estimated γ for companies in low-corruption countries, but has little effect on the estimated γ^D for companies in high-corruption countries (Column 5); (vi) we show that the results do not depend on the market correction, since we obtain similar results using raw returns ($r_{i,t}^{(-1,1)}$) or returns net of the market ($r_{i,t}^{(-1,1)} - r_{m,t}^{(-1,1)}$) (Columns 6 and 7).

Timing. In Appendix Table A6, we investigate on which day the stock returns incorporate the information of the event. We run specifications as in equation (2) in the main text, except that the dependent variable is a 1-day abnormal return at different windows around the event. Half of the impact of the events for the high-corruption countries (γ^D) occurs on the day of the event, and about one fourth of the impact each occurs on the day before and the day after the event. This suggest that our coding of the event date is fairly accurate. Somewhat surprisingly, the impact for the low-corruption countries (γ) occurs more on the day before than on the other days.

Individual detection methodology. In Appendix Table A7 we illustrate the categorization we use for the individual detection results discussed in Section 7 of the paper. Columns (1)-(6) show the company, the country, the event, whether the event occurs during an embargo, and our classification of the effect on the intensity of conflict. Column (7)-(8) report the event return $e_{i,t}^{(-1,1)}$ and the p-value of the test that $e_{i,t}^{(-1,1)} = 0$ against the one-sided alternative. In Column (9) we classify the type of detected reaction (if any) using the relationship between the sign of conflict intensity (Column (6)) and that of the event return (column (7)), and the presence of embargo (Column (5)).

Company A displays a significant positive abnormal return in correspondence of the first event for Ethiopia, an event where conflict intensity increased before the embargo. We categorize this reaction as 'Outside_React' (Column (9)). Subsequently, this company reacts negatively to the news of the peace treaty signed by Ethiopia and Eritrea, an event lowering conflict during the embargo. This reaction is categorized as 'Illegal_React', since it is consistent with illegal arms sales. Interestingly, the same company displays reactions consistent with illegal arms trades also for the conflict in Former Yugoslavia. Company B instead displays no significant reaction to these events.

Because isolated reactions may be the result of noise, we look for multiple reactions for a company within a conflict. We define a '*Chain of Illegal Reactions*' as a sequence of at least two

statistically significant reactions for the same conflict, either *Outside_React* and *Illegal_React*, or a sequence of multiple *Illegal_React* reactions. For example, in Table A7, Company A has a chain of illegal reactions both in Ethiopia and in Yugoslavia, while Company B has no 'chain'.

Over the whole sample, we find a total of 23 company-country pairs with a chain of illegal reactions (Column (1) of Appendix Table A8). These chains pertain to 19 different companies, as two companies display chains in two embargoes and one company in three embargoes. To evaluate the frequency of these chains, we compare it to the number of all possible combinations of events within a company-country pair that could have led to identifying a chain (Column (2)). For example, in a country with three events occurring during an embargo, a chain requires at least two significant reactions in the illegal directions: either events 1-2, or 1-3, or 2-3. For a company with non-missing price data for all three events, there are three possibilities of chain; for a company with missing returns in event 1, instead, there is only one possibility. In general, let $n_{i,j}$ be the number of events inside the embargo with non-missing returns for company i in country j. Similarly, let m_i the number of events outside the embargo with non-missing returns for company i in country j. The number of possible chains for the country-company pair is $n_{i,j}^2/2! + m_{i,j}n_{i,j}$, where the first addendum corresponds to sequences of two illegal reactions inside the embargo and the second to sequences of one reaction outside and one illegal reaction inside. Column (3) reports the percent of possible chains (Column (2)) that are *actual* chains (Column (1)), which is 0.6 percent.

In the rest of Appendix Table A8 we provide aggregate statistics by sub-groups. Since the sample size of potential violators is small, this evidence should be considered as suggestive. The country with the greatest number of violations is Liberia, where 8 companies displayed a chain of reactions consistent with embargo violation, that is, 1.5 percent of the potential chains. Sudan follows with 7 chains of reactions (1.46 percent incidence). Next are Angola with 3 chains (0.64 percent incidence) and Sierra Leone with 4 chains (0.24 percent incidence).

Next, we evaluate the relationship with our proxies of the cost of embargo violation. In absolute levels, there is a higher number of violators among companies located in low-corruption (that is, high-cost) countries: 14 against 9. However, once we correct for differences in the number of return observations, the incidence of chains is higher in high-corruption countries, as expected: 0.88 percent versus 0.50 percent. The pattern is similar using the arms transparency index. The percentage of significant illegal chains is instead about the same for low- and high-cost companies when we use the other proxies. The results using the corruption index and the arms transparency index indicate a two-fold pattern of results. First, companies in low-cost countries appear more likely to engage in illegal arms trading, consistent with Prediction 1.(ii) and with the findings in Section 2. Second, a sizeable number of companies from high-cost countries are identified as potential violators too. This clarifies that our earlier findings did not imply that *only* companies from high-corruption countries were detected as violating embargoes.

Appendix Table A1. List of Countries with Arms Embargoes

Country	Embargo Target	Date Imposed	Date Lifted	Res. No.	By	Included
(1)	(2)	(3)	(4)	(5)	(6)	(7)
South Africa		11/4/1977	5/24/1994	UNSCR 418	UN	No (too early)
Iraq		8/6/1990	--	UNSCR 661	UN	No (Gulf War)
Former Yugoslavia		9/25/1991	10/1/1996	UNSCR 713	UN	Yes
		3/31/1998	9/10/2001	UNSCR 1160	UN	
Somalia		1/23/1992	--	UNSCR 733	UN	Yes
Libya		3/31/1992	12/9/2003	UNSCR 748	UN	No (no war)
Liberia		11/19/1992	--	UNSCR 788	UN	Yes
Haiti		10/13/1993	10/15/1994	UNSCR 841	UN	No (no event during embargo)
Angola	UNITA	9/15/1993	12/9/2002	UNSCR 864	UN	Yes
Rwanda		5/17/1994	8/16/1995	UNSCR 918	UN	Yes
	Rebels	8/16/1995	--	UNSCR 1011	UN	
Sudan		3/15/1994	9/28/2001	94/165/CFSP	UN	Yes
		7/30/2004	--	UNSCR 1556	UN	
Sierra Leone		10/8/1997	6/5/1998	UNSCR 1132	UN	Yes
	Rebels	6/5/1998	--	UNSCR 1171	UN	
Ethiopia & Eritrea		5/17/2000	5/16/2001	UNSCR 1298	UN	Yes
Afghanistan	Taliban	12/19/2000	--	UNSCR 1267	UN	No (Afghan War)

Notes: The Table lists all embargoes imposed from 1975 on by the United Nations. Column (1) and (2) list the country affectd and the embargo target, if different from the whole nation. Columns (3) and (4) report the date the Embargo was imposed and the date the embargo was lifted, if any. Columns (5) and (6) report the resolution number and the organization issuing the embargo. Finally, Column (7) states whether the embargo is included in the data set in this paper, and if not why.

Appendix Table A2. List of Events (with Emphasis for Events under Embargo)

Country	Date Event	Type of Event	Event Description	Effect on Hostilities	Event Surpr.	Event Import.
Angola	12/22/1988	Peace Agreement	Angola, Cuba and, South Africa reach agreement. South Africa agrees to withdraw troops.	Decreases	2.84	32.00
	12/14/1998	Major Battle	UNITA attacks town of Cuito.	Increases	1.67	28.00
	09/28/1999	Ceasefire	Top UNITA general and 2,000 rebels surrendered in Bailundo.	Decreases	2.32	21.50
	02/22/2002	Assassination	Jonas Savimbi was killed on Feb. 22 by soldiers of the Angolan army.	Decreases	3.69	54.50
Ethiopia	02/06/1999	Major Battle	Fighting renews after a several month lull; heavy casualties.	Increases	3.27	63.00
	05/12/2000	Major Battle	Ethiopia launches major offensive against Eritrean positions.	Increases	2.69	58.50
	12/12/2000	Peace Treaty	Ethiopia and Eritrea sign a treaty formally ending their 2 year war.	Decreases	1.87	35.50
Liberia	04/29/1996	Fighting Resumes	Fighting resumes; Liberia's head of state, Wilton Sankawulo, and Charles Taylor flee.	Increases	6.95	36.50
	09/19/1998	Major Battle	Fighting erupts in Monrovia between government forces and partisans of former warlord Roosevelt Johnson.	Increases	4.59	19.50
	08/10/1999	Major Battle	Liberian president declares emergency. Fighting rages between government troops and forces who seized the key town of Kolahun in northwest. State of emergency declared.	Increases	3.68	28.50
	06/05/2003	Major Battle	LURD rebels launch attack on Monrovia, then withdraw. 300-400 people die and others fled.	Increases	1.44	39.50
Rwanda	10/21/1993	Coup	Burundi President Melchior Ndadaye executed by his captors after a coup.	Increases	22.00	16.50
	04/06/1994	Assassination	The airplane carrying President Habyarimana was shot down as it prepared to land at Kigali. Military and militia groups began rounding up and killing all Tutsis as well as political moderates irrespective of their ethnic backgrounds.	Increases	34.67	52.00
	07/04/1994	Major Battle	RPF capture Kigali.	Decreases	1.68	59.50
Sierra Leone	04/29/1992	Coup	Captain Valentine Strasser stages a coup and removes President Momoh from power.	Increases	17.33	13.00
	02/26/1996	Elections	Elections organized by the military junta give victory to the Sierra Leone People's Party.	Decreases	2.61	23.50
	05/25/1997	Coup	Major General Johnny Paul Koroma deposes President Kabbah in a military coup, suspends the constitution, bans demonstrations, and abolishes political parties. Kabbah flees to Guinea to mobilise international support.	Increases	16.67	50.00
	03/10/1998	Return to power	The elected president of Sierra Leone, Ahmad Tejan Kabbah, returns home - ten months after he was forced into exile by a military coup.	Decreases	2.67	40.00
	01/06/1999	Coup Attempt	Unsuccessful coup attempt by Revolutionary United Front.	Increases	6.25	86.00
	05/18/1999	Ceasefire	Tentative ceasefire between government forces and RUF.	Decreases	2.26	21.50
	05/17/2000	Leader Captured	Rebel leader Foday Sankoh captured. His capture came nine days after he had disappeared from his home where he had been detained under house arrest.	Decreases	1.97	107.50
Somalia	10/03/1993	Major Battle	Black Hawk Down Incident. 18 US troops killed leading immediately to increased troops levels.	Increases	4.28	131.50
	08/02/1996	Leader Dies	Aidid, a Somali politician and the leader of the Habr Gidr clan, dies. He had hindered international famine relief efforts in the early 1990s and challenged the presence of United Nations and United States troops in the country.	Decreases	8.70	43.50
Sudan	04/06/1985	Coup	Commander-in-Chief of the people's armed forces of Sudan, Abdel Rahman Mohamed Hassan Suwar al Dahab, terminated the constitution and proclaimed martial law in the country.	Increases	2.25	22.50
	06/30/1989	Coup	National Salvation Revolution takes over in military coup.	Increases	14.00	21.00
	12/13/1999	Fighting Begins	President Bashir dissolves the National Assembly and declares a state of emergency following a power struggle with parliamentary speaker, Hassan al-Turabi.	Increases	3.36	42.00
	07/20/2002	Peace Agreement	After talks in Kenya, government and SPLA sign Machakos Protocol on ending 19-year civil war. Government accepts right of South to seek self-determination after six-year interim period. Southern rebels accept application of Shariah law in North.	Decreases	2.03	31.50
	07/31/2005	Death	John Garang, leader of the rebel Sudan People's Liberation Army and Sudanese First-Vice President, is killed in a helicopter crash.	Decreases	5.71	155.50
Yugoslavia	06/25/1991	Independence	Croatia and Slovenia proclaim independence.	Increases	3.13	47.00
	03/30/2001	Leader Captured	Milošević arrested on charges of abuse of power and corruption	Decreases	4.90	277.00
	03/12/2003	Assassination	The prime minister of Serbia, Zoran Djindjic is assassinated.	Increases	7.19	93.50
	03/17/2004	Start Fighting	Mitrovica, in Kosovo, experiences the worst ethnic violence in the regions since the 1999 war. At least 22 people are killed, and another 500 are injured.	Increases	5.92	77.00

Notes: List of events affecting hostilities occurring inside the embargo period (emphasized) and outside the embargo period (not emphasized). The effect on hostilities is the presumed effect on hostilities of the event. The measures of event importance and of event surprise are based on the number of news stories containing the country name in the days surrounding the event. The event importance is the average daily number of news hits in the day of and the day after the event. The event surprise is the ratio of the event importance and the average daily number of news hits in the four days preceding the event.

Appendix Table A3. Measures of Cost of Embargo Violation for Countries of Headquarter of Arms Companies

OECD Countries								Non-OECD Countries							
Country	Number Of Companies Headquart.	High Corruption (Benchm.)	High Corruption (Alternate)	Low Transp.	Low Press Freedom	High Bribe-Payer	High Self-Dealing	Country	Number Of Companies Headquart.	High Corruption (Benchm.)	High Corruption (Alternate)	Low Transp.	Low Press Freedom	High Bribe-Payer	High Self-Dealing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Usa	53	No	No	No	No	No	No	China	5	Yes	Yes	Yes	Yes	Yes	No
France	14	No	No	No	Yes	Yes	Yes	Brazil	4	Yes	Yes	Yes	Yes	Yes	Yes
Japan	14	Yes	Yes	Yes	No	No	No	South Korea	4	Yes	Yes	Yes	Yes	Yes	Yes
Uk	10	No	No	No	No	No	No	Malaysia	3	Yes	Yes		Yes	Yes	No
Germany	7	No	No	No	No	No	Yes	South Africa	3	Yes	Yes	Yes	Yes	Yes	No
Australia	6	No	No	No	No	No	No	Czech Rep.	2	Yes	Yes	No	No		Yes
Italy	4	Yes	Yes	No	Yes	Yes	Yes	India	2	Yes	Yes		Yes	Yes	No
Canada	3	No	No	No	No	No	No	Israel	2	No	Yes	Yes	Yes	Yes	No
Switzerland	3	No	No	Yes	No	No	Yes	Peru	2	Yes	Yes		Yes		Yes
Norway	2	No	No	No	No		Yes	Chile	1	No	Yes		Yes		No
Spain	2	Yes	No	No	No	Yes	Yes	Russia	1	Yes	Yes	Yes	Yes	Yes	No
Austria	1	No	No	Yes	No	No	Yes	Singapore	1	No	No	Yes	Yes	No	No
Belgium	1	Yes	No	Yes	No	No	No		30						
Greece	1	Yes	Yes		Yes		Yes								
Netherlands	1	No	No	No	No	No	Yes								
Sweden	1	No	No	No	No	No	Yes								
	123														

Notes: The Table lists all the countries in which the arms-producing companies are head-quartered. Columns (1) and (2) list the countries, and the number of companies in each country, for the OECD countries (OECD membership is defined as of 1985, the beginning of our sample). Columns (3) through (7) present information on whether the country is above the median in the corruption level (according to the CPI index), Column (3)), in low transparency (Column (4)), in low press freedom (Column (5), in high payment of bribes (BPI Index, Column (6)), in high self-dealing (Column (7)). Columns (8) though (14) present the same information for the non-OECD countries. The measures of corruption are defined in the text.

Appendix Table A4: Arms-Producing Companies in the Sample

Company Name	Country	NoObs	Source	Company Name	Country	NoObs	Source	Company Name	Country	NoObs	Source
Advanced Tchn.Prds.	Usa	3367	W	United Technologies	Usa	5477	S	Orica	Australia	5475	W
Alliant Technologies \	Usa	3910	WS	Venturian	Usa	4001	W	Transfield Services	Australia	1040	S
Allied Defense Group	Usa	5420	W	Aerospatiale Matra	France	132	W	Alenia	Italy	1619	S
Anteon International	Usa	781	S	Charlatte	France	1824	W	Alenia (Dus)	Italy	519	S
Armor Hdg.	Usa	2605	S	Cs Communication S\	France	4648	W	Breda	Italy	2078	W
Ball	Usa	5475	W	Dassault Aviation	France	4692	W	Ericsson	Italy	4505	S
Blount International	Usa	1548	W	Eads (Par)	France	1301	W	Cae	Canada	5453	S
Boeing	Usa	5475	WS	Explosifs Et Produits (	France	3474	W	Snc-Lavalin Group	Canada	4926	W
Caci International	Usa	5464	S	Geci International	France	1031	W	Spar Aerospace	Canada	4425	W
Computer Scis.	Usa	5474	S	Latecoere	France	4097	W	Compagnie Financier	Switzerland	1910	W
Cordant Technologies	Usa	4010	W	Matra	France	1657	W	Ems-Chemie	Switzerland	4431	W
Cubic	Usa	5477	S	Sagem	France	82	S	Richemont	Switzerland	4431	W
Curtiss Wright	Usa	5477	S	Snecma	France	256	W	Dyno	Norway	3309	W
Diehl Graphsoft	Usa	1140	S	Thales (Adr)	France	4890	W	Kongsberg Gruppen	Norway	2866	W
Ducommun	Usa	5446	W	Thales (Ex Thomson-	France	4692	W	Indra Sistemas	Spain	2402	S
Dynamic Materials	Usa	4028	W	Verney Carron	France	1396	W	Tubos Reunidos	Spain	486	W
Dyncorp	Usa	961	S	Asahi-Seiki Manufactu	Japan	3742	W	Steyr-Daimler-Puch	Austria	3059	W
Engd.Support System	Usa	5201	S	Daicel Chemical Indus	Japan	5475	W	Sabca	Belgium	3099	W
Esco Technologies	Usa	1301	W	Daikin Industries	Japan	5475	W	Econ Industries	Greece	1071	W
Firearms Training Sys	Usa	1724	W	Hosoya Pyrotechnics	Japan	2772	W	Fokker	Netherlands	3382	W
Gencorp	Usa	5475	W	Howa Machinery	Japan	5475	W	Saab Scania	Sweden	1679	W
General Dynamics	Usa	5475	WS	Ishikawa Seisakusho	Japan	5475	W	Anhui Leimingkehua	China	246	W
General Electric	Usa	5477	S	Japan Carlit	Japan	5159	W	Guizhou Jihlian	China	232	W
Goodrich Corporation	Usa	5475	WS	Kanematsu Engineeri	Japan	779	W	Jiangsu Gaochun Cer	China	518	W
Grumman	Usa	2417	WS	Miroku	Japan	3313	W	Shaanxi Aerospace P	China	518	W
Halliburton	Usa	5474	S	Mitsubishi Electric	Japan	5477	S	Wuhan Plastics Indus	China	2015	W
Harris	Usa	5477	S	Mitsubishi Plastics	Japan	5475	W	Amadeo Rossi Pn 10(	Brazil	696	W
Hi Shear Technology	Usa	2836	W	Nec	Japan	5477	S	Cbc Cartucho Pn	Brazil	38	W
Honeywell Internation	Usa	5216	S	Ricoh Elemex Corpor	Japan	4410	W	Embraer On	Brazil	1824	S
Jacobs Engr.	Usa	5477	S	Toshiba	Japan	5477	S	Forja Taurus Pn	Brazil	2291	W
Lockheed Martin	Usa	2606	WS	Alvis	Uk	4762	W	Daewoo Precision Ind	Southkorea	1427	W
Mantech International	Usa	778	S	Babcock International	Uk	706	S	First Technologies	Southkorea	3873	W
Martin Marietta	Usa	2659	W	Bae Systems	Uk	5472	W	Hanwha	Southkorea	5454	W
Mcdonnell Douglas	Usa	3281	W	Cobham	Uk	5374	S	Samsung Techwin	Southkorea	4551	S
Moog	Usa	5477	S	Gkn	Uk	5477	S	Rohas-Euco Industrie	Malaysia	2544	W
Olin	Usa	5475	W	Meggitt	Uk	5261	S	Sugar Bun Corporatio	Malaysia	1819	W
Orbital Sciences	Usa	3910	WS	Smiths Group	Uk	5477	S	Weida	Malaysia	866	W
Oshkosh Truck	Usa	5216	S	Ultra Electronics Hdg.	Uk	2237	S	Aeci	Southafrica	4393	W
Primex Technologies	Usa	799	W	Vickers	Uk	3860	W	Omnia	Southafrica	3101	W
Raytheon	Usa	611	S	Vt Group	Uk	4198	S	Plessey	Southafrica	722	W
Ride	Usa	983	W	H & R Wasag	Germany	4365	W	Aliachem	Czechrep	1138	W
Rockwell Collins	Usa	1042	S	Indus Holding	Germany	2606	W	Ceska Zbrojovka	Czechrep	1055	W
Rohr	Usa	3382	W	Krauss-Maffei	Germany	1082	W	Bharat Electronics	India	2085	S
Starmet	Usa	3869	W	Renk	Germany	4364	W	Ici India	India	3834	W
Stewart & Stevenson	Usa	5477	S	Rheinmetall	Germany	5475	W	Aryt Industries	Israel	1621	W
Sturm Ruger & Co	Usa	5397	W	Rheinmetall Pref.	Germany	5341	W	Elbit Systems	Israel	1824	S
Taser International	Usa	1040	W	Thyssenkrupp	Germany	5477	S	Exsa	Peru	2088	W
Textron	Usa	5474	S	Electro Optic Systems	Australia	1027	W	Famesa Explosivos	Peru	1359	W
Titan	Usa	5327	S	Harrington Group Lim	Australia	881	W	Enaex	Chile	1774	W
Trw	Usa	4679	W	Lomah Corporation	Australia	933	W	Irkut	Russia	205	S
United Defense Indus	Usa	645	S	Metal Storm	Australia	1558	W	St Electronic&Engr.	Singapore	1491	S

Notes: Companies included in the sample of arms-producing companies. The Table reports the country in which the company is head-quartered, the number of observations in the sample, and the source of the data. The Source is coded as follows: "W" indicates that the company is identified as an arms-producing company using the Datastream-WorldScope data set; "S" indicates that the company is listed in the SIPRI list of top 100 arms-making companies; "WS" indicates that the company is present in both data sets.

Appendix Table A5. Stock Market Reaction to War Events: Robustness

Dep. Var.:	Abnormal 3-Day Stock Return (-1,1)				2-Day Abn. Returns (0,1)	3-Day Raw Returns (-1,1)	3-Day Excess Returns (-1,1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Event During Embargo (1=Increase War, -1=Decrease, 0=No Event)	0.0093 (0.0343)	-0.0041 (0.0014)***	-0.0042 (0.0013)***	-0.0042 (0.0018)**	-0.0023 (0.0014)	-0.0045 (0.0024)*	-0.0046 (0.0022)**
Event During Embargo* (High-Corruption Country)	0.0105 (0.0046)**	0.0118 (0.0039)***	0.0115 (0.0036)***	0.0113 (0.0039)***	0.0092 (0.0031)***	0.012 (0.0049)**	0.0117 (0.0040)***
Event During Embargo* (Log GDP in 2000$)	-0.0013 (0.0034)						
High-Corruption Country Indicator	-0.0001 (0.0002)		-0.0001 (0.0002)	-0.0001 (0.0002)	-0.0001 (0.0001)	-0.0004 (0.0002)	0 (0.0002)
Log GDP in 2000$	0.0001 (0.0002)						
Constant	-0.0009 (0.0023)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0023 (0.0002)***	0.0011 (0.0001)***
Shift Date for Time Difference > 8 Hours		X					
Exclude Stale Company-Year Obs.				X			
Clustering of Standard Errors	By Date	By Date	By Company	By Date	By Date	By Date	By Date
N	492541	492541	492541	465369	492541	492541	492541

Notes: An observation in the regression is a trading day for one of the 153 arms-producing companies in the years 1985-2005. The dependent variable is the abnormal 3-day cumulative return. The market correction is computed on the calendar year previous to the trading day. The variable Event During the Embargo takes value 1 if on day t, during the embargo period, an event increases the conflict, takes value -1 if, during the embargo period, an event decreases the conflict, and takes value 0 otherwise. The variable High-Corruption Country is an indicator variable indicating companies head-quartered in countries with above-median corruption according to the Corruption-Perceptions Index of *Transparency International*. The variable Low-Corruption Country is defined conversely for below-median values of corruption.

In Column (2) the event date is shifted by one day if the difference in time zones between the country of the event and the country where the company shares are traded is larger than 8 hours. In Column (3) the standard errors are clustered by date rather than by company as in the other regressions. In Column (4) we drop all company-year observations with fewer than 230 non-stale returns. In Columns (6) and (7) we present the results with raw returns (Column (6)) and returns net of the market return (Column (7)), instead of beta-corrected returns. Robust standard errors clustered by date in parentheses, except in Column

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table A6. Timing of Stock Market Reaction

Dep. Var.:	Abnormal 1-Day Stock Return				
Timing relative to Event:	**(-2,-2)**	**(-1,-1)**	**(0,0)**	**(1,1)**	**(2,2)**
	(1)	(2)	(3)	(4)	(5)
Event During Embargo	0.0003	-0.0019	-0.0009	-0.0013	0.0015
(1=Increase War, -1=Decrease, 0=No Event)	(0.0015)	(0.0007)***	(0.0012)	(0.0009)	(0.0007)**
Event During Embargo*	0.0023	0.0022	0.0058	0.0034	-0.0006
(High-Corruption Country)	(0.0017)	(0.0020)	(0.0019)***	(0.0020)*	(0.0024)
Indicator for High-Corruption	-0.0001	-0.0001	0	0	0
Country	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0	0	0	0	0
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
N	491433	492541	492541	492541	491433

Notes: An observation in the regression is a trading day for one of the 153 arms-producing companies in the years 1985-2005. The dependent variable is the abnormal 1-day stock return for the five days surrounding the event day. The market correction is computed on the calendar year previous to the trading day. The variable Event During the Embargo takes value 1 if on day t, during the embargo period, an event increases the conflict, takes value -1 if, during the embargo period, an event decreases the conflict, and takes value 0 otherwise. The variable High-Corruption Country is an indicator variable indicating companies head-quartered in countries with above-median corruption according to the Corruption-Perceptions Index of *Transparency International*. Robust standard errors clustered by date in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table A7. Detection methodology, An Example

Company (1)	Country (2)	Event Date (3)	Event Type (4)	UN Embargo (5)	Event and Conflict Intensity (6)	Cumulative 3-day Abnormal Return (7)	P-value of Test CAR=0 (8)	Detected Reaction (9)	Detected Chain Of Reactions (10)
Company A	Ethiopia	02/06/1999	Major Battle	No	+	+0.11	0.031	Outside_React	Chain of Illegal Reactions
Company A	Ethiopia	05/12/2000	Major Battle	No	+	+0.03	0.116	.	
Company A	Ethiopia	12/12/2000	Peace Treaty	Yes	-	-0.05	0.039	Illegal_React	
Company A	Yugoslavia	06/25/1991	Independence	No	+	-0.04	0.111	.	Chain of Illegal Reactions
Company A	Yugoslavia	03/30/2001	Leader Captured	Yes	-	-0.12	0.015	Illegal_React	
Company A	Yugoslavia	03/12/2003	Assassination	No	+	+0.12	0.015	Outside_React	
Company A	Yugoslavia	03/17/2004	Start Fighting	No	+	+0.03	0.161	.	
Company B	Yugoslavia	06/25/1991	Independence	No	+	-0.01	0.344		No Chain
Company B	Yugoslavia	03/30/2001	Leader Captured	Yes	-	0.00	0.470		
Company B	Yugoslavia	03/12/2003	Assassination	No	+	+0.02	0.212		
Company B	Yugoslavia	03/17/2004	Start Fighting	No	+	-0.02	0.144		

Notes: "Event and Conflict intensity" in Column (6) is coded as "+" when the event increases demand for arms and "-" when it decreases it. The cumulative 3-day abnormal return in Column (7) is calculated using an event window of (-1,+1) days around the event and an estimation window of 100 trading days. The p-value in Column (8) is computed using use the parametric tests of no abnormal returns of Campbell et al. (1997). In Column (9) we report whether the abnormal return leads to a detected reaction: 'Illegal_React' denotes the case in which the return significantly increases (decreases) at the 10 percent level when conflict increases (decreases) during the embargo; 'Legal_React' denotes the case in which the return significantly decreases (increases) when conflict increases (decreases) at the 10 percent level during the embargo; 'Outside_React' denotes the case in which the return significantly increases (decreases) at the 10 percent level when conflict increases (decreases) outside the embargo. In Column (10) we identify Chains of Illegal reactions when a company within a conflict displays more than one reaction 'Illegal_React' or a combination of a reaction "Illegal_React' and a reaction 'Outside React'.

Appendix Table A8. Detection: Chains of illegal reactions

		# Illegal Chains of Reactions (1)	# Possible Chains of Reactions (2)	Percent of Chains of Illegal Reactions (3)
Full sample		23	3813	0.60%
In which conflicts?				
	Angola	3	467	0.64%
	Ethiopia	1	184	0.54%
	Liberia	8	532	1.50%
By Country Under	Rwanda	0	173	0.00%
Embargo	Sierra Leone	4	1643	0.24%
	Somalia	0	82	0.00%
	Sudan	7	479	1.46%
	Former Yugoslavia	0	253	0.00%
Which type of companies?				
By Corruption	High corruption	9	1019	0.88%
Perception Index	Low corruption	14	2794	0.50%
By Transparency	Low Transparency	10	944	1.06%
of Arms Trade	High transparency	13	2730	0.48%
By Membership in	non-OECD	3	468	0.64%
OECD	OECD	20	3345	0.60%
By Press Freedom	Low Press Freedom	4	767	0.52%
	High Press Freedom	19	3046	0.62%
By Bribe-Payer	High BPI	4	755	0.53%
Index (BPI)	Low BPI	19	2945	0.65%
By Self-Dealing	High self-dealing	7	980	0.71%
Index	Low self-dealing	16	2833	0.56%

Notes: In this Table we report in Column (1) all company-country observations for which we detect a Chain of Illegal reactions. A Chain of Illegal reactions occurs when a company within a conflict displays more than one reaction 'Illegal_React' or a combination of a reaction "Illegal_React' and a reaction 'Outside_React'. 'Illegal_React' denotes the case in which the return significantly increases (decreases) at the 10 percent level when conflict increases (decreases) during the embargo; 'Outside_React' denotes the case in which the return significantly increases (decreases) at the 10 percent level when conflict increases (decreases) outside the embargo. In Column (2) we report the number of all possible combinations of events within a company-country pair that could have led to identifying a Chain. In Column (3) we present the fraction of Chains (Column (1) to possible Chains (Column (2)). We display the information by conflict, and using six different indicator variables of below-median cost of violating an embargo for the country where the company is head-quartered (see Section 4 in the text).