Conservation of Violence

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Abstract

Does the arms trade escalate conflicts? This problem is hard to answer due to many confounding effects. This paper tries to resolve this by using the end of conflicts as an exogenous variation. In so doing, this paper also finds spillover effects of conflicts. The paper first formulated a network model of the weapon market to help illustrate the mechanism in which conflicts ending in other places might affect the situation in other countries. Using traditional data, the empirical analysis shows that peace in other countries indeed increases arms trade in other countries. The paper, on the other hand, cannot reject that the arms trade has no impact on the severity of conflicts.

[1]This paper was written for an independent study project at the University of Tokyo. I thank Professor Yasutora Watanabe, Professor Makiko Nakamuro, and Professor Yasuyuki Sawada for comments on this paper. Please address correspondence to: Shotaro Beppu, University of Tokyo. E-mail: *shotarobeppu0811@g.ecc.u-tokyo.ac.jp*.

1 Introduction

Does an end of a conflict start or aggravate another conflict? This is a critical question for peacekeeping activities as the benefit of negotiating peace can be offset by intensified conflict in other countries. To this end, this paper uses global trade in small arms and light weapons (SALW) to see how conflicts might propagate to other countries. Despite the fact that most conflict-related casualties are caused by SALW, to what extent the influx of SALW affects ongoing or potential conflicting regions remains an open question. It is also a useful tool for investigation, as SALW are more sensitive to market conditions than other larger arms and interpretable in a simple supply and demand model.

This paper starts with the simple observation that all conflicts need weapons and that they cannot be easily self-manufactured. Therefore, buyers and sellers of weapons are subject to their relevant economic conditions. As an example, consider the scenario where a conflict ended. In this case, the demand for weapons in that region will decrease and might lead to lower prices. This will then encourage other buyers in different regions where there is a demand to buy more weapons. In this scenario, then, an end of conflict likely led to more weapons in other regions and aggravated the conditions in already conflicted regions or pushed regions into conflict. This example illustrated that a change in conflicts affects other conflicts, which might not be related at all, through the mechanism of trade in weapons. From this standpoint, as globalisation spreads to even the most distant countries, this may have posed and will pose more problems in the future as anyone has increasing access to weapons.

To test whether the above is indeed the case, this paper first formulates a model inspired by the network literature. Formulating a model in terms of networks is beneficial as it can easily incorporate spillover effects (the fact that your action also influences other people in different degrees). In this model, there will be a finite number of buyers and sellers of both weapons and other goods. Sellers will try to maximize their profit by producing weapons subject to the demand function. The buyer, on the other hand, will try to maximize its utility conditional on how likely it will need to deploy weaponry. Naturally, if the buyer needs more weapons sellers have more incentive to produce. The network effect is that the market conditions change when the demand from buyers in a country where conflict ended goes close to zero and this changes the behaviour of sellers in even different countries. The model illustrates heterogeneous impacts on weapon trade depending on what kind of country ended its conflict. In most cases, an end of conflict may lead to more arms trade in other countries.

This paper then conducted an empirical analysis to test the results from the model.

Specifically, the paper tests two hypotheses: i) does peace in other countries increase weapon trade to other countries, more so for countries with ongoing conflicts and ii) did the increase in weapons intensify conflicts. The first hypothesis was tested using the OLS estimate quantifying the end of conflicts in other regions. For the second hypothesis, this paper used the instrumental variable approach based on the first hypothesis by assuming the end of the conflict in other regions is unrelated to the ongoing conflict in other countries except for changes in market conditions of weapons. For the first hypothesis, this paper shows that other conflicts indeed affect weapon trade in other countries. For the second hypothesis, this paper cannot reject the null hypothesis that trade intensifies conflicts. In order to understand this further, this paper used a method similar to shift-share research designs; namely, the exposure to the demand shock for conflict ending in other regions depends on the amount of weapon imported from suppliers for the conflict that ended. The result from this specification shows that with more exposure to conflicts ending through import-export relationships, countries have less weapons imported but have more intense conflicts. This result suggests that the network may induce many countries to actually decrease weapon imports which the model shows it might exist.

The paper is structured as follows. Section 2 gives an overview of existing literature. Section 3 describes the overall facts about SALW and conflict. Section 4 defines the model and presents the basic result concerning the spillover effect. Section 6 concerns the empirical analysis to test the results from the model. Section 7 suggests the implication of this result and shows a couple of counterfactual analysis. Section 8 concludes.

2 Literature Review

One of the main strands of conflict research is whether weapons play the role of initiating or aggravating the conflict. From a bigger picture, trade literature shows that trade, including arms trade, can help decrease the likelihood of a deadly conflict but increase small scale conflicts (Martin et al. (2008)). On the other hand, Pamp et al. (2018) empirically shows that weapons imported by governments can significantly increase the onset of conflict under volatile conditions. In this case, weapons do not work as a deterrent.

Directly related to this paper is the spillover effects of war termination on other parties. Bara (2018) gives weapons as one of the reasons conflicts can propagate to other neighbouring countries. This is because an end of conflict generates a surplus of weapons within post-conflict societies and markets, including black markets reacting to this. Lane (2016) finds that ethnic intrastate conflicts can often be explained by spillover effects of their neighbouring ethnic communities in other countries. As in Salehyan et al. (2006), conflicts themselves can cause mass immigration and this could fuel future conflict in other areas. This paper specifically focuses on issues after conflict, and thus this issue is not addressed forefront. However, to identify the pure effect of arms trade this paper tries to control these issues.

Contagion of conflict has vital implications for peacebuilding as well. This is because if conflicts are preserved in the region as a whole, the peacebuilding process in one country might not be effective for regional peace. Beardsley (2011) shows that peacebuilding activities addressing problems related to transnational movement of and support for insurgencies are the key for the success of preventing intrastate conflict in other countries and even lighter deployment can help mitigate tension building.

This paper is also related to the general market equilibrium applied to the setting of weapons. Smith and Tasiran (2005) uses SIPRI and WMEAT datasets to estimate the demand functions of weapons at the cross-country level. The main insight was that price is a significant determinant of weapon imports with an elasticity of -1; that is a one percentage point decrease in price is associated with a one percentage point increase in weapons imported. An interesting extension to this is the impact of globalization on this trade. Soysa et al. (2009) shows that globalization likely has differential impacts on countries and as weapons are mostly exported by developed countries to developing countries, it is said that globalization might ease the proliferation of arms trade.

Does this increased imports of weapons raise the possibility of a conflict possibly more deadly. This topic has been investigated using game theory.

Erickson (2013) has shown that arms embargoes are effective in reducing weapon flow. The model formulated in this paper can give insights into how the arms embargo might affect distant countries as well. That is, the market of weapons will be distorted by the arms embargo by a sudden rise in costs and whether cost increased (i.e. whether arms embargo changed the market) can be tested using other countries. Related to the arms embargo, illicit trade is also relevant. As Tierney (2005) shows, arms embargoes have sometimes increased the demand for illicit trade which is not well captured by available data. This is an important point to consider and the model, although not empirically tested, can give some conditions as to what extent illicit trade increases. The literature has tried to quantify illicit trade (Lebacher et al. (2021)) and this would help future studies into this part. Finally, possible international sanctions are also relevant. Hultman and Peksen (2017) shows that international sanctions such as economic sanctions increase the likelihood of conflict whilst arms embargoes do not. This strengthens the need to investigate the impact of the arms embargo as it could be used more often in the future.

Finally, this paper is related to the growing literature on using network analysis. Network analysis is often used in the trade literature as one can express bilateral trade flows of multiple countries as networks and important results from graph theory can be used for analysis. Thurner et al. (2019) uses the endogeneity when countries form weapon trades and shows that inclusion of this increases the accuracy of future weapon trade prediction. This paper also showed that security considerations have gained more importance in the 21st century. Network has also been used for describing arms dependence (Lebacher et al. (2020)), relationship between trade and conflicts (Westveld and Hoff (2011)), and the proliferation of arms (Montgomery and Kinsella (2017)). Networks are also being used to model trade and conflict. Benson and Ramsay (2018) uses Cournot competition in a fixed network to help illustrate the proliferation of weapons after demand in certain countries go to zero. Franke and Öztürk (2015) used networks to model resource allocation of conflicting parties. More generally, it has been applied to investigate whether trade reduces conflict (Jackson and Nei (2015)) and alliances in conflicts (Cranmer et al. (2012)).

3 SALW and Conflict

Small arms and light weapons, SALW, includes pistols, carbines, assault rifles, light machine guns. It is said that there are 640 million in circulation across the world and the primary means of conflicts (Stohl et al. (2012)).SALW is traded across the globe. figure 1 depicts the export share of weapons. As one can observe, the majority of weapons traded are exported by developed countries. This dominance of developed countries are often criticized when these countries export weapons to developing countries. Furthermore, the amount traded seemed to have exploded in the 21st century (figure 2). As explored in section 2, there is numerous research concerning this. The impact of this influx of weapons however is not well explored yet.

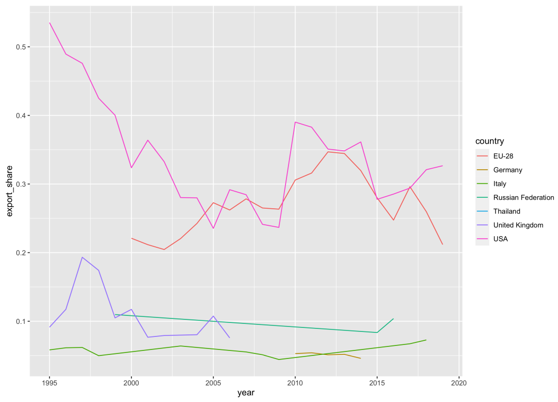


Figure 1: Top exporters of SALW

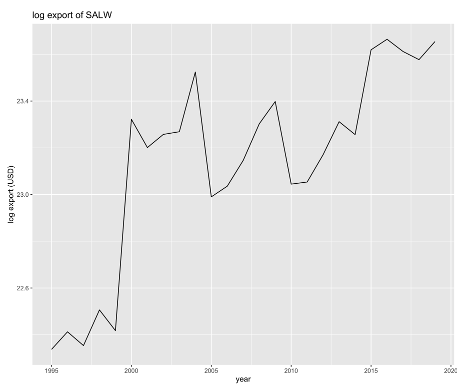
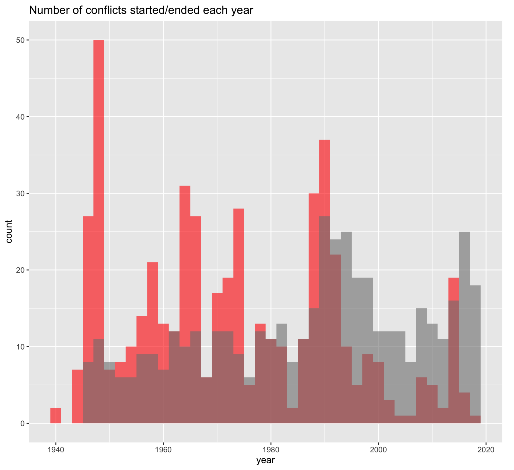


Figure 2: Total exports of arms yearly (USD)

source COMTRADE

One of the reasons an increase in weapon trade does not directly mean negative outcomes is that the world is seeing conflicts ending. UCDP records show that the number of conflicts that saw an end has recently increased. Figure 3 and Figure 4 both shows that across the world, conflicts are ending much more than starting.



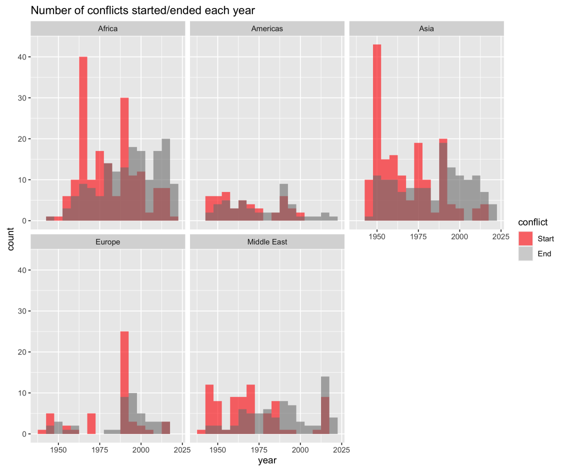
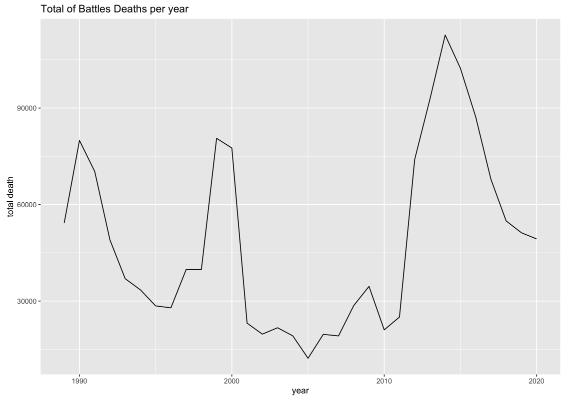


Figure 3: Top exporters of SALW

Figure 4: Total exports of arms yearly (USD)

source UCDP-PRIO

This leads to an important question. That is, what are the causes of an increase in weapon trade whilst we see more wars ending? A couple of explanations are plausible. One important point could be missing data. It is possible that the increase in weapons are more to do with reporting as countries started to report more about their weapon trade. However, Stohl and Grillot (2009) does note that there is an increasing amount of weapons distributed across the world. Another explanation is that although the total number of wars is decreasing, the intensity of the wars has increased. An example of this is the Syrian war. Indeed, Figure 5 shows that casualties in the last decade are comparatively higher compared to the 2000s. However, Figure 6 shows that the intensity of war is decreasing. This is measured by the number of occasions where there were 1000 or more battle deaths in a conflict. The reason this paper considers, therefore, is that market conditions of weapon trade change as more wars end; this makes it easier for weapons to be sold in larger quantities. This reason is explored in the next section.



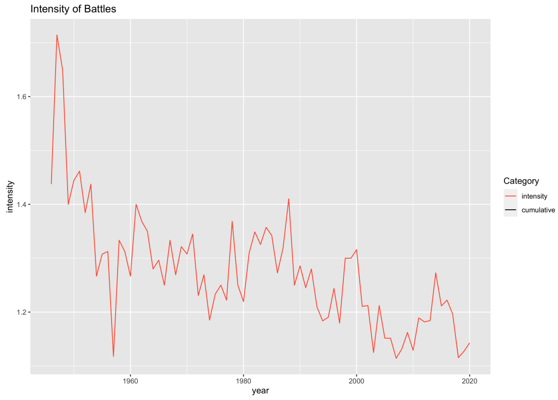


Figure 5: Total number of battle deaths Figure 6: Total exports of arms yearly (USD)

source UCDP-PRIO

4 Model: Arms inflow

4.1 Set Up

4.1.1 Environment

This paper considers a population of buyer and sellers of small arms and light weapons (SALW). Denote $\boldsymbol{\Omega_c} = \{1, 2, ..., N\}$ the set of countries and $\boldsymbol{\Omega_p} = \{1, 2, ..., n\}$ the set of all players. For each $k \in \boldsymbol{\Omega_c}$, let $\boldsymbol{b_k} = \{b_{k,1}, b_{k,2}, ...\}$ be the set of buyers that is in country k and $\boldsymbol{s_k} = \{s_{k,1}, s_{k,2}, ...\}$ be the set of sellers in country k likewise. $\eta_{b_k} = |\boldsymbol{b_k}|, \eta_{s_k} = |\boldsymbol{s_k}|$ is the number of buyers and sellers in country k respectively. From this, denote $\boldsymbol{B} = \{\boldsymbol{b_1}, \boldsymbol{b_2}, ..., \boldsymbol{b_n}\}$ as the set of all buyers in the environment and $\boldsymbol{S} = \{\boldsymbol{s_1}, \boldsymbol{s_2}, ..., \boldsymbol{s_n}\}$ the set of all sellers. The number of buyers is $\eta_b = |\boldsymbol{B}|$ and sellers is $\eta_s = |\boldsymbol{S}|$. An alternative way we could denote the set of buyers and sellers are thus $\boldsymbol{B} = \{1, 2, ..., \eta_b\}$ and $\boldsymbol{S} = \{1, 2, ..., \eta_s\}$.

Subsequently, this paper defines the trade network. For any $s \in \boldsymbol{S}$ and $b \in \boldsymbol{B}$, denote $g_{s,b} = 1$ if trade link is established and $g_{s,b} = 0$ otherwise. By definition $\forall s \forall b, g_{s,b} = \{0, 1\}$ and $g_{bs} = g_{s,b}$. A *network*, $g = \{(g_{s,b})_{s \in \boldsymbol{S}, b \in \boldsymbol{B}}\}$, is a formal description of the trade links that exist between all buyers and sellers. Let $\mathbf{G}$ denote all the possible shapes of the network and we denote a *complete network* as g^c which satisfies $g_{s,b} = 1 \; \forall s \in \boldsymbol{S}, b \in \boldsymbol{B}$ and an *empty network* as g^e where $g_{s,b} = 0 \; \forall s \in \boldsymbol{S}, b \in \boldsymbol{B}$. In addition, let $g + g_{s,b}$ and $g - g_{s,b}$ denote the network whereby we replace $g_{s,b} = 0$ with $g_{s,b} = 1$ for the former and vice versa for the latter.

Given this network, sellers sell SALW to buyers. Let $q_{s,b}$ be the amount of SALW sold to $b \in \boldsymbol{B}$ from $s \in \boldsymbol{S}$. Thus, the total amount a buyer b obtains can be written as $q_b = \sum_{s \in \boldsymbol{S}} q_{s,b}$ and the total amount a seller s sells as $q_s = \sum_{b \in \boldsymbol{B}} q_{s,b}$. Let $a_s =$

$(q_{s,1}, q_{s,2}, ..., q_{s,|B|})$ be the strategy set of seller s and $a = (a_1, a_2, ..., a_{|S|})$ be the strategy profile of this game. Denote for each $k \in \boldsymbol{\Omega_c}$, $Q^b_k = \sum_{b \in b_k} q_b$ and $Q^s_k = \sum_{s \in s_k} q_s$ where the former is the total amount of SALW in country k and total amount sold from country k in the latter. The total amount of SALW is $Q = \sum_{k \in \boldsymbol{\Omega_c}} Q^b_k = \sum_{k \in \boldsymbol{\Omega_c}} Q^s_k$.

4.1.2 Equilibrium

From subsection 4.1.1, seller s tries to sell SALW so as to maximize profit in line with the demand function for each buyer, $P_b(q_b) = f(q_b)$, and cost for selling (production), $C_s(q_s) = g(q_s)$ (both are assumed to be differentiable). From this, the seller's profit can be written as

$$\pi_s(a) = \sum_{b \in \boldsymbol{B}} g_{s,b} P(q_b) q_{s,b} - C_s(q_s). \tag{1}$$

Assuming the network is fixed, each seller will maximize its profit given a_{-s}, the strategy profile of all sellers except s. It is thus possible to obtain an equilibrium. An extension whereby link formation is also endogenous is considered in section 4.3.

4.2 Results

4.2.1 Illustration

Let us first consider a simple example. There are two sellers (s_1 and s_2) and three buyers (b_1, b_2, and b_3). Assume network formation is fixed and as below. The network is common knowledge to all the players.

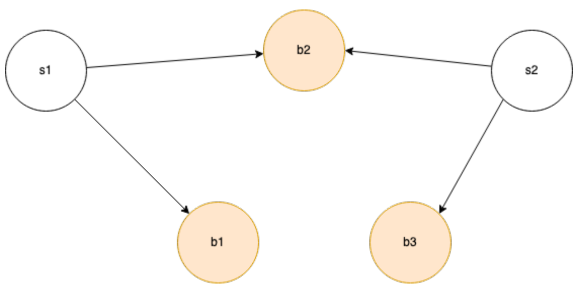


Figure 7: Example of a buyer and seller network

In addition, for $\alpha, \beta, c > 0$

$$P_b(q_b) = \alpha - \beta q_b \tag{2}$$

$$C_s(q_s) = c q_s^2 \tag{3}$$

Then profit for each seller is

$$\pi_{s_1} = P_{b_1}(q_{s_1,b_1})q_{s_1,b_1} + P_{b_2}(q_{s_1,b_2} + q_{s_2,b_2})q_{s_1,b_2} - C_{s_1}(q_{s_1,b_1} + q_{s_1,b_2})$$
$$\pi_{s_2} = P_{b_3}(q_{s_2,b_3})q_{s_2,b_3} + P_{b_2}(q_{s_1,b_2} + q_{s_2,b_2})q_{s_2,b_2} - C_{s_2}(q_{s_2,b_3} + q_{s_2,b_2}).$$

Solving for the first order conditions, we obtain

$$q_{s_1,b_1} = q_{s_2,b_3} = \frac{3\alpha}{10c + 6\beta} \tag{4}$$
$$q_{s_1,b_2} = q_{s_2,b_2} = \frac{\alpha}{5c + 3\beta} \tag{5}$$
$$q_{s_1,b_3} = q_{s_2,b_1} = 0. \tag{6}$$

Now suppose, conflict in country 2 ended and b_3 no longer demands SALW. Then the profit will become

$$\pi'_{s_1} = P_{b_1}(q'_{s_1,b_1})q'_{s_1,b_1} + P_{b_2}(q'_{s_1,b_2} + q'_{s_2,b_2})q'_{s_1,b_2} - C_{s_1}(q'_{s_1,b_1} + q'_{s_1,b_2})$$
$$\pi'_{s_2} = P_{b_2}(q'_{s_1,b_2} + q'_{s_2,b_2})q'_{s_2,b_2} - C_{s_2}(q'_{s_2,b_2})$$

and again solving the first order condition,

$$q'_{s_1,b_2} = \frac{\alpha}{8c + 3\beta} \tag{7}$$
$$q'_{s_2,b_2} = \frac{\alpha\beta + 4\alpha c}{3\beta^2 + 8c^2 + 11\beta c} \tag{8}$$
$$q'_{s_1,b_1} = \frac{3(\alpha\beta + 2\alpha c)}{2(3\beta^2 + 8c^2 + 11\beta c)}. \tag{9}$$

We can see that $q'_{b_2} > q_{b_2}, q'_{b_1} > q_{b_1}$ when $\alpha, \beta, c > 0$. Furthermore, $q'_{b_2} - q_{b_2} > q'_{b_1} - q_{b_1}$. Thus in this simple case, after country 2 ends its conflict, there will be more SALW for both sides in country 1. If b_2 decides to go on the offensive due to more SALW compared to b_1, then this might result in more casualties. If, on the other hand, both sides are risk averse and an influx of weapons worked as a deterrence, there will be less conflict at least in the short term.

4.2.2 The case of two suppliers

Building on section 4.2.1, the model can explore a more general situation with two suppliers. Suppose there are two suppliers s_1 and s_2 and n number of homogeneous buyers which have weapon supply from s_1, s_2 or both. Denote the number of trade links for s_1 as $g_{s_1} = \sum_{b \in \boldsymbol{B}} g_{s_1,b}$ and likewise for s_2, $g_{s_2} = \sum_{b \in \boldsymbol{B}} g_{s_2,b}$. Then, since $n = g_{s_1} + g_{s_2}$ there are $N = g_{s_1} + g_{s_2} - n$ buyers who are supplied by both suppliers, $N_1 = n - g_{s_2}$ buyers supplied by s_1 alone, and $N_2 = n - g_{s_1}$ buyers supplied by s_2 alone. Since, buyers are homogeneous, suppliers will supply the same amount for buyers with only one link and also for buyers with two links (possibly different than the quantity supplied to buyers with only one link). Thus, let $q_{i,1}$ and $q_{i,2}$ be quantity supplied to buyers with only one supplier and both suppliers respectively ($i = s_1, s_2$). Using the same demand and cost function as in section 4.2.1, namely equations 2 and 3, the profits for suppliers will be as follows.

$$\begin{aligned} \pi_{s_i} =& (n - g_{s_{-i}})(\alpha - \beta q_{i,1})q_{i,1} + (g_{s_1} + g_{s_2} - n)(\alpha - \beta(q_{i,2} + q_{-i,2}))q_{i,2} \\ & - c((n - g_{s_{-i}})q_{i,1} + (g_{s_1} + g_{s_2} - n)q_{i,2})^2 \end{aligned} \tag{10}$$

The First Order Condition with respect to $q_{i,1}$ and $q_{i,2}$ implies

$$q_{i,1} = \frac{\alpha - 2cNq_{i,2}}{2(\beta + cN_i)} \tag{11}$$

$$q_{i,2} = \frac{\alpha N - \beta N q_{-i,2} - 2cN_i q_{i,1}}{2(\beta + cN)}. \tag{12}$$

Solving the 4 equations from this gives the equilibrium quantity.

The dynamics of this game can be illustrated by simulation. Set $\alpha = 2,\ \beta = 1,$ and $c = 1$ and generate different numbers of $N,\ N_1,$ and N_2 from the range 1 to 20. The simulation eliminates cases where supplier supplies negative amount to a buyer. The dynamics are robust for different parameters.

First, consider the case when buyers buying only from s_1 end their conflicts. Due to symmetry, this is directly applicable to cases for s_2 as well. Figure 8 shows the change in supplies for different types of buyers. Each line corresponds to the same N and N_2. 2 link buyers means buyers who get supply from both suppliers while the others only get supplied by either. For buyers who trade with s_1, their trade amount increases as more buyers leave s_1. The increase is steeper for those that only trade with s_1. Importantly, due to suppliers sharing some of their buyers, a decrease in buyers for s_1 also leads to more weapons for buyers only trading with s_2.

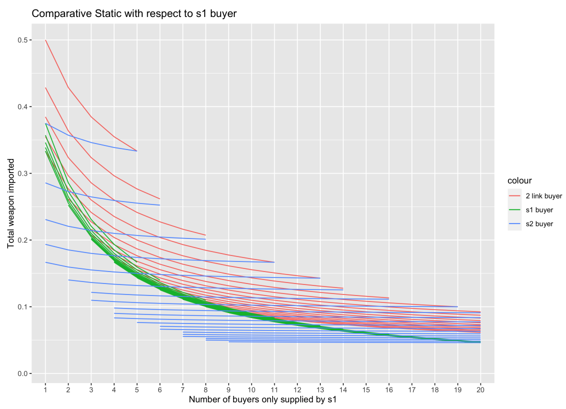


Figure 8: A buyer that trades with s_1 only end its war

Next, consider the case when the number of buyers who have two links decreases exogenously. That is one country in which both suppliers supplied weapons ended its war and no longer joins this trade network. The amount traded is shown in Figure 9. Each line corresponds to the same N_1 and N_2. Due to symmetry, the amount exported to buyers with only one link is identical. In this scenario, we observe the heterogeneous impact. For buyers with 2 links, their trade volume will drop whilst trade for buyers with 1 link increases. In this case, an end of the conflict has opposing effects depending on connections.

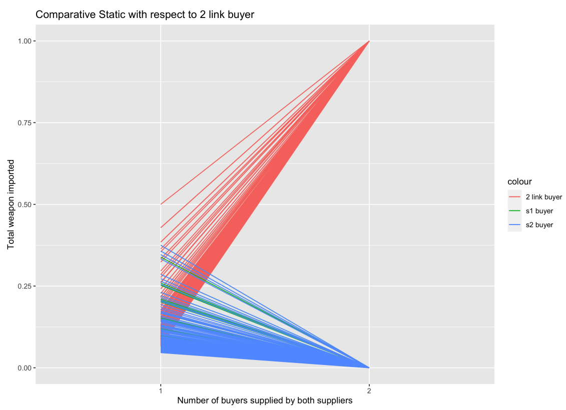


Figure 9: A buyer with two links end its war

4.3 Extensions

The basic model does not account for endogenous link formation. That is, the model does not consider link formation after the war ended. The suppliers will likely look for potential buyers after some of their buyers disappeared. In other words, the above model is applicable when buyers are divided into two parties as in the Cold War where trading with the other supplier is hard for a multitude of reasons. In addition, trade in the real world is not only composed of direct links. As exemplified by supply chains, goods travel through multiple countries before the final destination.

Another extension necessary is to consider what happens after weapon trade changes. Ultimately, the goal is to quantify what is the effect of more weapon trade on conflict intensity. Many research, including ones mentioned in section 2, have discussed and tried to quantify the impact of weapon flows on conflict. The main focus is on which situation will weapons work as a deterrence. This could be formulated using relative conflict effort as in König et al. (2017). This paper derives the optimal fighting effort with consideration to the number of allies and enemies. Analogous thinking could be applied to this case; whether to use weapons now or not depends on future expectations of whether one can out-muscle enemies' supply of weapons. In theory, if one can expect that their suppliers can increase their supply, then it is more likely that war ensues. On the other hand, if one anticipates that the other side will be able to have more supply and hence exert more fighting effort compared to oneself, the increasing amount of weapons will not be used at that time.

5 Model: Conflict Risk

The previous section 4 explored one potentially important mechanism of arm inflow to other areas. However, this does not answer a much more important question: does this inflow of weapons increase the probability of conflict and henceforth more casualties?

To answer this question multiple papers used game theory and this paper uses a similar approach. For example, Baliga and Sjöström (2020) considers a bargaining game (primarily one period) with consideration to first-mover advantage and resources. Yared (2010) considers a dynamic game where the results of conflicts come from a probability distribution and investigates the conditions in which war occurs. Chassang and Miquel (2010) shows that while complete information can induce peace, the uncertainty of military strength makes war possible or not depending on conditions.

5.1 Set Up

There are two players , A and B. At period t, player $i \in \{A, B\}$ controls a share $\omega_i^t \geq 0$ such that $\omega_A^t + \omega_B^t = 1$. Player's utility of controlling ω_i^t is denoted $u_i(\omega_i^t)$ where the function is an increasing, strictly concave, and differentiable function normalized such that $u_i(1) = 1$ and $u_i(0) = 0$. Next, denote λ_i^t as the relative military strength of player i. In addition let the cost for having λ_i^t as $c_i^t \lambda_i^t$. To connect with section 4, c_i^t captures the relative ease of obtaining weapons and this changes as other countries end their conflicts. In each period both players make a claim about how much territory to occupy. Denote this as σ_i^t. Naturally, $\sigma_i^t \geq \omega_i^t$. Then players can either concede or take arms. Without loss of generality, if player A concedes there will be peace in the next period but B will obtain σ_B^{t+1}. If both player decides to fight, the share in the next period will be a function of both military strength, $w_i^{t+1} = f(\lambda_i^t, \lambda_{-i}^t)$. Taking these conditions into account, both players will decide how much to invest on weapons in each period.

5.2 Preliminary Result

Currently working

6 Empirical Analysis

This paper now proceeds to use the model described in section 4 to test the impact of weapon trade on conflict intensity. In order to do so, this paper uses the instrumental variable approach. The instrument used here is the end of conflicts in other regions (the Middle East, Other parts of Asia, Europe, Africa, and the Americas). The reason behind this is two-fold. First, as indicated by the model, the end of conflicts in other regions will also change the flow of weapons in other countries. This satisfies the relevance condition for using IV. Secondly, the end of conflicts in other regions does not affect conflict intensity other than the inflow of weapons. This satisfies the exclusion restriction. This is not directly testable due to its nature. One might consider other effects associated with ending conflicts. Migration or unused weapons in conflict zones could be factors other than the market condition of weapons that impact conflict intensity. As Bara (2018) has shown, there are multiple pathways in which an end of conflict can affect other countries. However, by limiting conflicts that ended in other regions, this problem is solved to some extent. For example, the end of a war in Africa likely does not bring huge immigrants or unused weapons from that area to Asia.

6.1 Data and Variables

6.1.1 Conflict

Data on civil wars come from the UCDP/PRIO Armed Conflict Dataset Lacina and Gleditscha (2005). The main variables used are the year of conflict ended, conflict type (dispute over government or territory), estimated battle deaths, the intensity of battles (battles exceed 1000 battle deaths or 250 battle deaths). To avoid spillover effects from interstate wars, this paper only used conflicts that occurred between states and actors in the same state. The observation unit is at the country level for each year.

6.1.2 Trade

Data on SALW and other trade come from Comtrade data from the United Nations. This is the standard database for collecting trade flows recorded by tariffs and other means. In general, trade reported by importers is used to quantify trade. This is in part due to importers generally wanting to maximize their available tariff revenue. However, in the case of weapon trade and its effect on conflicts, importers are generally unreliable. Conflicts are highly correlated with corruption and negative political institutions. In comparison, weapons are mostly exported by developed countries. Due to these two views, trade amount was calculated using reports from exporters. The period uses is from 1995 to 2019.

Given the insight from the model (especially section 4.2.2), whether trade volume increases or decreases depends on their positions in the market. In the 2 supplier model, it would be enough to construct the number of shared links of suppliers with countries that ended its conflict. However, as mentioned in section 4.3, the real world has link formation as well as intermediate transfers. To account for this, this paper constructed network centrality measures as a proxy for possible network effects. This paper mainly used in-degree (that is the number of countries the country imports weapon from).

An important concern for weapon trade is the scale of illicit trade. If some countries disproportionately export weapons whilst not reporting, this will bias the results. A couple of research often incorporating event studies have tried to quantify the amount of illicit trade (DellaVigna and La Ferrara (2010)). Another useful approach perhaps applicable to the paper's theme is explored by Fisman and Wei (2009). This paper uses gaps in exporting and importing data of antiques controlling for corruption and other measures. However, as reporting from importing countries of weapons are often in worse conditions than countries participating in the illicit trade of antiques. Therefore, this paper turns to conventional data for this analysis.

6.2 Specification

6.2.1 Impact of other conflicts on trade volume

This paper first uses the following model to estimate the impact of a conflict ending on the total trade volume of SALW in other countries.

$$import_{i,t} = \alpha_{i,t} + \beta_1 End_{i,t} + \beta_2 End_{i,t} * Degree_{i,t} + \beta_3 End_{i,t} * Conflict_{i,t} + \mu_t + \varepsilon_{i,t} \quad (13)$$

$logimport_{i,t}$ is the amount of weapons imported each year, $End_{i,t}$ is the variable used to quantify conflicts that end in other regions, $Degree_{i,t}$ is the number of links, $Conflicti, t$ is the dummy variable for the ongoing conflict in the country i, μ_t are fixed effects for the year, and $\varepsilon_{i,t}$ is the residual term. In this paper, end of conflict was quantified in two ways. One is the number of conflicts ended as recorded by the UCDP-PRIO data. Another is to use the total of battle deaths in the years in which conflicts ended. Multiple conflicts that ended in each period are summed or averaged with equal weights. Since conflicts can have impacts not only in that year but also in the next couple of years, this paper also considers lags of this variable.

6.2.2 Impact of trade volume on conflict

Using section 6.2.1 as a first stage, the paper uses the following two-stage least squares model to quantify the impact of weapon trades on conflict severity.

$$import_{i,t} = \alpha_{i,t} + \beta_1 End_{i,t} + \beta_2 End_{i,t} * Degree_{i,t} + \varepsilon_{i,t} \tag{14}$$

$$Int_{i,t} = \delta_{i,t} + \gamma_1 i\hat{mport}_{i,t} + \gamma_2 Type_{i,t} + \chi_i + \xi_t + \nu_{i,t} \tag{15}$$

where $Int_{i,t}$ is the conflict intensity (Estimated number of battle deaths), $Type_{i,t}$ is the type of battle (dispute over government or territory), chi_i and μ_t are country and year fixed effects respectively, and $\nu_{i,t}$ is the residual term.

6.2.3 Heterogeneous Impact based on pre-existing relationships

As the result of the model in section 4 indicates, the structure of network allows for heterogeneous impacts to countries after a conflict ended. Especially, previous relationships with exporters who also exported to the country that ended its conflict should matter. As illustrated in figure 10, there are two effects that should be accounted when considering the magnitude for countries. First is the substitution effect where exporters switch to another country to export since weapons are no longer sold to previously high demand countries. Another is the conflict effect which is the effect of countries stop importing after there are no need for weapons en masse. In the literature of empirical economics, the shift-share design (Autor et al. (2013)) is used to take advantage of the variation in the level of shock. In this paper, the level of shock depends on the above two factors; the shock of the conflict demand level to the exporter and the shock of exporter supply level on countries. Using the results of Borusyak et al. (2021), the estimate should be consistent given the effect of conflict ending in other countries is exogenous to countries in different regions.

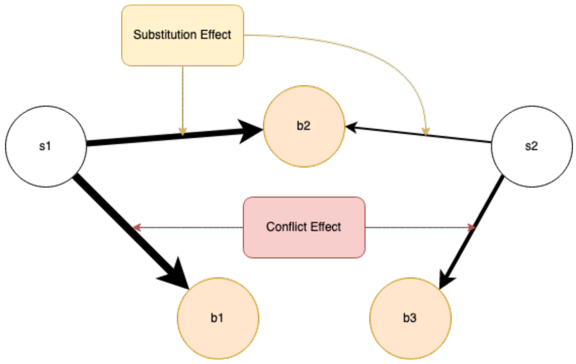


Figure 10: An illustration of different effects in play

For this reason, this paper uses the below specification to quantify the degree of shock from countries where s, b stands for supplier and buyer respectively and $w_{s,b}$ is the amount of weapon trade between the two countries.

$$c_{s \to b} = \sum_{b'} \frac{w_{s,b}}{w_{s,b'}} \text{ as conflict effect} \tag{16}$$

$$s_{s \to b} = \sum_{s'} \frac{w_{s,b}}{w_{s',b}} \text{ as substitution effect} \tag{17}$$

$$e_{b \to b'} = \sum_{s} c_{s \to b} * \sum_{s} s_{s \to b'} \text{ overall shock} \tag{18}$$

With the above, the impact of weapons on conflict intensity is estimated as follows.

$$import_{i,t} = \theta_0 + \theta_1 z_{i,t} + \theta_i + \theta_t + \nu_{i,t} \tag{19}$$

$$Int_{i,t} = \zeta_0 + \zeta_1 import_{i,t} + \zeta_2 x_{i,t} + \upsilon_{i,t} \tag{20}$$

$z_{i,t}$ is the modified shift-share instrument calculated as $z_{i,t} = \sum_j e_{j \to i} \delta_{j,t}$ where $\delta_{j,t}$ is dummy for whether conflict ended in the time span. $x_{i,t}$ is the controls previously used in the above specifications.

6.3 Results

6.3.1 Impact of conflicts ending on trade volume

The results for the empirical model specified in section 6.2.1 is shown below. The results show that conflicts that ended in other regions are correlated with weapons trade. Countries that trade more with respect to arms have more imports. This is in line with theory, as more links increase trade flow. More importantly, the intensity of the battle in the final year of conflicts significantly predicts imports of weapons. Specifically, this effect is stronger for countries engaged in conflict. In line with the model, the end of intense fighting seems to have led to an influx of weapons elsewhere. In addition, the interaction term between conflict intensity in other regions and degree shows that those with higher degrees comparatively decrease trade flow after conflicts end.

Dependent Variable:		logimport	
Model:	(1)	(2)	(3)
Variables			
endyear_intensity_0	0.1782***	0.1065	0.0750
	(0.0524)	(0.0654)	(0.0675)
conflict	-0.0925	-0.1325	-0.2959
	(0.1731)	(0.2281)	(0.1910)
degree	0.2595***	0.2577***	0.2585***
	(0.0276)	(0.0297)	(0.0284)
endyear_intensity_0 × conflict	0.1034***	0.0911***	0.0782**
	(0.0267)	(0.0246)	(0.0293)
endyear_intensity_0 × degree	-0.0068**	-0.0060	-0.0051
	(0.0032)	(0.0037)	(0.0040)
endyear_intensity_1		0.1194**	0.0676
		(0.0562)	(0.0537)
endyear_intensity_1 × conflict		0.0179	-0.0136
		(0.0288)	(0.0370)
endyear_intensity_1 × degree		-0.0010	1.8×10^{-5}
		(0.0034)	(0.0037)
endyear_intensity_2			0.1293*
			(0.0675)
endyear_intensity_2 × conflict			0.0674**
			(0.0266)
endyear_intensity_2 × degree			-0.0024
			(0.0036)
Fixed-effects			
year	Yes	Yes	Yes
Fit statistics			
Observations	1,663	1,663	1,663
R^2	0.62465	0.62730	0.63176
Within R^2	0.60932	0.61209	0.61672

Clustered (year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 1: Impact of Conflict Ending on Trade Volume

6.3.2 Impact of trade volume on conflict

The first result uses a simple OLS estimate with country and year fixed effects regressing battle deaths on weapon imports. The results are shown below. The result show that import of weapons does not significantly affect battle deaths. However, this neglects the fact that there are potentially many confounding variables and reverse causality between weapon imports and battle deaths.

Dependent Variable:	log_battledeath				
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
logimport_lag0	0.0230	0.0192	0.0372	0.0444	0.0394
	(0.0440)	(0.0331)	(0.0242)	(0.0380)	(0.0362)
logimport_lag1		0.0415	0.0231	0.0185	0.0255
		(0.0390)	(0.0158)	(0.0279)	(0.0327)
logimport_lag2			0.0046	-0.0210	-0.0127
			(0.0363)	(0.0345)	(0.0340)
logimport_lag3				0.0519*	0.0476**
				(0.0291)	(0.0187)
logimport_lag4					-0.0461
					(0.0434)
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
country	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	660	575	511	457	408
R^2	0.55591	0.56597	0.61746	0.63103	0.65772
Within R^2	0.00096	0.00422	0.00409	0.00951	0.01183

Clustered (year & country) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 2: Impact of Trade volume on conflict

To address this problem, the results for the empirical model specified in section 6.2.2 are shown below. As in the previous section, the first stage does not suffer from weak instruments. The F-test is above the conventional 10. Given this first stage, one cannot reject the null that an increase in weapons increases battle death (p-value 0.23). The same holds true for the model without country fixed effect. The coefficients themselves are positive suggesting weapons are not used for deterrence alone. It suggests that a 10

Dependent Variables:	logimport	log_battledeath
Model:	(1)	(2)
Variables		
endyear_intensity_0	0.1530*	
	(0.0770)	
degree	0.1542***	
	(0.0287)	
endyear_intensity_0 × degree	-0.0051**	
	(0.0021)	
type_of_conflictterritory	0.0450	-0.2618
	(0.1940)	(0.1901)
logimport		0.1496
		(0.1240)
Fixed-effects		
year	Yes	Yes
country	Yes	Yes
Fit statistics		
Observations	660	660
R^2	0.78952	0.54464
Within R^2	0.08672	-0.02524
F-test (IV only)	18.514	2.1223
Wald (IV only), p-value	1.66×10^{-6}	0.22817

Clustered (year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 3: Impact of Trade volume on conflict

Dependent Variable:	log_battledeath	
Model:	(1)	(2)
Variables		
logimport	0.1496	0.0464*
	(0.1240)	(0.0238)
type_of_conflictterritory	-0.2618	-0.7078***
	(0.1901)	(0.0989)
Fixed-effects		
year	Yes	Yes
country	Yes	
Fit statistics		
Observations	660	660
R^2	0.54464	0.06773
Within R^2	-0.02524	0.05053

Clustered (year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 4: Impact of Trade volume on conflict using different fixed effects

6.3.3 Heterogeneous Impact based on pre-existing relationships

The result for section 6.2.3 is shown below. The result uses a five year window similar to Autor et al. (2013). This is to incorporate any lasting influence from an immediate conflict and the shock to take effect in other countries.

Dependent Variables:	log(total import)	log(battle deaths)
Model:	(1)	(2)
Variables		
log(shift-share)	-1.465**	
	(0.5879)	
conflict	0.6874*	
	(0.3845)	
log(import of weapons)		7.065**
		(3.284)
Fixed-effects		
country	Yes	Yes
ranges	Yes	Yes
Fit statistics		
Observations	935	935
R^2	0.86603	-24.584
Within R^2	0.00705	-92.285
F-test (IV only)	3.2956	1,836.7
Wald (IV only), p-value	0.01749	0.03169
Clustered (country) standard-errors in parentheses		
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*		

Table 5: Impact of Trade volume on conflict using exposure levels

The result, although a weak instrument shows that the exposure level in fact is negatively associated with total import of weapons in the next window. This can be attributed to multiple factors but the model implies that there may be many countries where an end of conflict in other regions decreases the supply of weapons (the blue lines in figure 8). Regardless, more analysis is required to clarify this relationships. With this first stage, however, the amount of weapons imported is positively associated with battle deaths. A 1 per cent increase in weapon imports are associated with about 7 per cent increase in battle deaths. The causal relationship, however, is still not clear due to weak IV problems.

7 Globalisation

7.1 Market Response

An interesting implication of this is the effect of globalization. As people and goods can travel around the world faster and faster, weapons can also be traded quickly. Based on the model, as globalisation progresses one can predict that if a conflict ends someplace, the market reacts quicker and thus trade will increase faster. Although this is not rigorously tested, one can obtain some idea from the coefficients of year fixed effect in section 6.2.1. The below plot shows this. Consistent with this observation, the most recent years have a higher coefficient.

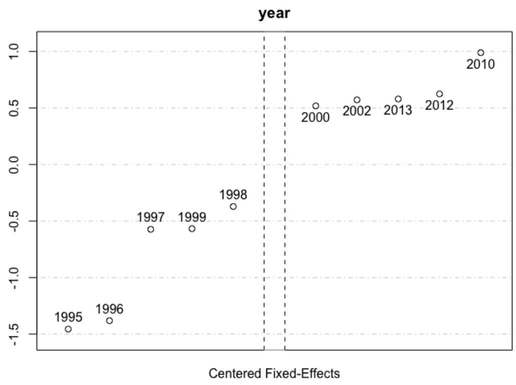


Figure 11: Coefficients of year fixed effects

7.2 Link Formation

Another interesting extension related to link formation is the overall efficiency in this trade network. A simple calculation using the two-seller model suggests that it is always beneficial to connect to more buyers. This means that the trade network is most efficient, meaning that suppliers obtain maximum profit as a whole when the network is complete, i.e., all buyers are connected to all sellers. From a policy standpoint, assuming that more links lead to more trade, and thus worse conflicts, this is something to be discouraged. This leads to an investigation of the impact of the arms embargo and overall weapons trade. At first sight, an effective arms embargo would likely decrease conflicts in that area. However, this may trigger link formation in other countries and a general increase in trade.

8 Conclusion

In conclusion, this paper sought to quantify the impact of conflicts that ended in other regions and, through this, the effect of weapon trade on the intensity of the conflict. For the first part, this paper formulated a model in which weapons are sensitive to market conditions. The model gave insights into how an end of conflict leads to more weapons in other areas. Building on this observation, the paper tested this model using conflict data and arms trade. The results show that peace in other regions is positively correlated with weapon imports in other regions. This increase is more pronounced in countries that have a war on. This article then used this positive relationship to causally estimate the impact of an increase in weapons on the intensity of the conflict. However, the IV approach cannot reject the null hypothesis that an influx of weapons intensifies conflicts. To investigate further, this paper quantified the exposure level to conflicts ending using shift-share design. With this analysis, however, peace in other regions exerts a negative impact on weapons imported and at the same time increases conflict intensity. Further research is required to investigate this further. Formulation of in which cases arms trade functions as a deterrence utilising market condition would be a plausible next step.

A Details of solving the simultaneous equations

$$\begin{aligned}\pi_{s_i} =&(n - g_{s_{-i}})(\alpha - \beta q_{i,1})q_{i,1} + (g_{s_1} + g_{s_2} - n)(\alpha - \beta(q_{i,2} + q_{-i,2}))q_{i,2} \\ &- c((n - g_{s_{-i}})q_{i,1} + (g_{s_1} + g_{s_2} - n)q_{i,2})^2\end{aligned} \tag{21}$$

The First Order Condition with respect to $q_{i,1}$ and $q_{i,2}$ implies

$$q_{i,1} = \frac{\alpha - 2cNq_{i,2}}{2(\beta + cN_i)} \tag{22}$$

$$q_{i,2} = \frac{\alpha N - \beta N q_{-i,2} - 2cN_i q_{i,1}}{2(\beta + cN)}. \tag{23}$$

Solving the 4 equations from this gives the equilibrium quantity. For this to obtain a solution to matrix must fist be invertible. The sufficient condition for this is that the determinant is non-zero. By calculation

$$\begin{aligned}&(\beta^2N^2)/(4(\beta + cN)^2) - (c^4N_1N^2N_2)/((b + cN_1)(\beta + cN)^2(\beta + cN_2)) \\ &+(c^2N_1N)/((\beta + cN_1)(\beta + cN)) + (c^2NN_2)/((\beta + cN)(\beta + cN_2)) \neq 1\end{aligned} \tag{24}$$

The exact solution to this is not clean and simulation used matrix calculation to get the equilibrium output.

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