Business performance and arms embargoes: An empirical analysis of the international defense industry

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Abstract

This study explores the impact of arms embargoes on the business performance of major international defense companies. For this purpose, a panel model including data for up to 215 defense firms from 25 countries between 2002 and 2016 is used. The main findings generally suggest that military sanctions lead to a drop in the total revenues, while at the same time trade costs increase. As a result, the profit rate in the international defence industry is under downward pressure after the introduction of an arms embargo. It turns out that multilateral sanctions put the business performance of arms producing firms substantially more under a downward pressure compared to unilateral military sanctions. The ability of a firm to effectively mitigate the adverse consequences of an embargo relies to a great extent on firm-specific characteristics such as whether a company also produces dual-use goods.

Keywords: Business performance; Defense firms; Arms embargoes.

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1. Introduction

Since the end of the cold war, arms embargoes have become an important tool of foreign policy as a 'smart' alternative to comprehensive economic sanctions. The increased popularity runs from the fact that arms embargoes hit a regime where it hurts, without resorting to military force or necessarily harming the general population (Fruchart et al., 2007). Besides, arms embargoes are comparatively cheap for senders, and thus even when they are only partially enforced, they may be seen as a success by their initiators (Baldwin, 1997; Drezner, 1999). Arms embargoes are commonly used in cases of war, human rights violations, support for terrorism, or nuclear weapons development. In such cases, these coercive measures are meant to punish the target, send a message about acceptable behavior to other actual or potential offenders, and lessen the target repressive and warlike ability. In recent years, arms embargoes have been at the forefront of the international responses to Russia's annexation of Crimea and Iran's program for the development of nuclear technology.

Despite their popularity as a foreign policy tool, arms embargoes have been widely criticized in academic and policy circles as being ineffective. Embargo busting practices by sending states coupled with a lack of international enforcement are believed to fundamentally undermine embargo success (Bondi, 2002; Boucher and Holt, 2009; Kaempfer and Lowenberg, 1995; Staibano, 2005; Bondi, 2002; Durch, 2000; Cortright and Lopez, 2001; Moore, 2010; Tierney, 2005; Brzoska, 2008; Brzoska and Lopez, 2009). For instance, Fruchart et al. (2007) conclude based on extensive and detailed case research that nearly every single UN arms embargo has been systemically violated. Likewise, the widely used Peterson Institute for International Economics sanctions database shows that military sanctions fail to achieve their policy goals in about two out of three cases (Hufbauer et al., 2009). More recent research by the Targeted Sanctions Consortium on United Nations sanctions suggests an even lower rate of success.

One explanation for this disappointing result is that states are often reluctant to impose serious limitations on their arms transfers as ending an existing arms export relationship can be both economically and politically costly. The defense-related industry is an important business sector in many countries and has gained some significant political influence in the last decade (Moore, 2010; Rundquist, 1978). This latter is especially the case in the US where the revolving door has gone the other way. Former top managers in the defense industry have secured key government positions. This illustrates the tight relationship between politicians and the defense industry also often referred to as the military-industrial complex (Defense News, 2019). Thus, governments have to weigh the importance of the domestic defense industry against the costs of violating an embargo (Sandler, 2000). These costs are going beyond the monetary fine imposed by the enforcing authorities, but also involve the negative effects on security, the loss of trade privileges and the reputational damage of firms and states.

More generally, the defense industry and its market are characterized by key elements of imperfect competition, with the government acting in a dual role as the primary buyer and the regulator of the market (Driessnack and King, 2004)[2]. As a result, pricing and profits in defense markets are determined by bargaining involving strategic behavior. The large number of international suppliers creates a weak link phenomenon in that the state that does the least to comply with an embargo determines the success of it. In this common pool situation, one state may be capable of reaping substantial economic benefits by sending arms to embargoed states, benefits that will easily exceed the cost the state would pay from the consequences of embargo failures (Russett and Sullivan, 1971). Thus, in more competitive arms markets, governments more easily allow to violate the boycott and try to promote their own arms industries as matters of national economic necessity and industrial support.

The interesting question then also remains what impact arms embargoes really have on the business performance of the international defense industry when compliance is weak and enforcement is hard. On the one hand, the profits and revenues of defense firms are likely to drop as the volume of arms exports surge and trading costs rise. On the other hand, one can argue that the business performance is not being affected as the compliance to arms embargoes is not effectively enforced or even that the revenues increase due to illicit trade and higher prices on the black market in target countries.

One major shortcoming of the existing studies is that most research on the economic consequences of arms embargoes is primarily focused on the behavior of the target state and deals with questions related to whether weapons get through rather than on explaining senders' export behaviour (Peksen, 2019). This latter issue is likely to be even more important as it is crucial for understanding implementation and enforcement practices that ultimately determine the success of military sanctions (see e.g. Erickson, 2013; Moore, 2010). At the same time, the objective of most studies is on examining the impact of military sanctions at the national level, for instance, whether sanctions are able to restrain the total arms transfers between two countries rather than on explaining how the business activities of individual defense firms are being affected. However, it is highly questionable whether the economic consequences of arms embargoes are shared equally among the broad range of defense-related firms competing around the world. The contribution of this article is to partly fill the gaps in the literature in two ways. First, by exploring empirically the impact of unilateral (US) and multilateral (EU and UN) arms embargoes on the business performance of international defense companies.

[2] It is well known that the spending in the defense industry is vast. For example, sales of arms and military services by the world's largest arms-producing and military services companies—the SIPRI Top 100—amounted to nearly $400 billion in 2016. This figure has increased by about forty percent the last fifteen years. The United States, Russia, France, Germany, and the United Kingdom dominate the defense market as they export nearly eighty percent of the world's major conventional arms.

Second, by revealing the mechanisms underlying the main results and relate them to firm-specific and market structure elements.

For this purpose, I use a panel model including data from more than 200 major defense companies from 25 countries mainly taken from the Stockholm International Peace Research Institute (SIPRI) for the period 2002 to 2016. After testing for the sensitivity of the results, my main findings generally suggest that military sanctions lead to a drop in the total revenues, while at the same time trade costs increase. As a result, the profit rate in the international defense industry is under downward pressure after the introduction of an arms embargo. It turns out that multilateral embargoes put the business performance significantly more under a downward pressure compared to military sanctions imposed by a single sender. One rational explanation is that the multilateralization of an arms embargo strengthens the signal of dissociation sent to a target. The ability of a firm to effectively mitigate the adverse consequences of an embargo relies to a certain extent on firm and market-specific characteristics such as whether a firm also produces dual-use goods.

The remainder of the paper is structured as follows. Section 2 provides the theoretical considerations underlying the relationship between the business performance of the defense industry and arms embargoes, while Section 3 describes the data and methodology used. Section 4 shows my empirical results on the influence of arms embargoes on the business performance of the international defense industry, while the final section offers the conclusions.

2. Arms embargoes and the business performance of defense companies

2.1 Theoretical considerations

The relationship between arms embargoes and the business performance of a defense firm can best be illustrated using the following simple theoretical framework. The model starts by considering a representative profit-maximizing firm. Since military-strategic goods are highly differentiated products, companies operate under monopolistic competition with some considerable market power.

$$\pi(e,\eta,\gamma) = [p(e) - c(\eta)]Q^S(e,\gamma) \tag{1}$$

$$Q^S(e,\gamma) = Q^D[1-\gamma e] \qquad 0 \leq \gamma, e \leq 1 \tag{2}$$

Where $\pi(e)$ represents the total profits of a representative defense firm, $p(e)$ is the unit price of military goods, $Q^S(e)$ is the quantity of goods produced under the influence of an arms embargoes e, and $c(\eta)$ are the marginal costs. In equilibrium, part of the demand is subject to an embargo (e). As already argued above, the success of the embargo is directly related to the degree of enforcement by the government of the sending state. The enforcement of and compliance with an embargo is captured by

parameter γ. When γ is close to zero, the embargo is practically not enforced and embargo busting practices are widely spread. As a result, the total supply is almost equal to the sum of the legitimate and prohibited exports. In turn, when γ is about one, the embargo is strictly enforced and the total supply consists only out of only the permitted exports. Assume further that the inverse linear demand and the unit production costs for military goods are respectively given by[3]

$$p(e) = a - bQ^D(e) + \gamma e\mu \; ; \; c(\eta) = d + \eta \tag{3}$$

Where *a* and *b* are constant parameters, μ captures the direct embargo effect on the price, for instance, through a black market premium in target countries that needs to be paid on illicit arms imports. The unit production costs c(η) are the sum of the variable production cost *d* and the additional trade and compliance cost a defense firm needs to make. Besides, the costs of transportation, licensing, financing and brokering may rise of dual-use goods that do not fall directly under the embargo, but are also often being produced by many defense firms (Salisbury, 2018; Seyoum, 2017).

Moreover, as the defense market exhibits particularities of imperfect competition, firms will produce the quantity up to the point where the marginal costs (*MC*) are equal to the marginal revenues (*MR*). This optimal production (Q^*) and price (p^*) are respectively given by

$$Q^*(e) = \frac{(1-e)(a-d-\eta+e\gamma\mu)}{2b} \; ; \qquad p^*(e) = \frac{a+d+\eta+e\gamma\mu}{2} \tag{4}$$

Based on this simple theoretical model, embargoes influence the optimal unit price and quantity through four channels: (i) black market premium μ, (ii) trade and compliance costs η, (iii) trade volume *e* and (iv) stringency of enforcement γ. Meanwhile, the business performance of a defense company is commonly evaluated based on the total revenues ($TR = p^*(e)Q^*(e)$), total costs ($TC = c(\eta)Q^*$), or the net profits (π). To determine the impact of embargoes on these three business performance indicators, I have to take the first-order conditions of the different business performance indicators with respect to the four embargo channels. Table 1 summarizes these derivatives by providing the expected direction of the different channels (in the appendix, the complete derivatives are reported). Based on the derivatives it is not directly straightforward what impact the introduction of an embargo has on the business performance of a defense firm as some effects are expected to have a

[3] This section uses the simple assumption that the arms demand is elastic. One can argue that the market structure differs among the various types of military equipment. While the market for nuclear weapons can best be described as a monopoly, small arms are usually produced by large number of firms sharing the characteristics of a perfect competitiveness market.

positive effect, while others may turn out to be negative. Thus, whether military sanctions affect the economic performance of the defense industry, and if so, in which direction is ultimately an empirical question.

<<< Insert Table 1 about here >>>

More generally, the effectiveness of an arms embargo is the product of imposition and enforcement. Based on this multiplication, the existing empirical literature identifies three scenarios about the possible impacts of arms embargoes on the business performance of the defense industry. These different scenarios affect the business performance in opposite directions. In the first scenario the business perspectives of the defense industry worsen due to a reduction in the export volume in strategic-military goods and the subsequent downward pressure on prices. For instance, Brzoska (2008) finds that UN, EU, and US arms embargoes decrease the arms imports of a target state by more than 39 percent. This result is supported by the findings from Erickson (2013) who concludes that arms embargoes on average restrain sending states' arms exports by 5 percent. Based on these studies, one can argue that major exporters generally appear to implement sanctions, despite strong economic incentives to ignore them and a lack of formal accountability mechanisms to punish violators.

In a second scenario, the business performance of the defense industry improves due to illicit arms exports to countries that are being subject to military sanctions. Arms embargoes may raise the arms price on the black market in target countries (Tierney, 2005). When the relative decline in the export volume is more than compensated by an increase in the price, this will lead to better economic perspectives. For instance, DellaVigna and La Ferrara (2010) find that the intensity of a conflict during an embargo period creates upward pressure on the stock prices of weapon-making companies as many of them are trading illegally and violating the embargo. This effect is in particular visible for companies that have their headquarters located in countries with high corruption and low transparency in arms trade. Although suppliers often have various political and economic reasons for embargo busting, the empirical evidence by Moore (2010) claims that states are more willing to violate embargoes to transfer weapons to countries with similar political and strategic interests.

The last scenario assumes that the business performance of defense companies is unaffected by arms embargoes as one key problem with arms embargoes is the failure to implement them successfully which makes them far from effective. The success of an arms embargo primarily depends on three elements: the will of individual senders to impose them, the swift comprehensive implementation in national legislation and on rigorous enforcement and monitoring. If the costs of non-com-

pliance remain low, politicians and state leaders do not have the incentive to invest in effective policies. Using a sample of more than seventy arms embargo cases, Brzoska (2008) concludes that embargoes had only a significant effect on arms import patterns in less than thirty percent of all cases. Even when major powers have imposed embargoes, including permanent members of the United Nations Security Council, they have also sought to promote, or at least not restrain, arms exports by their own producers (Cortright and Lopez, 2002; Brzoska and Lopez, 2009). Likewise, according to Johannsen and Martinez-Zarzoso (2017) mandatory UN embargoes appear to be successful in decreasing the probability of arms transfers between two states, but have any significant impact on the trading volume between the same two states. Thus, despite the popularity of embargoes, busting practices by sending states coupled with a lack of international enforcement are believed to fundamentally undermine the success of an embargo. Without institutionalized enforcement, senders may avoid external punishment for non-compliance with multilateral sanctions, while unilateral sanctions may be undermined by uneven domestic accountability (Bondi, 2001; Boucher and Holt, 2009; Kaempfer and Lowenberg, 1995; Staibano, 2005; Tierney, 2005). Besides, implementing restrictive trade measures can be quite costly in a competitive arms market as it may deprive current and future orders of intended buyers. Therefore, senders implement only trade measures that are the most beneficial and least costly to them. However, sanctions that are not costly to a sender – those that would not jeopardize a valuable arms trade relationship, for example – may often not be costly to a target, either.

Thus, based on this short review of the existing empirical literature, it is still not clear whether the business performance of the defense industry worsens or even improves when new arms embargoes are introduced. However, an alternative explanation for the inconclusive effect of arms embargoes might be attributed to a so-called micro-macro paradox. The scope of most studies is mainly focussed on explaining whether military sanctions reduce the aggregate arms exports or imports of a country or the arms transfers between two states (i.e., Johannsen and Martinez-Zarzoso, 2017; Erickson, 2013; Moore, 2010). However, the impact of embargoes might have different or even opposing effects on the business performance across the broad range of defense-related companies within a country. In particular, the new-trade theory, stresses the importance of internal firm particularities rather than sector-related elements in understanding the challenges and the opportunities countries face in international trade (Markusen and Venables, 1998). This latter argument suggests that the impact of arms embargoes relies to a great extent on firm-specific characteristics. As a result, embargoes may harm the economic performance of particular firms, but at the same time, it might improve the business perspectives of other companies that are able to cope effectively with this new situation.

2.2 Senders of arms embargoes

The primary purpose of arms embargoes is to prohibit the export of military-strategic goods such as arms (including major conventional arms, weapons of mass destruction), technology, data, services (maintenance, technical advice, assistance and training) and knowledge that can be used for military purposes to listed persons and entities (i.e., states, companies, organisations). In the last decade, the US, EU or the UN are the main senders of arms embargoes. To date, arms embargoes have imposed for mainly four reasons: (i) to signal disapproval of behavior by a certain actor, (ii) to maintain neutrality in an ongoing conflict, (iii) to limit the ability of an actor to inflict violence on others or (iv) to weaken country's military capabilities before foreign intervention. Meanwhile, embargoes send by the US are unilateral foreign policy measures, whereas military sanctions imposed by the EU and UN have a multilateral character. Multilateral sanctions are not typically subject to enforcement by the institutions that impose them and depend mainly on the obligation of individual senders to translate them into national legislation and practice, while unilateral sanctions (US) depend primarily on the sender's willingness to implement them. Better enforcement, from this perspective, means better compliance and therefore more effective embargoes.

In the remainder of this section, I will discuss the legislative decision-making structure of a number of primary senders. The UN Security Council (UNSC) can call on its member states to partially or completely prohibit arms trade relationship with a state that threatens or breaches international peace and security. First employed in 1965 against Rhodesia, the use of an arms embargo has become increasingly popular during the past two decades. All UN member states are legally obliged to adopt and enforce the sanction measures determined by the UNSC. UN arms embargoes are invoked when a UNSC resolution decides that all member states shall prohibit the sale or supply of arms, ammunition, military equipment and related services. Embargoes may be prohibiting arms transfers to an entire country, to particular areas within a country, to non-governmental forces or prohibiting arms transfers to individuals or terrorist movements wherever they may be located. UN arms embargoes can end by a UNSC resolution declaring the lifting of the embargo or by lapsing through the expiration of a time-limited arms embargo.

In addition to the UN, the European Union may also impose autonomous multilateral measures as part of its Common Foreign and Security Policy (CFSP). Generally, the European Union implemented all recent United Nations' Security Council embargoes, but also decided independently on additional ones, for example against China, Bosnia Herzegovina, Egypt, Myanmar and several other countries. The legal basis for the European Union to impose restrictive measures—and have them enforced by its Member States—lies in both the Treaty of the European Union and the Treaty on the Functioning of the European Union. The scope of sanctions falls under the responsibility of

the EU Council. In the EU context, sanctions and embargoes are flexible tools that allow rapid decision and enforcement that better fit political timing and constraints. Especially considering the reluctance of some member states to conduct military action outside of the European Union.

With regard to the US, no other country in the world has imposed military sanctions more often (Hufbauer, 1998; Hufbauer et al., 2009). Although unilateral, the importance of the United States to the global economy, and in particular as the most important exporting country of military goods, may make them a powerful policy instrument. While the European Union's decisions regarding the implementation of sanctions regimes are applicable to only EU member states, US international sanctions and embargoes apply as soon as there is a nexus with US jurisdiction. The United States policy relating to embargoes tends to establish an extra-territorial application of US legislation. All military items exported from the United States are controlled under the ITAR (International Traffic in Arms Regulations) and thus subject to prior authorization from the US authorities, while dual-use goods fall under the Export Administration Regulations (EAR)[4]. Arms embargoes are based on article 126.1 of ITAR that prohibited exports, imports, and sales to or from certain countries. Once exported, either for stocking purposes or for integration into a higher assembly, and ultimately into the final product, the US-controlled commodity remains subject to an export authorization, regardless of its incorporated state. Besides, it also entails that all foreign persons that will be involved in the manufacturing, exportation and financing of the utilization of a foreign-made product incorporating a US-origin part need prior vetting from the US authorities. Thus, US embargoes therefore do not only apply to arms producers in the sending state, but also to firms that produce military equipment from other countries using US manufactured parts, data or knowledge.

3. Data and methodology

3.1 Embargo and business performance data

In this study, in total 132 US, UN and EU arms embargoes are considered that were in place between 2000 and 2016, covering both voluntary and mandatory military sanctions. The data on arms embargoes are collected from different sources including Erickson (2009), SIPRI (2016), the Directorate of Defense Trade Controls of the US Department of State and The Sanction Consortium. Figure 1 shows the evolvement of the number of embargoes over the time period of my analysis. The picture shows a clear increasing time trend. The majority of embargoes is imposed by the US.

One of the key challenges in the quantitative literature dealing with arms embargoes is to come up with an appropriate measure on these coercive trade policies that capture both the imposition

[4] In addition, financial sanctions are registered by the Department of the Treasury, Office of Foreign Assets Control (OFAC).

and magnitude. Clearly, it makes a difference for the export performance of the defense industry whether an embargo is imposed against a large or small importing country. In my approach, the magnitude of arms embargoes (emb_{jt}) to which companies in a country j need to comply with within a particular year t is based on the following formula.

$$emb_{jt} = \sum_{n}^{j=1} \varpi_k E_{kjt} \tag{5}$$

Where E_{jkt} captures the imposition and indicates whether the arms trade relationship between exporting country j and importing country k in a year t is subject to an arms embargo that is either imposed by the EU, US or UN[5]. To measure the imposition of an embargo as precise as possible, I will take the imposition of an arms embargo in the course of a year into account. This allows embargoes introduced (lifted) at the beginning of the year to have a different impact on the economic performance of a firm than those that are started (ended) near the end of the year. To be precise, the indicator E_{kjt} is calculated as $M/12$, where M is the number of months within a calendar year the embargo was in place. In all other years, the value was set to zero. In the next step, I multiply the imposition indicator E_{kjt} by an embargo intensity measure (ω_k). This intensity is based on the average arms imports by the embargoed country as a share of the total world arms imports in the five consecutive years prior to the start of the embargo to assure exogeneity[6]. The data on arms imports by embargoed states is taken from the Arms Transfers Database reported by SIPRI. To anticipate my main results, the arms embargo measure used is robust to alternative weighting schemes based on the size of the defense budget, population size, size of the armed forces and the land size of a country (see Table A2 in the appendix).

<<< Insert Figure 1 about here >>>

As my dependent variable, I use three commonly used measures to evaluate the business performance of a defense company: the annual percentage-change in total revenues, the annual percentage_change in total costs and the annual percentage-change in the net profits[7]. The business performance indicators are calculated based on data mainly taken from SIPRI Arms Industry Database. In

[5] Due to extraterritorial working of the US legislation, I assume that all EU defense firms need to comply also with US embargoes as a large majority of EU arms exports contain US-origin parts, knowledge, data or components. The so-called "ITAR free" goods are only an extremely small part of the total military exports by EU firms.

[6] Using only the year before the arms embargoes will distort my results as their might be a hoarding effect present in the period shortly before the imposition (see the results section for a more detailed discussion). For countries that are constantly subject under an embargo before the data series on arms imports start, I use the first five years for which data is available.

[7] Total costs are calculated by subtracting the profits (after taxes) from the revenues..

particular, the database contains financial data, including sales and profit information, and employment data for more in total than 200 public and private arms-producing companies in more than 25 countries and is available from 2002 onwards. The database collects information from company annual reports and articles in journals and newspapers (see also Blum, 2019)[8]. The data is supplemented using information taken from World Top 100 Defense Firms published by the Defense News Media Group. The SIRPI Arms Industry Database also considers large foreign subsidiaries of international defense corporations which as an independent company would rank among the top 100. Subsidiaries are specified by the country in which they are located. Since sales figures of subsidiaries are included in the sales figures of the parent company, including both subsidiaries and parent companies into one panel would result in double-counting. I therefore have removed the foreign subsidiaries from my sample. In order to make the business performance indicators comparable over time, I have converted the current values into constant US dollars using the GDP deflator[9].

3.2 Empirical model

This section describes the empirical approach applied to explore the impact of arms embargoes on the business performance of defense firms. For the empirical application, I use an unbalanced panel between 2002 to 2016 compromising about 215 firms from 25 countries[10]. The estimated model is given as follows

$$\Delta \ln busper_{ijt} = \alpha_{ij} + \mu \ln busper_{ijt-n} + \beta_k \boldsymbol{x}^k_{ijt-m} + \gamma emb_{jt} + \varepsilon_{ijt} \qquad (6)$$

Where $busper_{it}$ are the business performance indicators introduced above (total annual revenues, annual total costs or annual net profits) of defense company i in country j in year t[11]. The revenues and costs are not only determined by the current market situation, but are also constrained by investment decisions taken in the past. The installed capital is fixed in the short run and cannot be reversed due to the high initial costs regardless of the presence of an arms embargo. This argument suggests that

[8] One major limitation of the dataset is that it is subject to sample selection as it only reports the data on the 100 largest companies in a particular year and excludes some countries i.e. China. For a critical review about this SIPRI dataset, see the special issue on this database published by the Economics of Peace and Security Journal in 2018.

[9] It is not possible to subtract subsidiary figures from parent company figures, because only large subsidiaries are included in the dataset. Direct subtraction would lead to an incomparable dataset.

[10] Included countries are Australia, Brazil, Canada, Finland, France, Germany, India, Israel, Italy, Japan, Kuwait, Netherlands, Norway, Poland, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and the United States.

[11] To be precise, in case of the annual net profits, I add a small value to the dependent variable to avoid truncating the dependent variable when taking the natural logarithm at zero or negative.

there is possibly some autoregressive tendency present. To capture this, the lagged level of the dependent variable is included in the econometric specification. These variables are taken in natural logarithms as they are not normally distributed and to smooth out extremely high values.

The variable emb_{jt} captures the imposition of arms embargoes as computed above. We are able to estimate the impact of an arms embargo by a difference-in-difference methodology. The firm-years when an embargo is imposed that a particular firm needs to adhere with ($emb_{jt} > 0$) are the "treated", and those years that there is no embargo that needs to be followed ($emb_{jt} = 0$) are the "controls". The hypothesis that is tested in this study is whether parameter γ in equation (6) is statistically significant different from zero. However, as already highlighted above, the direction is not directly straightforward. When γ is statistically smaller than zero, than the business performance deteriorates after the imposition of an embargo. In turn, when γ is statistically larger than zero than the economic perspectives of the international arms industry have improved. One important empirical issue is that embargoes are mainly enforced at the country (US) or even the supranational level (EU). This means that all firms *j* within country *i* are to a certain extent subject to the same degree of embargo enforcement by the government. This assumption entails that the firm observations within a particular country-year are not fully independent from each other. Neglecting this hierarchal structure in the data would deliver biased estimates. This is corrected by clustering the standard errors at the country level[12].

The parameter α_{ij} is a firm-specific intercept to control for time-invariant unobserved characteristics such as the location of the headquarters or legal status. By using firm-specific intercepts, I place the emphasis of my analysis on the identification of the within-firm variation over time and control for observable and unobservable fixed characteristics. In addition, this approach also reduces the influence of any potential selection bias that might arise, for example, since US firms and embargoes are over-represented in my data. The final term ε_{ijt} is the error term.

The vector $\boldsymbol{x}^k$ includes a set of control variables that is necessary to avoid an omitted variable bias and are related to structural supply and demand factors for defense goods and the role of national and international defense policies. First, to control for factors that affect the demand of military-strategic equipment, I include the following variables: the number of armed conflicts (worldwide), real GDP per capita (in natural logarithms), military expenditures (as a share of GDP), the size of the armed forces (measured by the military personnel as share of the labour force), and changes in the real exchange rate. As the demand for military equipment is primarily affected by global factors, I consider both the domestic as well as the global values for the real GDP per capita, military expenditures and the size of the armed forces as covariates in my specification.

[12] As a sensitivity test, I have also run the main model using clustered standard errors at the firm level. Though, generally the significance of the embargo variables drops slightly, the main results remain unaffected (detailed results are available upon request).

In turn, factors that affect the supply of military goods are mostly related to the costs of production. That is, I include the real interest rate, inflation rate, unemployment rate and the institutional quality in a country[13]. In particular, the strength of the political institutions is directly related to the enforcement of regulations including military trade sanctions. The data on the control variables are mainly taken from the World Bank Development Indicators (WDI) or the Worldwide Governance Indicators (WGI) both reported by the World Bank and the Armed Conflict Dataset published by the Peace Research Institute Oslo (PRIO).

Finally, I add a number of firm and market-specific variables. First, I add the share of revenues of a firm in the previous year that can exclusively be attributed to the sales of military goods rather than civilian or dual-use goods. Second, the size of a firm measured by the total number of employees (in natural logarithms). Third, a dummy variable taking the value one when the firm is publicly listed at the stock market and zero when the firm is government-owned or owned by a dominant private shareholder. Fourth, a dummy variable indicating whether a parent company has also a foreign branch in the SIPRI Top 100 defense companies ranking. One of the reasons to move business activities abroad is the regulatory environment including policies on strategic trade controls. However, a parent and subsidiary relation often also creates principal-agent issues that might increase business costs. Moreover, I control for the international competition on the defense market by including a concentration measure based on the Herfindahl-Hirschman index of the total revenues of a firm and a merger and acquisition dummy taking the value one when a company has merged or is taken over in a particular year (and zero otherwise). In rather competitive markets, profits are usually more under downward pressure after an arms embargo due to more intensive competition and a shrinking international market. Finally, I add a dummy variable taking the value one when there was a change of CEO in a particular year based on information taken from World Top 100 Defense Firms reported by the News Defense Media Group. All explanatory variables are lagged to avoid simultaneity and endogeneity problems with the embargo variable. The optimal number of lags for the lagged dependent variable and each control variable is determined by using the Schwarz Bayesian Information Criterion (SBC).

Estimating the econometric model reported in equation (6) delivers us two problematic issues. First, due to reasons of data availability, using all suggested control variables in one specification would reduce my dataset dramatically thereby increasing the risk that the results are driven by a sample selection bias. To balance the omitted variable bias against a possible sample selection bias, I have selected my set of control variables by applying the general-to-specific method. This method does not rely on economic theory, but is a widely used method in applied econometrics to decide on

[13]The level of institutional quality of a country is measured by the first-principal component on voice and accountability, government effectiveness, regulatory quality, rule of law and control of corruption in a particular country and year taken from the Worldwide Governance Indicators (2015).

the model specification (see Hendry, 1993). I first estimate a model including all control variables as outlined in the previous section, but without including my embargo indicator. Next, I drop the least significant variable and estimate the model again. This procedure is repeated until only variables that are significant at the ten percent level remain. The results in Table A3 in the appendix show the baseline specifications for the three models (total revenues, total costs and net profits) using the OLS-FE estimator[14].

A second problematic concern regarding arms embargoes is that they cannot be considered as exogenous as sending states do not randomly target other countries. There are various political factors that drive both the likelihood of an arms embargo and the business performance of the international defense industry. For instance, an escalation of an armed conflict will increase the demand for arms, but at the same time raises the likelihood of military sanctions (Klomp, 2019). When I fail to explicitly control for these factors, my results might be spurious. To capture for this endogeneity issue, I apply the two-stage least squares (2SLS) estimation technique suggested by Newey (1987). In the first step of this approach, a first-stage regression is estimated including a number of external instrumental variables. For this purpose, the embargo measure (emb_{jt}) is slightly modified. In particular, we first compute this variable on a country-by-country base (emb_{jkt}) and use this measure as a dependent variable in a first-stage regression. The specification of this regression is given by

$$emb_{jkt} = \chi_k + \eta_r \boldsymbol{w}^r_{jt-v} + u_{jkt} \tag{7}$$

Where emb_{jkt} is the embargo measure between exporting country j and importing state k incorporating both the scale and scope of the military trade restriction. The vector $\mathbf{w}$ includes a set of r (lagged) instruments. The final term u_{jkt} is the error term, while χ_k is an importing country fixed effects controlling for unobserved country-specific effects that are time-invariant. For instance, large countries may need more military equipment to defend or protect themselves. This will make these countries important players on the international arms market and might reduce the likelihood of being targeted by an arms embargo. To capture the imposition and scale of an embargo, I consider two instruments. First, one of the most important decisive reasons whether or not military sanctions are imposed against a particular country is the violation of human rights. To proxy the level of human rights protection, I make use of the Freedom House dataset where countries receive a score based on their political rights and civil liberties. A higher value indicates fewer political rights or civil liberties. Figure 1 clearly indicates that both the number of embargoes and the average Freedom House score

[14] The complete results of the general-to-specific approach are available upon request. A potential problem with this approach is that the sample may change in each step due to data availability. However, I prefer this approach to ad hoc specifications.

have an upward trend in the period of my analysis. Second, the international status ranking as reported in the Banks International dataset is used as an instrument. The international status ranking is a composite score based on the diplomatic reputation of a country. For senders it might be more costly to impose and enforce sanctions that target countries that are politically and economically important (Wezeman, 2014). Clearly, these instrumental variables do not directly affect the business performance of the defense industry. This is also reflected in the pairwise correlations between the instruments and the business performance indicators of the considered defense firms, which are close to zero. The predicted values from this first-stage regression ($\overline{emb}_{jkt}$) are used to compute the adjusted embargo by taking the sum of the predicted scores on the embargo measure aggregated by country-year. In turn, this total is included in the second-stage specification that is given equation (6) above.

$$\overline{emb}_{jt} = \sum_{n}^{k=1} \overline{emb}_{jkt} \tag{8}$$

4. Empirical findings

4.1 Baseline results

In this section, I present my estimation results on the relationship between arms embargoes and the business performance of the major defense companies. In Table 1, I report my baseline results using the second stage of the 2SLS estimator, while the results of the first-stage regression are provided in Table A1 in the appendix. To obtain robust standard errors, I use the bootstrap procedure with 1,000 replicators since the number of observations substantially differs among the firms considered. The validity of my instrumental variables is formally checked by using the Sargan test under the null hypothesis that the used set of instruments is valid, i.e., they are uncorrelated with the error term in the structural equation. The Sargan test indicates that I cannot reject the null hypothesis so my instruments are valid ($p > 0.05$). Alternatively, I apply the Wald test of exogeneity under the null hypothesis that the instrumented variables are exogenous ($p < 0.05$). The Wald test indicates that the embargo variable is potentially endogenous and that instruments should be used. To obtain robust standard errors, I use the bootstrap procedure with 1,000 replicators since the number of observations substantially differs among the firms considered.

The results in column (1) indicate that the imposition of arms embargoes significantly puts the business performance of a defense company under downward pressure as they reduce the total revenues, while at the same time increase the total costs at common statistical confidence levels. To assess the economic significance of this outcome, I need to interpret the size effect. On average, countries that are subject to an arms embargo are responsible for about 4 percent of the total world

arms imports in the five consecutive years before the embargo. Using this figure together with the findings of column (1) suggests that the total revenues decline by approximately 2.7 percent due to military sanctions, while the total costs increase with 1.2 percent. Finally, the net profits are about 4 percent lower in the same year as the embargo compared to a situation without any arms trade bans.

To test the sensitivity of my results to the estimation technique chosen, I use the OLS-FE approach as an alternative. For this purpose, I employ the embargo measure provided in equation (5). In particular, OLS estimation with fixed effects is the least restrictive estimation method as it assumes that embargoes are exogenous. One can argue that this assumption is valid for individual defense firms as they cannot influence the imposition or enforcement of embargoes other than by using collective actions i.e., using lobby activities or providing political support. However, based on the results in column (2) it turns out that the OLS-FE results are statistically insignificant at common confidence levels. This strengthens the idea that arms embargoes are not randomly imposed around the world. However, one important note regarding these latter findings is that since the used empirical specification poses a dynamic component the OLS estimator might be biased.

One critical remark one can make about these first results is that I have assumed that embargoes introduced by the different senders have the same effect on the total costs and revenues. One can argue that this assumption is rather questionable. A key element in this debate is whether sanctions are imposed multilateral or unilateral. On the one hand, broader participation in arms embargoes is generally hypothesized to lead to better and more effective implementation. However, on the other hand, because of the dominant and bureaucratic process of arms embargo initiation, a powerful state such as the US, may be able to make a formally unilateral embargo effective. Due to these concerns, I relax the assumption that embargoes should have a uniform effect and split the total number of embargoes by their respective sender, i.e., EU, UN or US. One concern is that there is a significant overlap of some embargoes by their senders. For instance, the European Union implemented all recent United Nations Security Council embargoes. Simultaneous inclusion of the different senders allows for isolation of the true effect of each individual sender. The results in column (3) of Table 2 indicate that UN and EU embargoes have the strongest significant effect on the business performance. This finding supports the view that the multilateralization of an arms embargo strengthens the signal of dissociation sent to a target (i.e., Brzoska, 2008). In turn, US embargoes have only a weak effect. The possible explanation for this latter result is twofold. First, it is difficult to enforce US embargoes outside of the US or punish foreign violators other than using diplomatic means or economic deterrence. Second, it might be that the US regulator does not strictly enforce sanctions to its domestic defense industry as a way of economic support or due to its close ties. Both these reasons make US embargoes less effective.

Furthermore, some embargoes are only a partial ban that explicitly prohibits transfers to selected parties or regions in the target state. To explore whether there is a significant difference in the impact of full and partial embargoes, I follow Erickson (2013) and have split the total number of embargoes into full and partial embargoes. The results in column (4) indicate that while both embargo categories have a significant adverse effect, full embargoes harm the business activities in the defense industry significant more.

It is widely documented in the existing literature that the impact and effectiveness of an embargo changes during the imposition period. After the onset of an embargo, firms might adapt to the new reality and try to mitigate the adverse consequences, for instance, by selling military equipment to other buyers or adjust their production. To explore this issue more thoroughly, I adjust my embargo measure by focusing only on the first year of an arms embargo. The results in column (5) in Table 2 seem to support this idea since the adverse economic impact that is created in the first year of an embargo is generally larger compared to the average annual impact over the course of an embargo reported in the previous columns.

<<< Insert Table 2 about here >>>

4.2 Firm-specific effects

The effect found so far shows that arms embargoes worsen the business performance in the defense industry. Especially multilateral embargoes and embargoes in the first year of their imposition harm the economic perspectives of defense-related firms. However, what is less clear is which mechanisms are responsible for these findings. Thus, an important question to which I will turn now is whether firm-specific characteristics affect the impact of arms embargoes on the business performance. For instance, the industrial base between the EU and US substantially differs. The EU defense industry is characterized by a large degree of fragmentation and national protection, while the US industrial base is determined by large internal economies of scales. Besides, companies producing both dual-use and military goods are most likely to suffer less from an arms embargo than firms that produce only military equipment. In the remainder of this section, I will try to reveal these mechanisms underlying the impact of arms embargoes. In more detail, I estimate the following model.

$$\Delta \ln busper_{ijt} = \alpha_{ij} + \mu \ln busper_{ijt-n} + \beta_k \boldsymbol{x}^k_{ijt-n} + \lambda_m \boldsymbol{z^m_{it}} + \gamma_1 emb_{jt} + \gamma_2 \left(emb_{jt} \times \boldsymbol{z^m_{it}}\right) + \varepsilon_{ijt} \quad (9)$$

Where $\mathbf{z^m}$ is a vector containing *m* mediating factors represented by a series of dummies. The other variables have the same meaning as in equation (6). Moreover, I can test whether the impact of embargoes relies on firm-specific characteristics using the following marginal effect.

$$\frac{\Delta \ln busper}{\partial emb} = \gamma_1 + \gamma_2 \boldsymbol{z^m} \tag{10}$$

In Table 3, I report the regression results. First, I test whether arms embargoes have the same effect on firms that produce only military goods and companies that also produce dual-use goods. The expectation is that companies that also produce dual-use goods are better able to diversify their business activities and therefore suffer less from military sanctions. To explore this issue, I create a dummy taking the value one when the majority of the firm revenues is contributed by the sales of military goods rather than by dual-use or civil goods. The results in column (1) generally confirm the presence of this diversification effect as firms that produce predominantly military goods suffer the most. In the literature, this diversification effect is often related to the size of a company (i.e., Aw and Batra, 1998). Small companies are less able to diversify their business activities or markets as they produce only a limited range of goods or services. To examine this latter issue in more detail, I create a dummy variable indicating whether a defense firm is small or large based on the median size of the labor force employed of a firm in my sample. The results in column (2) do not support this idea as the interaction term between the size of a firm and the embargo indicator is not statistically significant at common confidence levels in any of the models. One possible explanation is that the sample used in this study consists of only major defense companies due to data availability. This reduces the variation among the considered firms and creates a potential sample selection bias.

To explore in more detail whether the embargo effect depends on the specific type of military equipment is being produced by a company, I add in column (1) of Table 4 an interaction between the embargo indicator and four dummies that capture the different broad categories of military goods: (1) aircrafts, ships and vehicles; (2) service and maintenance; (3) electronics and communication technology and (4) artillery and missiles. The information on this categorization is taken from various versions of the Defense Top 100 reported by the Defense News Media Group. A firm can appear in multiple categories as it produces different goods and services. The results indicate that especially the revenues and net profits of firms producing aircrafts, ships and vehicles or artillery and missiles suffer from embargoes. One possible explanation is that for these particular goods it is hard to find alternative buyers and high upfront investments are needed when purchasing and producing these goods. Besides, these goods might be at an early stage subject to coercive trade measures as they can directly be used for battle purposes or cause many civilian causalities. One important note regarding

these latter results is that the sample size is reduced substantially due to the lack of detailed data about the military goods a firm produces. As a result, there might be a sample selection bias present.

Moreover, as already mentioned above, the defense industrial base significantly differs among countries. For instance, the US defense industry is regarded to be highly competitive and dominated by economies of scale, while the defense industry in most other countries is much more fractionalized and thrives on government support. To explore whether the impact of arms embargoes differs between US and non-US firms, I add in column (3) of Table 3 an interaction term between my arms embargo measure and a dummy variable indicating whether a defense firm has its statutory headquarter is located in the United States. Surprisingly, the results suggest that embargoes have the most severe effect on the revenues and net profits of US-based firms. The explanation of this finding is threefold. First, US defense firms might produce more sensitive goods that can only or readily be used for military purposes and therefore fall more often under an embargo. Second, US-based firms are likely to face more intensive competition and receive less government support during adverse times. Third, although US sanctions are not adequately enforced internationally, they may be more strictly enforced against domestic firms. As a result, violations by US firms might be punished rather severely.

In the next test, I explore whether the impact of arms embargoes depends on if a company has a foreign subsidiary. One of the reasons why firms move or outsource their business activities abroad is the regulatory environment such as policies on strategic trade controls and the stringency of enforcing sanctions (Seyoum, 2017). For this purpose, I have created a dummy variable taking the value one if a parent company owns a foreign subsidiary that is also recorded in the SPIRI Arms Industry Database and zero otherwise. The results in column (4) indicate that companies that have large foreign subsidiaries are better able to cope with an arms embargo as the interaction term is statistically, although weakly, significant in each econometric specifications at common confidence levels.

Furthermore, as already mentioned above, the successful compliance and enforcement of an arms embargo rely to a great extent on the institutional capacities of the sender state government. For instance, DellaVigna and La Ferrara (2010) find that defense firms that have their headquarters in countries with high corruption and low transparency in arms trade benefit from the illegal arms trade to embargoed countries. In order to explore this notion some further, I create a dummy taking the value one when the institutional quality measure composed above is larger than the median and zero otherwise. The results in column (5) indicate that the business performance of firms in countries with poor institutional quality benefits from an embargo, while defense companies from countries with strong political institutions suffer from an embargo. This finding indicates that better enforcement would lead to better compliance and therefore more effective embargoes (see also DellaVigna and La Ferrara, 2010).

Additionally, in more competitive arms markets, it is likely that governments more easily allow violating the boycott to promote their own arms industries as matters of protecting national economic interests. By noncompliance, states may be capable of reaping substantial economic benefits by sending arms to the embargoed state. To explore this issue some further, the data is split into two equal-size samples using a concentration measure based on the Herfindahl-Hirschman index of the total revenues in a particular year. A lower Herfindahl index indicates more competition among firms in a particular year (see also Dunne and Smith, 2016). The results in column (6) indicate that the degree of competition is not a mediating factor of the impact of arms embargoes. One explanation is that an increase in competition might lead to two effects that run in opposite directions. On the one hand, an increase in competition will put prices under downward pressure, but on the other hand, when competition increases the likelihood to turn to embargo busting practices increases as well. These two effects apparently cancel each other out. Alternatively, the time period used in this research is rather short leading to low variation in the competition measure. Besides, the sample consists only out of major defense firms again reducing variation and reducing the accuracy of the competition measure especially when the number of small-size firms starts to increase. In a similar vein, due to the lack of more detailed information, I have aggregated all firms into one competition measure. This latter might be questionable as the market structure is likely to differ among the various and highly differentiated military goods that are being produced. For example, the market for navy ships or fighter jets can best be described as an oligopoly, while small arms are usually being produced by a large number of firms sharing the characteristics of perfect competition.

Moreover, in column (7), I examine whether the impact of arms embargoes relies on the concentration of the ownership. In more detail, I distinguish between companies of which the ownership is widely dispersed as they are publicly listed and other companies including firms with one dominant shareholder or government-owned companies. The results indicate that there appears to be no significant difference in the impact of arms embargoes on both groups of firms. One explanation might be that while on the one hand, publicly listed firms are more closely monitored by investors who demand compliance with the trade ban to avoid high fines. On the other hand, these firms are likely to be also more profit-oriented due to the pressure by return-seeking investors that again may increase the likelihood of embargo busting practices.

Finally, it is well-known that expectations about future imposition of embargoes can lead to a change in the behaviour of buyers and sellers already long before the embargo is really implemented or even agreed on. Thus, changes in expectations about future imposition of sanctions can lead to a change in buying decisions of target states already long before the embargo is really implemented or even agreed on. This implies that when buyer states expect that they will be subject to an embargo, they will anticipate and already try to hoard military equipment in the period before to avoid a future

embargo. To explore whether this hypothesis holds, I include the embargo onset variable also with a one-year lead to capture the first signals of the likelihood of an embargo. The results in columns (4)-(6) of Table 4 indicate that on average about a quarter of the reduction in the revenues and profits caused by the imposition of an embargo in its first year is compensated by the mentioned hoarding effect in the year before. This result illustrates that it is likely that defense firms will gain at the beginning from political tense situations, but have to incur a loss when the embargo remains for a couple of years.

<<< Insert Tables 3 and 4 >>>

5. Conclusion

Since the end of the cold war, arms embargoes have become an important tool of foreign policy as a 'smart' alternative to comprehensive economic sanctions. The increased popularity runs from the fact that arms embargoes hit a regime where it hurts, without resorting to military force or necessarily harming the general population. Despite their popularity as a foreign policy tool, arms embargoes have been criticized in academic and policy circles as ineffective. Embargo busting practices by sending states coupled with a lack of international enforcement are believed to fundamentally undermine embargo success.

The question then also remains what impact these embargoes really have on the profitability of the international defense industry. On the other hand, the profits of defense firms are likely to drop as the volume of arms exports is hampered and trading costs rise. On the other hand, the profits are not affected as the compliance to arms embargoes is not effectively enforced or even the revenues increase due to illicit trade and higher prices on the black market in target countries. Thus, whether military sanctions affect the economic performance of the defense industry, and if so, in which direction is ultimately an empirical question.

After testing for the sensitivity of the results reported throughout this study, I can draw several conclusions. First, on average military sanctions lead to a drop in the total revenues by about three percent, while at the same time trade cost increase in the defense industry by approximately one-percent. As a result, the profitability of the international defense industry is under downward pressure after the introduction of an arms embargo. Second, multilateral sanctions put the business performance of arms producing firms substantially more under a downward pressure compared to unilateral military sanctions due to more effective enforcement. Multilateral sanctions send a stronger signal of dissociation to a target. Finally, the ability of a firm to effectively mitigate the adverse consequences of an embargo relies to a certain extent on firm-specific characteristics, such as whether a company also produces dual-use goods or the economies of scale it can exploit. This latter finding supports the

new-trade theory emphasizing the importance of firms rather than sectors in understanding the challenges and the opportunities countries face in international trade. Meanwhile, it nuances the inconclusive picture raised by the literature focussing on the demand side effect embargoes. In particular, this research shows that embargoes are still effective at least on the supply side.

A critical limitation regarding this study is that it only considers major defense firms due to a lack of available data of small-scale firms. As a consequence, the results presented might be affected to a certain extent by a sample selection bias. For instance, the impact of arms embargoes might be more or less severe for small-size firms, which in turn will affect the overall effectiveness of embargoes.

References

Aw, B., & Batra, G. (1998). Firm size and the pattern of diversification. International Journal of Industrial Organization 16(3): 313-331.

Baldwin, D. (1997). The Sanctions Debate and the Logic of Choice. International Security 24: 80-110.

Blum, J. (2019). Arms production, national defense spending and arms trade: Examining supply and demand. Forthcoming European Journal of Political Economy.

Bondi, L. (2002). Arms Embargoes. In Name Only? In Cortright, D., Lopez, G., (eds) *Smart sanctions: Targeting economic statecraft.* pp. 125-144

Boucher, A., Holt, V. (2009). Targeting spoilers: The role of United Nations panels of experts. Henry L. Stimson Center.

Brzoska, M. (2008). Measuring the effectiveness of arms embargoes. Peace Economics, Peace Science and Public Policy 14.

Brzoska, M., Lopez, G. (2009). Putting teeth in the tiger: improving the effectiveness of arms embargoes. Emerald Group Publishing.

Cortright, D., Lopez, G. (2001). Targeted sanctions: Lessons from the 1990s. In: Brzoska, M. (ed.) *Smart Sanctions: The Next Steps*. Baden-Baden. pp. 19–37

DellaVigna, S., La Ferrara, E. (2010). Detecting illegal arms trade. American Economic Journal: Economic Policy 2, 26-57.

Drezner, D. (1999). *The Sanctions Paradox: Economic Statecraft and International Relations*. Cambridge University Press.

Driessnack, J., King, D. (2004). An initial look at technology and institutions on defense industry consolidation. Defense Acquisition University Alexandria.

Dunne, J. and Smith, R. (2016). The evolution of concentration in the arms market. The Economics of Peace and Security Journal 11(1): 12-17.

Durch, W. (2000). *Constructing Regional Security: The Role of Arms Transfers, Arms Control, and Reassurance*. New York: Palgrave

Erickson, J. (2013). Stopping the legal flow of weapons: Compliance with arms embargoes, 1981–2004. Journal of Peace Research 50, 159-174.

Fruchart, D., Holtom, P., Wezeman, S., Strandow, D., & Wallensteen, P. (2007). United Nations Arms Embargoes: Their Impact on Arms Flows and Target Behaviour. Solna & Uppsala: SIPRI & Uppsala University.

Hendry, D. (1993). *Econometrics: alchemy or science?: essays in econometric methodology*. Oxford University Press.

Hufbauer, G., Schott, J. & Elliot, K. (1990). Economic Sanctions Reconsidered: History and Current Policy, 2nd edition. Washington, DC: Peterson Institute for International Economics.

Hufbauer, G., Schott, J., Elliot, K. and Oegg, B. (2009). Economic Sanctions Reconsidered, 3rd edition. Washington, DC: Peterson Institute for International Economics.

Judson, R., Owen, A., 1999. Estimating Dynamic Panel Data Models: A Guide for Macroeconomists. Economics Letters 65 (1): 9–15.

Kaempfer, W., Lowenberg, A. (2018). The problems and promise of sanctions. In Cortright, D. (eds) Economic Sanctions: Panacea or peacebuilding in a post-cold war world, pp. 61-72.

Klomp, J. (2019). The Arab spring and the international defense market. Mimeo.

Markusen, J., Venables, A. (1998). Multinational firms and the new trade theory. Journal of International Economics, 46(2), 183-203.

Martínez-Zarzoso, I., Johannsen, F. (2017). The Gravity of Arms. Defence and Peace Economics 30: 1-25.

Moore, M. (2010). Arming the embargoed: A supply-side understanding of arms embargo violations. Journal of Conflict Resolution 54: 593-615.

Newey, W. (1987). Efficient estimation of limited dependent variable models with endogenous explanatory variables. Journal of Econometrics 36: 231-250.

Peksen, D. (2019). When Do Imposed Economic Sanctions Work? A Critical Review of the Sanctions Effectiveness Literature. Defence and Peace Economics 30, 635-647.

Rundquist, B. S. (1978). On testing a military industrial complex theory. American Politics Quarterly, 6(1): 29-53.

Russett, B., Sullivan, J. (1971). Collective goods and international organization. International Organization 25: 845-65.

Seyoum, B. (2017). National Security Export Control Regimes: Determinants and Effects on International Business. Thunderbird International Business Review, 59(6), 693-708.

Salisbury, D. (2013). Trade controls and non-proliferation: compliance costs, drivers and challenges a. Business and Politics 15(4): 529-551.

Sandler, T. (2000). Arms trade, arms control, and security: Collective action issues. Defence and Peace Economics 11: 533-48.

Staibano, C. (2005). Trends in UN sanctions: From ad hoc practice to institutional capacity building. In: Wallensteen, P. Staibano, C. (eds) International Sanctions: Between Words and Wars in the Global System. New York: Frank Cass, pp. 31–54.

Tierney, D. (2005). Irrelevant or malevolent? UN arms embargoes in civil wars. Review of International Studies 31: 645-664.

Windmeijer, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics 126: 25-51.

Figure 1: Number of arms embargoes

F

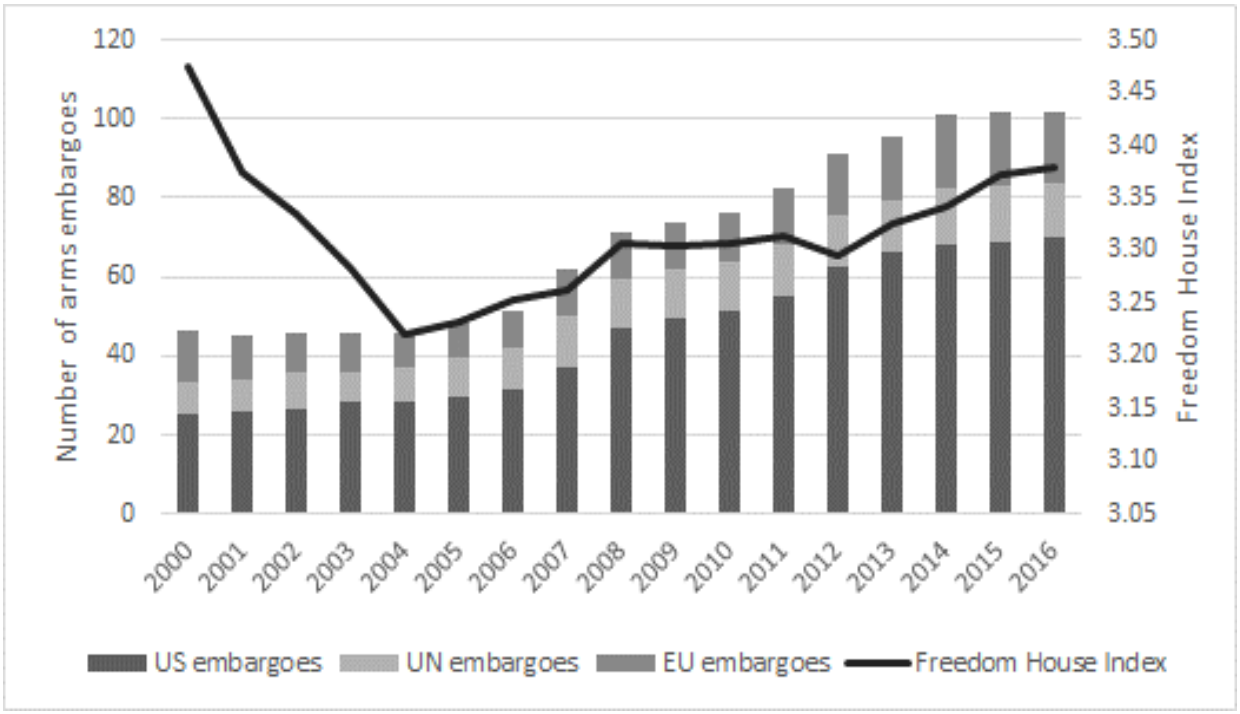

Table 1: Summary of the embargo effects

	Quantity (Q^*)	Price (p^*)	Unit prod. costs (c)	Total revenues (TR)	Total costs (TC)	Net profits (π)
Trade volume e	+/-	+		+/-	+/-	+/-
Price premium μ	+	+		+/-	+/-	+/-
Trade costs η	-	+	+	+	+/-	+/-
Enforcement γ	+	+		+	+/-	+/-

The table reports the theoretical direction of the expected embargo effects based on the partial derivatives of the business performance indicators (see appendix). (+) positive, (+/-) undetermined, (-) negative and (0) no effect.

Table 2: Impact of arms embargoes

	(1)	(2)	(3)	(4)	(5)
	Annual log-change total revenues				
Arms embargoes	-0.675 *	-0.914			
	(0.39)	(1.11)			
US arms embargoes			-0.068 *		
			(0.04)		
EU arms embargoes			-0.328 *		
			(0.20)		
UN arms embargoes			-0.490 **		
			(0.15)		
Partial embargo				-0.431 *	
				(0.24)	
Full embargo				-0.751 **	
				(0.37)	
First-year only					-1.075 *
					(0.64)
Estimation method	2SLS	OLS-FE	2SLS	2SLS	2SLS
Sargan test (p-value)	0.788		0.803	0.912	0.560
Wald test (p-value)	0.000		0.000	0.000	0.000
Observations	1258	1283	1258	1258	1258
	Annual log-change total costs				
Arms embargoes	0.300 *	0.242			
	(0.17)	(0.17)			
US arms embargoes			0.036 *		
			(0.02)		
EU arms embargoes			0.142 *		
			(0.08)		
UN arms embargoes			0.224 **		
			(0.08)		
Partial embargo				0.159 *	
				(0.08)	
Full embargo				0.363 **	
				(0.09)	
First-year only					0.569 *
					(0.30)
Estimation method	2SLS	OLS-FE	2SLS	2SLS	2SLS
Sargan test (p-value)	0.594		0.520	0.558	0.552
Wald test (p-value)	0.000		0.000	0.000	0.000
Observations	1003	1023	1003	1003	1003
	Annual log-change net profits				
Arms embargoes	-0.950 *	-0.693			
	(0.49)	(0.50)			
US arms embargoes			-0.165 *		
			(0.10)		
EU arms embargoes			-0.423 *		
			(0.25)		
UN arms embargoes			-0.699 **		
			(0.20)		
Partial embargo				-0.586 *	
				(0.35)	
Full embargo				-0.984 **	
				(0.37)	

First-year only					-1.879 *
					(1.02)
Estimation method	2SLS	OLS-FE	2SLS	2SLS	2SLS
Sargan test (p-value)	0.517		0.511	0.487	0.703
Wald test (p-value)	0.000		0.000	0.000	0.000
Observations	837	857	837	837	837

*Note: **/* Indicating significance levels of respectively 5 and 10 percent. Bootstrapped standard errors are shown between brackets. Estimated including the variables found significant in the general-to-specific approach, country and defense company fixed effects.*

Table 3: Firm-specific impact of arms embargoes I

Conditional factor :	Share military goods	Firm size	United States	Foreign subsidiary	Institutional quality	Competition	Dispersed ownership
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual log-change total revenues							
Arms embargoes	-0.571 *	-1.041 *	-0.796 *	-0.778 *	-0.769 *	-1.125 *	-0.691 *
	(0.31)	(0.60)	(0.41)	(0.43)	(0.46)	(0.59)	(0.36)
Arms embargoes × conditional factor	-0.135 *	-0.499	-0.233 *	0.340 *	-0.199 **	-0.391	-0.306
	(0.08)	(0.39)	(0.14)	(0.19)	(0.06)	(0.40)	(0.21)
Sargan test (p-value)	0.513	0.497	0.586	0.381	0.357	0.468	0.454
Wald test (p-value)	0.516	0.802	0.406	0.721	0.886	0.907	0.488
Observations	1132	1094	1258	1258	1258	1258	1019
Annual log-change total costs							
Arms embargoes	0.199 *	0.516 *	0.363 *	0.425 *	0.340 *	0.373 *	0.363 *
	(0.11)	(0.29)	(0.21)	(0.26)	(0.19)	(0.20)	(0.21)
Arms embargoes × conditional factor	0.078 *	0.215	-0.153	-0.206 *	0.098 **	0.126	0.103
	(0.04)	(0.26)	(0.10)	(0.12)	(0.05)	(0.09)	(0.08)
Sargan test (p-value)	0.845	0.787	0.579	0.700	0.739	0.498	0.705
Wald test (p-value)	0.382	0.939	0.889	0.814	0.723	0.500	0.808
Observations	903	873	1003	1003	1003	1003	812
Annual log-change net profits							
Arms embargoes	-0.622 *	-0.757 *	-1.289 *	-0.979 *	-1.214 *	-0.972 *	-1.328 *
	(0.35)	(0.40)	(0.71)	(0.55)	(0.70)	(0.57)	(0.70)
Arms embargoes × conditional factor	-0.234 *	-0.224	-0.442 *	0.451 *	-0.316 **	-0.467	-0.505
	(0.13)	(0.28)	(0.24)	(0.24)	(0.12)	(0.69)	(0.69)
Sargan test (p-value)	0.878	0.702	0.757	0.378	0.728	0.558	0.697
Wald test (p-value)	0.841	0.781	0.525	0.421	0.632	0.360	0.417
Observations	753	728	837	837	837	837	678

*Note: **/* Indicating significance levels of respectively 5 and 10 percent. Bootstrapped standard errors are shown between brackets. Estimated including the variables found significant in the general-to-specific approach, country and defense company fixed effects.*

Table 4: Firm-specific impact of arms embargoes II

	Type of military goods			Embargo expectations		
	Annual log-change total revenues	Annual log change total costs	Annual log change net profits	Annual log-change total revenues	Annual log change total costs	Annual log change net profits
	(1)	(2)	(3)	(4)	(5)	(6)
Arms embargoes *t*	-0.895 **	0.382	-1.516 **	-0.773 *	0.480 *	-1.627 *
	(0.38)	(0.45)	(0.62)	(0.44)	(0.27)	(0.86)
Arms embargoes × aircrafts, ships and vehicles	-0.507 **	-0.598	-0.592 **			
	(0.15)	(0.64)	(0.28)			
Arms embargoes × Service and maintenance	0.871 *	0.768	0.780 *			
	(0.45)	(0.69)	(0.42)			
Arms embargoes × Electronics and communication	0.790	0.805	0.806			
	(1.48)	(0.65)	(1.24)			
Arms embargoes × Artillery and missiles	-0.694 **	-0.490	-0.712 **			
	(0.20)	(0.81)	(0.25)			
Arms embargoes *t* + 1				0.176 *	-0.114	0.462 *
				(0.10)	(0.13)	(0.27)
Sargan test (p-value)	0.555	0.360	0.565	0.819	0.645	0.891
Wald test (p-value)	0.789	0.833	0.443	0.937	0.661	0.949
Observations	881	702	600	1258	1003	857

*Note: **/* Indicating significance levels of respectively 5 and 10 percent. Bootstrapped standard errors are shown between brackets. Estimated including the variables found significant in the general-to-specific approach, country and defense company fixed effects.*

Appendix – Not intended for publication

Table A1: First-stage regression

Rights and liberties	0.007 **
	(0.00)
Status ranking	-0.003 *
	(0.00)
R-squared	0.128
Number of observations	344762

*Note: the dependent variable is the product between a binary variable indicating whether an arms trade relation between two specific countries is subject to an arms embargo in a particular year multiplied by the share of world arms trade between these two countries in the five preceding non-embargo years. **/* Indicating significance levels of respectively 5 and 10 percent.*

.Table A2: Alternative weighting schemes

	Embargoes weighted by		
	Population size	Armed forces	Land size
Annual total revenues	-0.493 *	-0.447 *	-0.318 *
	(0.26)	(0.24)	(0.16)
Annual net profits	-0.569 *	-0.666 *	-0.703 *
	(0.30)	(0.39)	(0.42)
Profit margin	-0.388 *	-0.504 *	-0.401 *
	(0.20)	(0.28)	(0.21)

Note: **/* Indicating significance levels of respectively 5 and 10 percent.

Table A3: General-to-specific

	Annual log-change total revenues	Annual log-change total costs	Annual log change net profits
	(1)	(2)	(3)
Armed conflicts worldwide	0.825 *		0.341 **
	(0.48)		(0.12)
Military expenditures world wide (logs)	0.192 **		0.127
	(0.05)		
Changes in the real exchange rate	0.359 *	-0.781 **	
	(0.19)	(0.21)	
Institutional quality	0.255 **	-0.115 *	0.195 **
	(0.10)	(0.07)	(0.06)
Size	0.421 *		0.125 *
	(0.24)		(0.07)
Observations	1258	1003	837

Note: **/* Indicating significance levels of respectively 5 and 10 percent.

Partial derivatives of the theoretical model

Total revenue = $p \times q$:

$$\frac{\partial TR}{\partial e} = \overset{+}{p}\frac{\overset{+/-}{\partial q}}{\partial e} + \overset{+}{q}\frac{\overset{+}{\partial p}}{\partial e} = \frac{(d+\eta)^2 - (a+ey\mu)(a+(3e-2)y\mu)}{4b}$$

$$\frac{\partial TR}{\partial \eta} = \overset{+}{p}\frac{\overset{-}{\partial q}}{\partial \eta} + \overset{+}{q}\frac{\overset{+}{\partial p}}{\partial \eta} = \frac{(1-e)(d-\eta)}{2b}$$

$$\frac{\partial TR}{\partial \mu} = \overset{+}{p}\frac{\overset{+}{\partial q}}{\partial \mu} + \overset{+}{q}\frac{\overset{+}{\partial p}}{\partial \mu} = \frac{(1-e)ey(a+ey\mu)}{2b} > 0$$

$$\frac{\partial TR}{\partial \gamma} = \overset{+}{p}\frac{\overset{+}{\partial q}}{\partial \gamma} + \overset{+}{q}\frac{\overset{+}{\partial p}}{\partial \gamma} = \frac{(1-e)e\mu(a+ey\mu)}{2b} > 0$$

Total costs = $c \times q$:

$$\frac{\partial TC}{\partial e} = \overset{+}{c}\frac{\overset{+/-}{\partial q}}{\partial e} = \frac{(d+n)(d+n+(1-2e)y\mu-a)}{2b}$$

$$\frac{\partial TC}{\partial \eta} = \overset{+}{c}\frac{\overset{+/-}{\partial q}}{\partial \eta} + \overset{+}{q} = \frac{(1-e)(a-2(d+n)+ey\mu)}{2b}$$

$$\frac{\partial TC}{\partial \mu} = \overset{+}{c}\frac{\overset{+/-}{\partial q}}{\partial \mu} = \frac{(1-e)e(d+n)y}{2b}$$

$$\frac{\partial TC}{\partial \gamma} = \overset{+}{c}\frac{\overset{+/-}{\partial q}}{\partial \gamma} = \frac{(1-e)e(d+n)\mu}{2b}$$

Net profits = $(p - c) \times q$:

$$\frac{\partial \pi}{\partial e} = \overset{+}{q}\left(\frac{\partial \overset{+/-}{q}}{\partial e} - \frac{\partial \overset{+}{p}}{\partial e}\right) + (\overset{+/-}{p} - c)\frac{\partial \overset{+/-}{q}}{\partial e} = \frac{\left(a + d + (1 - ey)\mu\right)\left(a - d - \eta + \left(3e - 2\right)y\mu\right)}{4b}$$

$$\frac{\partial \pi}{\partial \eta} = \overset{+}{q}\left(\frac{\partial \overset{-}{q}}{\partial \eta} - \frac{\partial \overset{+}{p}}{\partial \eta}\right) + (\overset{+/-}{p} - c)\frac{\partial \overset{-}{q}}{\partial \eta} = \frac{\left(1 - e\right)\left(a - d - n + ey\mu\right)}{2b}$$

$$\frac{\partial \pi}{\partial \mu} = \overset{+}{q}\left(\frac{\partial \overset{+}{q}}{\partial \mu} - \frac{\partial \overset{+}{p}}{\partial \mu}\right) + (\overset{+/-}{p} - c)\frac{\partial \overset{+}{q}}{\partial \mu} = \frac{\left(1 - e\right)ey\left(a - d - n + ey\mu\right)}{2b}$$

$$\frac{\partial \pi}{\partial \gamma} = \overset{+}{q}\left(\frac{\partial \overset{+}{q}}{\partial \gamma} - \frac{\partial \overset{+}{p}}{\partial \gamma}\right) + (\overset{+/-}{p} - c)\frac{\partial \overset{+}{q}}{\partial \gamma} = \frac{\left(1 - e\right)e\mu\left(a - d - n + ey\mu\right)}{2b}$$