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State Capture and Defence Procurement in the EU

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Executive summary

This paper is part of a broader research project which aims to assess state capture risks in the field of defence procurement using a combination of qualitative and quantitative methods to overcome research challenges typical of this area, most of all the relatively low level of transparency due to specific procurement regulations. In this paper, we summarise the findings of the quantitative part also drawing out key policy recommendations.

Public procurement is one of the government activities most vulnerable to corruption (OECD, 2016; World Bank & IBRD, 2013), and risks are even higher in the field of defence due to the large amounts of money involved, the complex and large contracts, the low number of buyers and suppliers – which develops stable personal relationships, and the fact that governments themselves are the enforcers of secrecy (Pyman, Wilson, & Scott, 2009).

This paper aims to a) gauge the extent and types of state capture in defence procurement across the EU, and b) provide a data-driven assessment of changes in state capture risks due to the latest EU-wide reform in the sector (2009/81/EC Directive on public procurement in the fields of defence and security). In order to achieve these two goals, the paper goes beyond merely measuring corruption and assesses the phenomenon of state capture. We conceptualise state capture not just as widespread corruption, but as a tight clustering of corrupt actors, typically centred around certain public organisations, government functions, or supply markets. These captured clusters may behave radically differently – demanding different solutions – compared to their environment and may grow or shrink over time.

First, we evaluate the scope and quality of publicly available information on defence procurement by collecting data both from the official EU procurement website Tenders Electronic Daily (TED), and alternative information sources like news articles, parliamentary documents and Freedom of Information requests. Since a significant share of defence purchases does not appear on publicly available platforms, media reports are often the only available source of information regarding large value, strategic acquisitions. Our results show that countries differ significantly in terms of the quality and quantity of data published in media and other public repositories such as Freedom of Information requests. While in some countries we were able to collect 200-300 contracts with exact values and clear identity of the winner, in other countries only 3-4 contracts were available. Our data shows that while TED covers on average 6.9% of the total amount spent on defence procurement (Eurostat data – see footnote 3), ranging from 0.1% to 21% depending on the country. By contrast the manually collected dataset covers on average of 7.8% with a range of 0.5% to 19.9%. This seems to support the assumption that alternative information sources like news articles tend to report on large value transactions.

As manually collected data is not comprehensive, and rarely contains exact information on the tendering procedure, we use only TED data for exploring state capture risks in defence procurement. First, we adapt an objective Corruption Risk Index (CRI) from the academic literature (Fazekas, Tóth, and King 2016) which is calculated as a composite index of the following red flags: single bidding, not open procedure type, length of advertisement period, subjective evaluation criteria, call for tender publication,

and length of decision period. Second, we construct a contracting network of organisations to test whether corruption risks cluster or are randomly distributed.

We observe significant heterogeneity in corruption risks across countries. If we compare the average CRI score of each country's entire procurement market with their average military procurement CRI, our data shows that in most countries military procurement contracts have higher corruption risk scores, but there are significant outliers too: In Italy, Bulgaria, Finland and the Netherlands, military procurement has significantly higher corruption risks than procurement in general. The opposite is true in Denmark and Greece: their military procurement contracts have less corruption risk than other kinds of procurement on average.

In order to analyse the distribution of corruption risks in the relationships between buyers and suppliers, we performed a network analysis on the TED data. We find that, in most defence procurement markets, corruption risks are not random, but rather clustered around the relationships of specific buyers and suppliers. This is especially true in larger markets. Looking at the networks of countries' military procurement markets, we find that high-corruption risk contracts are not randomly distributed, but rather clustered around specific buyers. This finding highlights the risk of State Capture in specific institutions rather than as a wholesale phenomenon.

Finally, we considered how the most significant recent EU-level policy intervention in the market for defence procurement, the 2009/81/EC Directive, impacted corruption risk. Using a matching approach, we compare similar contracts awarded right before and after the implementation of the Directive at the national level, finding that some corruption risks decreased while others increased following implementation. For example, the rate at which contracts were awarded to a single bidder halved. This observation comes with an important caveat: the number of non-open procedures (for instance direct-awards or invitation-only competitions) significantly increased. More work is needed to assess the impact of the Directive, but this finding suggests that while its requirements may have closed some avenues for favouritism, others remain open.

Introduction

Public procurement is one of the government activities most vulnerable to corruption (OECD, 2016; World Bank & IBRD, 2013). Risks are even higher in the field of defence due to the large amounts of money involved, the complex and high value contracts, high market concentration, and the fact that governments themselves are the enforcers of secrecy (Pyman, Wilson, & Scott, 2009). The defence procurement market has certain specificities which clearly distinguish it from general public procurement, both in terms of market structure and regulation, which may limit efficiency and fair competition. While efficiency and quality of defence spending are of great importance to the public good via their impact on national security, citizens have limited options for monitoring and holding the government accountable in this field due to confidentiality (sometimes used excessively), and a relative scarcity of publicly available information.

This paper aims to a) gauge the extent and types of state capture in defence procurement across the EU and, b) provide a data-driven assessment of changes in state capture risks due to the latest EU-wide reform in the sector (2009/81/EC Directive on public procurement in the fields of defence and security). In order to achieve these two goals, the paper goes beyond merely measuring corruption and assesses the phenomenon of state capture drawing on the approach of Fazekas and Tóth (2014). According to their conceptual and analytical framework, state capture is not just widespread corruption, but a tight clustering of corrupt actors and ties among them, typically centred around certain public organisations, government functions, or supply markets. This phenomenon has high relevance for anti-corruption policy, as captured clusters are expected to behave radically differently – demanding different solutions – compared to their environment. Addressing state capture is especially relevant in defence procurement as the low number of contracting authorities and suppliers, the complex technology, typically large contract values and high degrees of secrecy in national security decisions create an environment of interdependence among insiders, and limit the capacity of outsiders to effectively monitor wrongdoing.

To explore state capture in defence procurement, 1) we establish a robust measure of corruption risks in public procurement transactions focusing on binary relationships between issuers and suppliers, and 2) we construct a contracting network of organisations to demonstrate the non-random distribution of corruption risks. We use reliable micro-level public procurement contracting data, which has become available with the appearance of online public procurement websites in many countries in the last decades, offering a unique opportunity to put theory into practice. The network data is publicly available here: ELVIS.

As this paper is part of a broader research project in which a combination of qualitative and quantitative methods is used to overcome research challenges typical of this area, the findings are used to identify certain high-risk networks of issuers and suppliers where detailed field research is carried out in order to explore them in more detail. The results of these case studies are available here: Does defence industry capture the state in France? and Public-private relationships in defence procurement in the UK.

The rest of the paper is organised as follows. Chapter 1 provides a brief overview of the legal and economic factors which differentiate defence procurement from general procurement, including national

security concerns, market structure and the specificities of EU legislation. Chapter 2 reviews the findings of the literature addressing defence procurement in terms of market structure, corruption risks, and state capture. In Chapter 3, we describe the data sources we used to carry out the quantitative analysis, and we present descriptive statistics in order to explore the extent to which defence procurement expenditure is covered by publicly available sources in European countries. As a significant share of defence purchases does not appear on publicly available platforms, media reports are often the only available source of information regarding large value, strategic acquisitions. We evaluate the quality of this data, and we provide an estimate of the share of total defence procurement expenditure covered by it. Chapter 4 presents the Corruption Risk Index we applied, and Chapter 5 shows the findings emerging from network analysis. Chapter 6 analyses differences before and after the 81/2009 EC Directive came into effect. The last chapter summarises findings and formulates recommendations.

1. Context of defence procurement in the EU

This section provides a summary of the economic, technological and legal background which needs to be considered when analysing value-for-money, transparency, and corruption risks in defence procurement.

The wide and narrow definition of defence procurement

Although there is no single clear definition of defence procurement which is widely accepted by experts of the field, there is certainly a distinction between the products belonging to the very core of national security functions of the State – such as ammunition, submarines and vehicles for transporting troops – and the whole range of products acquired by authorities operating in the field of defence, which also includes goods and services necessary to fulfil administrative functions, such as office furniture and basic IT services. These two categories can be referred to as the narrow and the wide definitions of defence procurement (OECD/SIGMA, 2011). The former covers goods and services which were manufactured or intended to be used for purely military purposes, especially armaments, and dual-use products and technologies can also be included, if they were acquired for military use[5].

The narrow and wide definitions of defence procurement draw attention to the fact that some goods and services in the field of defence are more affected by national security considerations than others. In this sense, the procurement of more sensitive goods requires a regulatory regime which acknowledges the defence-specific characteristics of this sector and finds the balance between openness and transparency of the procurement process on the one hand, and protection of the core security concerns on the other hand (OECD/SIGMA, 2011). In contrast, the acquisition of non-sensitive defence-related supplies is quite similar to ‘general’ public procurement, so lack of transparency and restrictive procedures cannot be justified necessarily.

[5] Dual-use technologies can be used for both military and civil purposes e.g. GPS, nuclear technologies, missiles developed for satellite launching. Their categorisation as military or non-military depends on the purpose they serve in practice.

This report focuses on sensitive goods and services in the field of defence, that is, the narrow definition of defence procurement is applied. This means in practice that it is not the buyer but the product that decides whether we consider a tender as defence-related or not. We do not consider all purchases of ministries of defence as defence procurement.

Defence procurement market size

The 28 member states of the EU spent 205 billion euros on defence in 2017 according to Eurostat, which is 1.7% of the GDP of these countries on average.[6] However, this value covers several different types of expenses, such as salaries, foreign military aid, etc. so it cannot be used directly as an estimation of the total value of defence-related public procurement in Europe.

The European Commission provides a method for the estimation of defence procurement in its working document 'Evaluation of Directive 2009/81/EC on public procurement in the fields of defence and security' which is based on 2010-2014 Eurostat data, where the total general government expenditure on military defence is further disaggregated into specific national accounts components. The maximum total value of military procurement can be estimated as the sum of 'Intermediate consumption' and 'Gross fixed capital formation'. The time series can be extended for the period 2007-2017 using the newest Eurostat data (Table 1).[7]

TABLE 1: GOVERNMENT PROCUREMENT EXPENDITURE ON MILITARY DEFENCE IN EUROPE (IN MILLION EUR)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
European Union 28	78 547	81 220	79 482	79 380	78 064	80 235	79 992	80 638	89 592	91 118	93 659
EU 28 +EEA	82 878	85 860	83 920	83 873	83 448	85 421	85 235	85 709	95 014	96 734	100 019

This report uses the country-level disaggregation of the tables above as proxy of the maximum potential value of defence procurement expenditure. The country-level table is available in Appendix A.

[6] The total amount spent on defence in 2017 grows to 216 billion if EEA countries are added.

[7] Data source: Eurostat. Extracted on 10 March 2019.
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=gov_10a_exp&lang=en
Total value of defence procurement is calculated as the sum of the following National accounts indicators (ESA 2010): 'P2 Intermediate consumption' and 'P51G Gross fixed capital formation' with the following parameters: Sector=General government, Classification of the functions of government (COFOG 1999)=GF0201 Military defence, Unit=MIO_EUR Million euro

Defence market: buyers and suppliers

Although in most countries the primary buyers of defence goods and services are ministries of defence, other types of entities also appear in this market, such as law enforcement and detention system. While defence ministries are responsible for handling territorial threats and military crises, other institutions can be responsible for a wide range of tasks (e.g. combating terrorism or providing airport security). The number of potential buyers varies greatly among the subcategories of defence goods: only ministries of defence buy warships, but there are more potential buyers for firearms.

The suppliers of defence procurement are not clearly distinguishable from companies manufacturing 'civilian' goods. Many companies, which produce goods for military use, have also other fields of activities without military character, and dual-use technologies are especially hard to be classified. In any case, two distinctions should definitely be considered when analysing defence procurement. First, there is an important difference between prime contractors - or system integrators – on the one hand, which are large companies capable of delivering complex security solutions, usually they are the one signing contracts with buyers, and smaller companies on the other hand, which are usually subcontractors of the prime contractors. Naturally, roles are not fixed, a middle-size firm may be the contracting partner of a buying entity in one transaction, and subcontractor in another, however, this flexibility strongly depends on the type of goods and the contract size. Second, the sensitivity of goods is an important factor. The market of core defence goods, or armaments, has certain characteristics which differentiates it from 'civilian' markets, while this is less relevant in case of non-sensitive goods. To sum up, differentiating factors apply for prime contractors operating in core defence markets the most, and these impacts fade gradually with digging deeper into the supply chain and with entering the market of non-sensitive defence-related goods and services.

According to estimations, the total turnover of the defence industry sector was 97.3 billion euros in 2014, and 500 000 people were directly employed[8] in this sector but defence capabilities are not evenly distributed among member states at all. EU countries can be classified into four broad groups based on their prime contractors and the size of their defence industry sector in general (Trybus, 2014). France and the UK are in the first group on account of their extensive defence industries, their nuclear power and their permanent seats in the UN Security Council. The second group contains countries with significant capacities: Germany, Italy, Sweden and Spain, while the third group covers countries with limited capacities: Belgium, Finland, the Netherlands, Poland, Czech Republic, Romania and Denmark. All other countries are in the fourth group with very limited or no defence capacities at all. It worth mentioning that even in countries with the largest defence industry, capacities are not enough to provide full range of equipment which results in a pressure for cooperation and mergers both at national and European level.[9] This phenomenon has also consequences for competition: in case of expensive high-end technology such as aerospace technologies, competition is bound to be very limited, while competition can emerge in other sectors such as ships and vehicles.

[8] Fact Sheets on the European Union. http://www.europarl.europa.eu/ftu/pdf/en/FTU_2.4.4.pdf

[9] BAe Systems and Thales were created as a result of merger of companies in the same country, while EADS and Agusta Westland are a result of international mergers.

Extensive supply chains are also an important characteristic of the defence industry, especially for complex contracts. The distribution of subcontractors is more even among EU countries than the distribution of prime contractors. Subcontracting is an opportunity SMEs can also take to participate in the defence industry.

As a result of the above, the following characteristics of the defence market can be identified, especially in case of core defence markets and prime contractors. National markets of certain goods and services are often characterised by monopsony, i.e. only one buyer on the market, and monopoly or oligopoly, i.e. only one or very few suppliers on the market, at the same time. The low number of actors, accompanied by protectionism, makes the relationship between governments and national champions often interdependent. This applies even more to countries where the state has ownership in the biggest and strategically most important defence companies, e.g. in France, Portugal, Poland and Germany. Consequently, decisions regarding defence procurement depend not only on value for money and budget considerations, but industrial policy, employment, control over know-hows, and national security reasons, or any combination of these. This often leads to a setting in which the national champion has certain benefits that potentially distorts competition, e.g. it is subject to tax exemptions, or contracts are awarded to it even if there would be other options.

At European level, the defence market is characterised by fragmentation and duplications, which results in inefficiencies thanks to the lack of economies of scale. Inefficiency could mean not only higher prices but lower quality and longer completion time too, which could raise concerns regarding national security in the long term. In this sense, opening up the EU internal market for defence products is of high importance, which is addressed by a range of interventions, including Directive 2009/81/EC on defence and sensitive security procurement, however, there are still room for improvement.

Legislative framework

The procurement of armaments and other security goods and services has a special place within the EU internal market. On the one hand, the Treaty certainly covers it, which means that free movement of goods and services, and the general prohibition of discrimination on grounds of nationality applies but on the other hand, national security interests of Member States are also recognised.

Acknowledging the special characteristics of defence, Article 346 of the Treaty on the Functioning of the European Union (TFEU) allows member states to derogate from these rules and principles in the field of trade and production of munition and war material, if this is necessary for the protection of their essential security interests. However, these measures should not adversely affect conditions of competition in the internal market regarding non-defence related products.

In practice however, many Member States used this Article extensively, exempting almost automatically the procurement of military equipment from EU public procurement rules (European Commission, 2016). Naturally, this does not mean that defence procurement was carried out by member states in an unregulated way, but national regulation was applied which resulted in a regulatory patchwork in practice.

With the aim of mitigating this situation, the European Commission published an interpretative communication[10] in 2006 to explain that these derogations can be used only on an ad-hoc basic, only by invoking Article 346 TFEU, and member states must show that the extraordinary measures were necessary in order to protect their essential security interests. The Communication suggests that other interests, such as industrial and economic, cannot justify the use of the Article (Georgopoulos, 2007).

The next important step was the Defence and Security Directive entering into force on 21 August 2009. Although member states must have transposed it in their national legislation by 21 August 2011, significant delays occurred. Therefore, transposition have been considered to be complete only from May 2013 (European Commission, 2016).

The main aim of the Directive is opening up defence procurement market to cross-border competition by reducing the unjustified use of 346 Article TFEU. To this end, the Directive provides a more flexible regulatory framework which is more appropriate for the specificities of defence procurement. The Directive covers the area of military equipment, associated services and works contracts, sensitive procurement for security purposes (not only defence or national security), and procurement involving classified information. The rationale behind the wide scope is that it is often hard to distinguish between military use and non-military use technologies because the determining factor is often not the nature of the technology but the use of it (OECD/Sigma, 2011). The value threshold of the application of the Directive is EUR 412000 for supplies and services, and EUR 5150000 for works which values are updated periodically. The main elements of the new Defence and Security Directive, which are intended to narrow the gap between the special characteristics of defence procurement and regulatory regime, are the following.

- *Procedure.* One of the central elements of the Directive is that contracting authorities are free to choose the ‘negotiated procedure with prior notice’ as a standard procedure, which allows them more room for discussions with the suppliers about available solutions. Under certain circumstances, competitive dialogue and ‘negotiated procedure without prior notice’ are also allowed to be used, e.g. when there is not enough time for a negotiated procedure with prior notice (not even for the accelerated version) due to urgency ensuing from a crisis.
- *Security of information.* Contracting authorities can set out requirements for economic operators and their existing and future suppliers in order to safeguard the confidentiality of classified information related to the purchase.
- *Security of supply.* Contracting authorities may ask extra documentation from contractors which demonstrates their (and their whole supply chain’s) ability to fulfil their obligations recorded in the contract. Contracting authorities may ask for the supplier’s commitments among others to carry out maintenance and modernisation of the supplies later, to provide spare parts, components, or to establish capacities in case of increased needs for the supplies as a result of a crisis.

[10] Interpretative Communication on the application of Article 296 of the Treaty in the field of defence procurement, (COM (2006) 779 final)

According to the Commission's evaluation report (European Commission, 2016), the results of the implementation the Directive are ambiguous. On the one hand, total value of contract award notices published in OJ/TED under the Directive equalled only 22 million EUR in 2011 but increased more than ten times between 2012 and 2015, from 1.4 billion EUR to 19 billion EUR. On the other hand, the majority of contract award notices were of relatively small values (90% of observations less than 10 million EUR), thus, the value of procurement awarded under the Directive was relatively small when compared to overall defence procurement expenditure, which suggests that the Directive was used to a very limited extent for the procurement of strategic equipment (European Commission, 2016).

2. Literature review

This review aims to provide a summary of studies and reports addressing the corruption and state capture risks of defence procurement markets in Europe. It also includes an outlook to market structure in the field of defence, as the relationship between buyers and suppliers in the market is indirectly linked with the problem of state capture too. Unfortunately, academic studies using objective, quantitative research methods are rare in this field, probably thanks to the limited availability of good quality, comprehensive micro-level data. Papers analysing military spending often focus on its impact on economic growth instead, where aggregate data is available for a long time period in many countries.

Competition, transparency and corruption risks are more often covered by papers coming from international NGOs and think tanks including Transparency International Defence and Security Programme, the Stockholm International Peace Research Institute (SIPRI), and the Geneva Centre for the Democratic Control of Armed Forces (DCAF). These studies often use surveys and case studies from all around the world to illustrate problematic areas in military procurement and to recommend tools to tackle them. Although case study methodology does not allow for the application of results under different circumstances, the broad scope and the systematic data collection (both qualitative and quantitative) of these research projects could help identifying key problems and vulnerable points in the process of procurement. Beyond exploring problems, these advocacy-focused organizations usually draw up recommendations, that is, steps towards a solution: lowering corruption risks, more transparency, and better value for money.

Corruption risks and state capture in defence procurement

Gupta et al. use aggregated budget data and corruption perception indicators to test the relationship between corruption and high levels of military spending in 120 countries in the period of 1985-1998. Results indicate that corruption - measured by Transparency International's Corruption Perception Index and International Country Risk Guide Index - is indeed associated with higher military spending, measured by its share in both GDP and total government spending (Gupta, S.; de Mello, L.; Sharan, 2000). This result supports the statement that military spending is associated with higher level of corruption risks compared to procurement in general, but it leaves open the question how corruption is done and what can be done to mitigate the risk.

According to Feinstein, Holden and Pace (2011), the following built-in features of the arms trade make this field prone to corruption: a) the secrecy related to national security and commercial confidentiality, b) the close personal relationship between buyers, suppliers and their brokers, c) the complexity, fragmentation, and often opacity of global production, transportation and financial networks, d) the technical specificity of products, e) procurement pressures, and f) the high financial rewards coupled with a lack of consequences of wrongdoings. Most of these factors appear also on the list of inherent risks and factors facilitating state capture in general (OECD, 2017), namely, technical complexity, opacity of decision making, stable policy networks with repeated interactions over time. This implies that besides one-off instances of corruption, state capture risks also have to be considered in the field of defence procurement.

Feinstein, Holden and Pace (2011) also describes the most frequently used methods to acquire undue influence in the arms trade, which are the following: a) bribery (often through a third party which provides a legal remove between the supplier and the corrupting act), b) failure to declare a conflict of interest, c) the promise of post-employment, or revolving door, which blurs the line between the state and the defence industry and d) the offer of preferential business access, which is often related to offsets, e.g. public officials are offered cheap or free shares in companies that have been founded in furtherance of an offset programme. Most of these means (except for bribery) assume a stable, long-lasting relationship in the background, rather than a one-off transaction, which also supports the relevance of state capture in this field.

A comprehensive report of Transparency International's Defence and Security Programme (Transparency International, 2014) explores the extent and the reasons behind non-competitive defence contracts in order to formulate recommendations for various actors in this field. They attempted to collect qualitative and quantitative defence procurement data from 45 defence ministries with special attention to non-competitive procedures, which they identified as a corruption risk in itself, but they only succeeded in seven countries[11], which in itself is a telling example of data-related challenges in this area. The countries participating in the research had single sourcing percentages between 9% (Bulgaria) and 55% (United Kingdom) in defence procurement, with even higher rates if we narrow down the analysis to armaments only. Based on the analysis, the following barriers to open competition were identified: 1) the protection of the national defence industry by over-using Article 346 of TFEU, 2) restrictive requirements in the request for tenders, 3) excessive use of classification, even in case of non-sensitive defence related information, 4) limited license rights, which often lead to a situation where repair and maintenance of an equipment can be done only by one contractor, i.e. the original supplier, 5) lack of unification of standards and interoperability of equipment.

Another report of TI UK (Ben Magahy, Cunha, & Pyman, 2010) analyses the corruption risks associated with defence offsets through three case studies. Defence offsets are arrangements between the purchasing government and a supplier from another country, where the latter is obliged to invest a certain share of the contract in the importing country either through defence-related projects (e.g. by subcontracting), or through activities not related to defence such as purchases of other goods and services. The percentage of the offsets contract is often very high, even above 100%, and they are

[11] These are the United States, United Kingdom, Slovakia, Bulgaria, Latvia, Poland, and Slovenia

highly susceptible to corruption due to their complexity and a reduced level of scrutiny compared to the main arms deal. The study identifies three main categories of corruption risks from offsets: 1) influencing the need for a particular defence acquisition, 2) influencing the decision for the main contract, 3) allowing favours to be repaid to corrupt government officials via the offset contracts.

Market structure

The analysis of market structure characteristics can complement the analysis of potential state capture in the field of defence as concentration indicators and network characteristics of buyers and suppliers can tell us about the power relations of actors.

The relationships of companies in the defence industry is often described as a hierarchy of 'tiers'. Prime contractors (or 'primes') are on the top of this pyramid. They are specialised in defence production and sell complex products, such as weapon systems to the end users, i.e. mainly government agencies and ministries of defence. Below that is the first tier containing system providers, who are the producers of complete subsystems or major components. They are the final step before the product reaches the prime contractor, who may complete the product or simply organises shipment, marketing, etc. Below first tier there are second tier and third tier companies, often producing dual-use components which can be used for military purposes after being integrated into larger systems. They are not always listed as defence producers because they usually produce non-defence goods too.

Most academic studies exploring European defence market structure focus on prime contractors, and the consolidation process at European-level. Very little evidence is available on first-tier, second tier (and lower tier) companies and the market processes at the national level.

Carril and Duggan analyse the impact of increasing concentration of the 1990's US defence market on procurement outcome variables (Carril & Duggan, 2018). Using micro-level data (US's Department of Defense contract awards), they find that market concentration made the procurement process less competitive, which revealed itself in the form of increasing share of spending awarded without competition, or via single-bid solicitations. Contracts tended to shift from fixed-price towards cost-plus contracts[12]. However, they found no evidence that consolidation led to a significant increase in acquisition costs of large weapon systems, neither to increased spending at the product market level. The government's buyer power constrained firms from exercising any additional market power gained by consolidation.

The structure of the defence market is analysed from a political-business perspective by Neil and Taylor who describe different paths of restructuring after the Cold War in the United States and Europe, focusing on prime contractors (Neal & Taylor, 2001). They show that while the major approach of consolidation in the US was merger and acquisition, in Europe, more cautious approach was applied, which consisted of a wide range of tools for consolidation such as strategic alliances, minority shareholdings, and joint ventures. The study states that whilst the core drivers of consolidation were

[12] A cost-plus contract, also termed a cost reimbursement contract, is a contract where a contractor is paid for all of its allowed expenses, plus additional payment to allow for a profit.

similar in the US and Europe, the more complex relationship-system of European defence companies, which emerged due to the many national champions involved, may be an advantage in the global market, where flexibility and the ability to deal with cultural and political differences have great significance.

A study analysed 135 cross-border alliances, mainly in the 1990s, involving defence manufacturing firms in the UK and Europe in order to explore the extent of participation in alliances, the different types of alliances and the problems experienced (Butler, Kenny, & Anchor, 2000). The authors show that the form of cooperation is predominantly collaborative rather than joint ventures, consortia, and licensing, mostly explained by the desire to control decision-making and protect core competencies.

RAND Corporation's report (Vlachnos-Dengler, 2002) identifies three strategies for growth in the 1990s in the European defence market covering military aircraft, helicopters, unmanned aerial vehicles, missiles, land systems, shipbuilding, space; and the following subsystems: propulsion, defence electronics with particular emphasis on radar/sonar and electronic warfare, and landing. First, consolidation by government acquiescence to the creation of a national champion (e.g. BAe Systems). Second, consolidation at the European level, that is, involving companies from different countries (e.g. EADS). Third, expansion of an individual firm through acquisition and integration of smaller businesses while maintaining the core vehicle (e.g. THALES). The study identifies the aerospace sector as the most concentrated among the segments, while land systems and naval shipbuilding segments are the most fragmented. Missiles and defence electronics fall somewhere in between.

To sum up, there is evidence shown in the literature that defence procurement is especially prone to low level of competition, lack of transparency and corruption risks compared to 'general' procurement. The reasons include on the one hand the extensive use the notion of national security to which limits the usability of usual monitoring mechanisms, and on the other hand, the size, complexity and technical specificity of major arms programmes. In the meanwhile, the level of competition and the power relations of buyers and suppliers strongly depend on the specific product and market, but even in the most concentrated sectors, the government's buyer power limits the companies' ability to enforce interests.

3. Data

In this section we outline the data sources we used for our analysis and the major steps we took to prepare the data for analysis.

Tenders Electronic Daily - TED

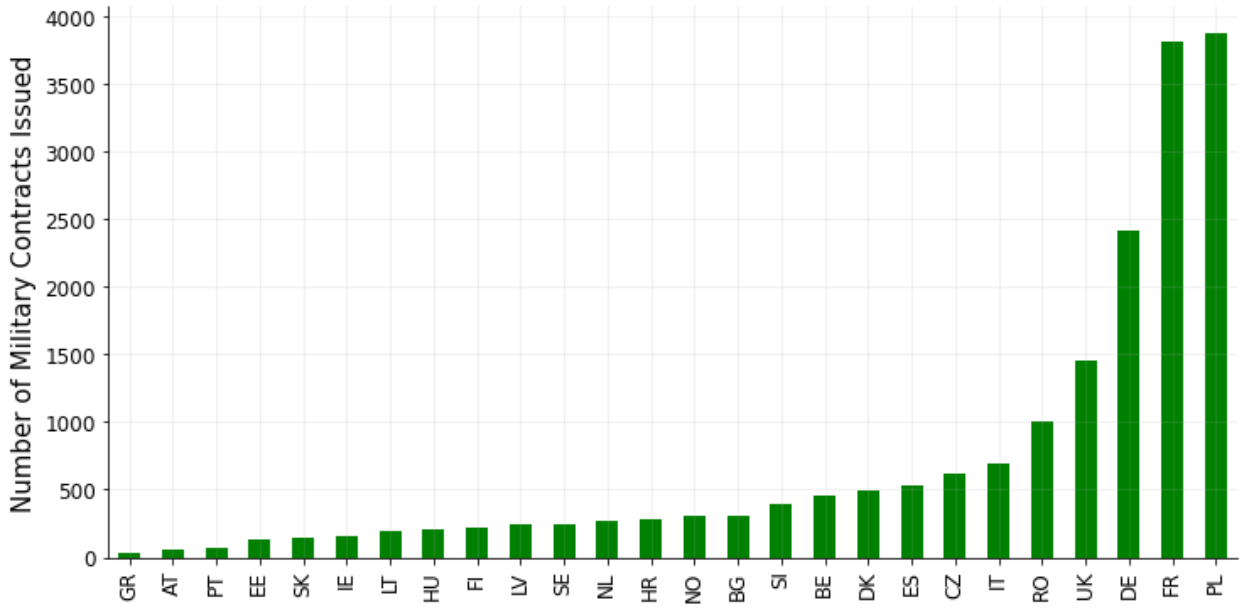
We collected contracts from a centralized database known as Tenders Electronic Daily (TED), the official EU portal for contract notices and awards. On the site, contracting authorities publish their calls for tenders and contract award notices above certain value thresholds, which differs for goods, services and works. Notices on TED contain the most important pieces of information on the tendering process

such as: the title and description of the tender, publication date and bidding deadline, estimated and final value, information on the tendering procedure and the identity of the buyer and the winner.

Before we could use this dataset for analysis, entity deduplication was necessary. Available public contracting data does not typically assign unique identifiers to entities involved in the contracting process. In other words, buyers and suppliers of goods and services are identified by plain text names and not tax numbers. For example, a contract awarded by the British Ministry of Defence to BAE Systems may list "MoD" as the buyer, and "BAE Systems, Ltd." as the supplier. Another contract between the same two entities may list "Ministry of Defence" and "BAE Systems". In order to properly analyse these markets, it is important to identify and merge the aliases of both buyers and suppliers as accurately as possible.[13]

Following deduplication, we considered all awarded contracts from 2006 to 2016, and filtered the data for contracts pertaining to defence-related activities. There are two ways in which we label a contract as military-related: a) one of the Common Procurement Vocabulary (CPV) product codes listed in the tender documentation comes from a list of curated codes deemed military related (see Appendix B on CPV codes), or b) the contract falls under the purview of the EU Directive 2009/81/EC[14] on defence and sensitive security procurement. The resulting dataset contains 18,608 contracts. We plot the count of military contracts in our database in Figure 1. Unsurprisingly, we generally have more contracts from larger countries.

FIGURE 1: NUMBER OF MILITARY CONTRACTS, TED, 2006-2016

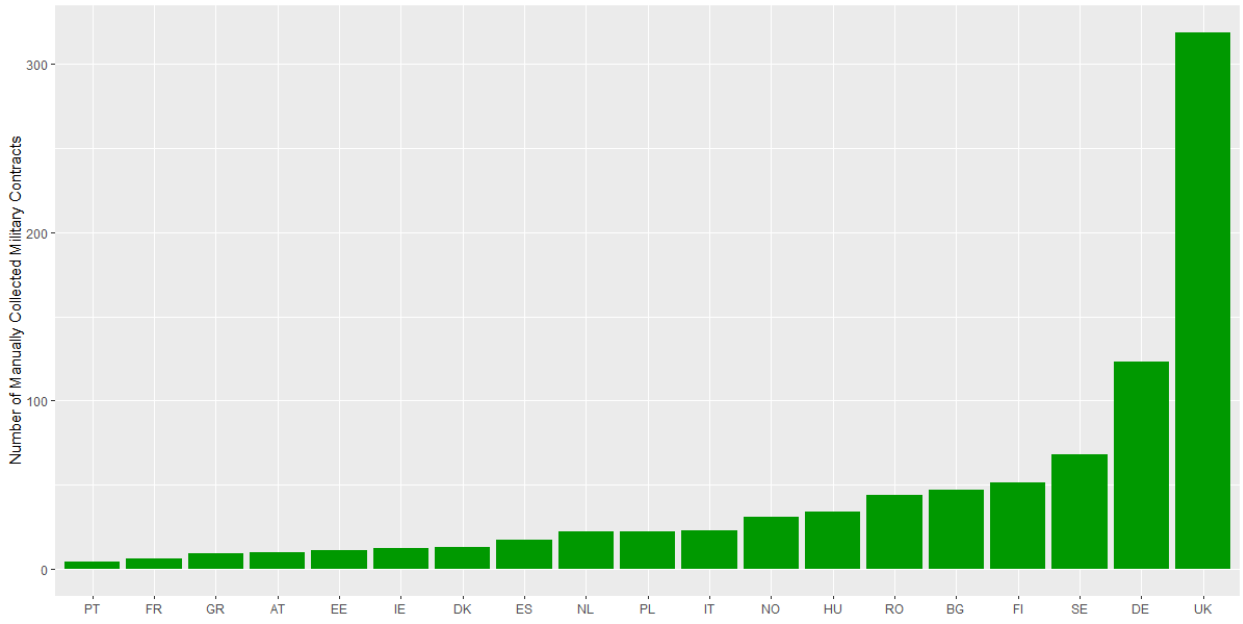


[13] The technical details of the entity deduplication method we applied are available in Appendix C.
[14] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32009L0081

Manually collected contract data

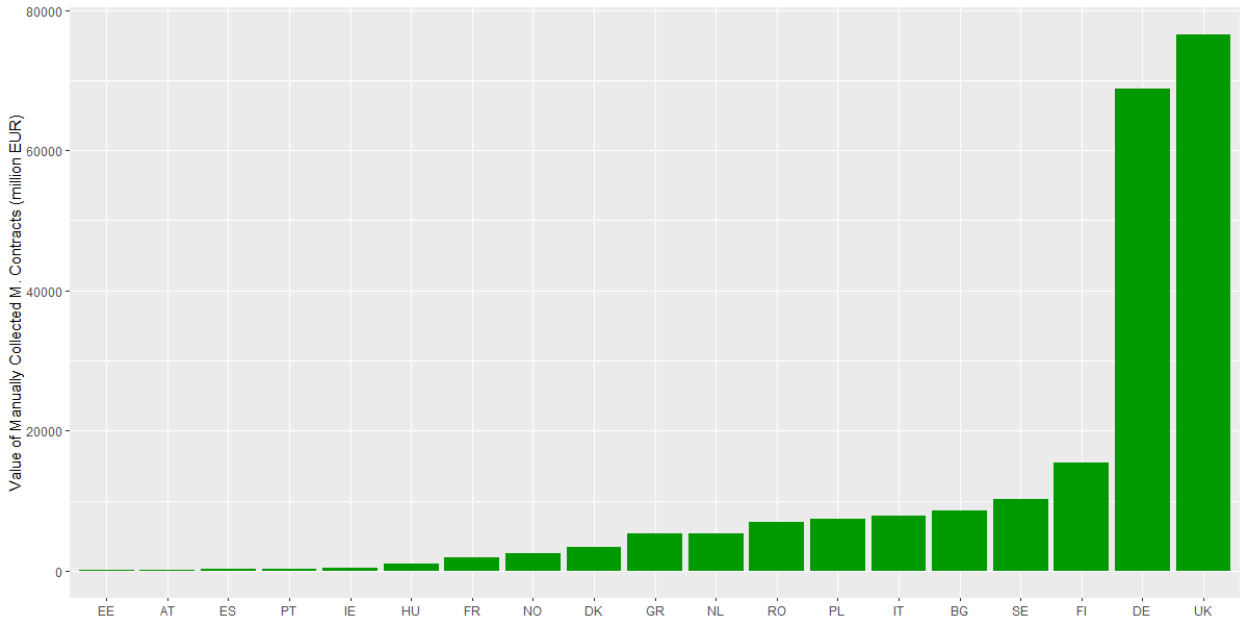
In order to overcome the challenges of limited availability of defence procurement data, additional sources were used to complement the dataset compiled from Tenders Electronic Daily notices. We systematically searched for defence contracts in 19 European countries using online journal articles, reports of local NGOs, parliamentary documents, freedom of information requests and general Google search with pre-defined search terms. Figures 1 and 2 show the number and total value of contracts respectively.[15]

FIGURE 2: NUMBER OF MANUALLY COLLECTED DEFENCE CONTRACTS PER COUNTRY, 2006-2018



[15] Where details were not clear we applied the following rules: 1) if contract value is defined as an interval, we used the upper threshold, 2) in case of multi-year contracts, we registered the whole amount in the year of contract signature. *This includes contracts that may be duplicated from the TED dataset.

FIGURE 3: TOTAL VALUE OF MANUALLY COLLECTED DEFENCE CONTRACTS (MILLION EUR) 2006-2018



The goal of manual data collection was twofold: a) we wanted to estimate the extent to which defence procurement spending is covered by publicly available data, and b) we also wanted to gain insights regarding the usability of alternative data sources apart from official data platforms.

Our general experience is that countries differ significantly in terms of the quality and quantity of data published in media. While in some countries we were able to collect 200-300 contracts with the exact values and clear identity of the winner, in other countries only 3-4 contracts were available. Besides, we identified the following limitations to the use of alternative data sources for quantitative analysis. First, details are often not exact (e.g. values are published like 'almost 4 million', or 'tens of millions') and it is often not clear whether a contract is already signed, or the transaction is still subject to changes. Second, the details of actual payments are often not defined in the case of framework agreements and multi-year programmes. To sum up, the usability of manually collected data is very limited in terms of complex quantitative analysis but it can still be used for estimating the share of defence procurement contracts which are covered by publicly available information to an extent.

We assume that, while TED mostly covers relatively small-value, non-strategic purchases, the media is more interested in large-value, strategic transactions; thus, the two datasets complement each other. As Table 2 shows, while TED covers on average 6.9% of the total amount spent on defence procurement (Eurostat data – see footnote 3), ranging from 0.1% to 21% depending on the country. By contrast the manually collected dataset covers on average of 7.8% with a range of 0.5% to 19.9%. This seems to support the assumption that alternative information sources like news articles tend to report on large value transactions. However, even if we add up the total value of contracts covered by TED and the manually collected data, which should be done only after removing the contracts which appear in both

datasets, merely 2-40% of total defence procurement expenditure is covered by publicly available data sources, and in two-thirds of the analysed countries this value is under 20%.

There are several possible reasons behind this large gap between available procurement data –both in TED and media outlets – and actual defence spending in Europe. The first pertains to the high thresholds for data reporting which exempt many low-value purchases from reporting requirements. The second potential factor is the opaque nature of military purchases overall, and in particular for high-value tenders. This translates into a large amount of incomplete reporting (e.g. 15% of tenders in the dataset have missing contract values); nevertheless, there has been an improvement in reporting discipline since the directive entered into force – see table 4. Whereas 16% of TED contracts had missing contract values before the directive entered into force, this ratio dropped to 14% following implementation. Third, contract extensions and modifications (e.g. an increase in the units demanded) are absent from both TED and manually collected data. Finally, given the secrecy of the defence sector, many contracts fall under exemption rules, thus making public information unavailable.

TABLE 2: TOTAL VALUE OF DEFENCE PROCUREMENT EXPENDITURE PER COUNTRY BASED ON EUROSTAT, TED, AND MANUAL DATA COLLECTION, MILLION EUR, 2007-2016

Country	Total defense procurement expenditure (Eurostat)	TED Value**	Manual Value	Total Value	TED %	Manual %	Total %
AT	€ 7,015	€ 128	€ 86	€ 214	1.8	1.2	3.0
BG*	€ 1,593	€ 301	€ 1,917	€ 2,218	18.9	120.4	139.2
DE	€ 133,497	€ 3,527	€ 19,391	€ 22,918	2.6	14.5	17.2
DK	€ 17,027	€ 2,330	€ 2,767	€ 5,097	13.7	16.2	29.9
EE	€ 2,009	€ 238	€ 43	€ 281	11.8	2.2	14.0
ES	€ 31,615	€ 475	€ 52	€ 528	1.5	0.2	1.7
FI	€ 16,006	€ 338	€ 401	€ 739	2.1	2.5	4.6
FR	€ 148,400	€ 10,143	€ 775	€ 10,918	6.8	0.5	7.4
GR	€ 20,721	€ 15	€ 1,753	€ 1,767	0.1	8.5	8.5
HU	€ 3,950	€ 337	€ 46	€ 383	8.5	1.2	9.7
IE	€ 1,317	€ 50	€ 262	€ 312	3.8	19.9	23.7
IT	€ 57,749	€ 3,003	€ 6,809	€ 9,812	5.2	11.8	17.0
NL	€ 27,635	€ 105	€ 600	€ 705	0.4	2.2	2.6
NO	€ 27,637	€ 2,449	€ 1,432	€ 3,881	8.9	5.2	14.0
PL	€ 25,098	€ 2,684	€ 1,966	€ 4,650	10.7	7.8	18.5
PT	€ 6,544	€ 142	€ 300	€ 442	2.2	4.6	6.7
RO	€ 3,895	€ 834	€ 614	€ 1,448	21.4	15.8	37.2
SE	€ 29,160	€ 77	€ 3,642	€ 3,719	0.3	12.5	12.8
UK	€ 261,745	€ 26,337	€ 38,087	€ 64,424	10.1	14.6	24.6
TOTAL	**€ 822,613**	**€ 53,513**	**€ 80,943**	**€ 134,456**	**Avg. 6.9**	**Avg. 7.8***	**Avg. 20.6**

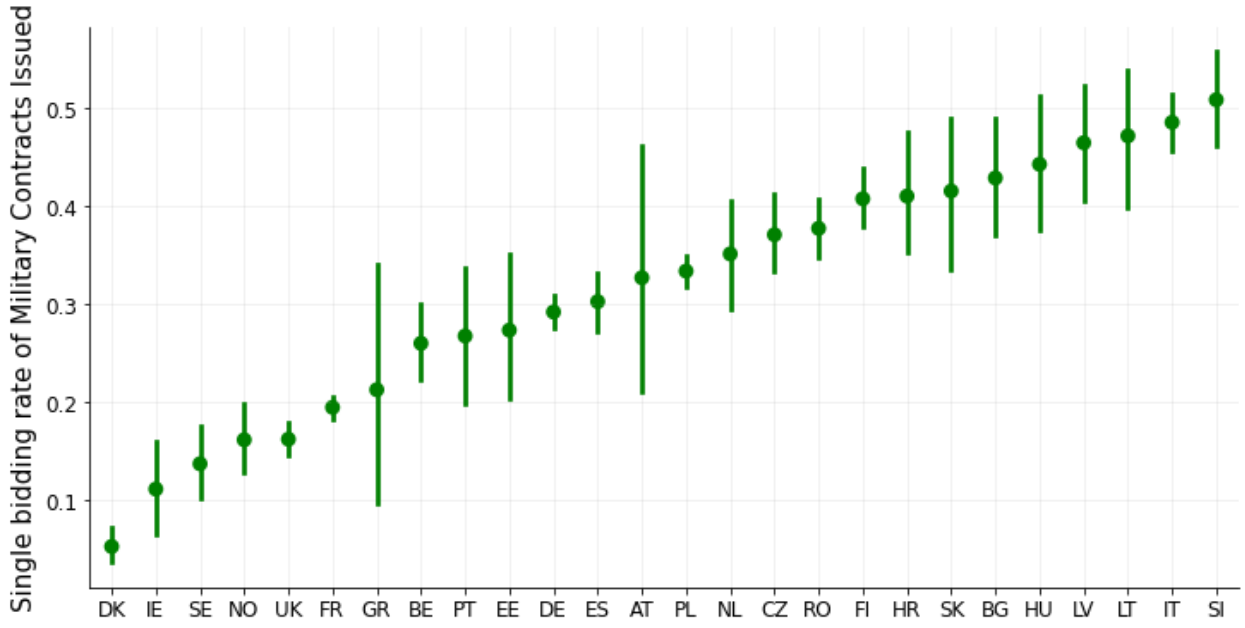
Notes: *The ‘manual %’ value is higher than 100% in Bulgaria because a large-value multi-year programme was taken into account in the first year of the contract, while payments will take place only later in practice, so they could not appear in Eurostat values yet. The manual average of total excludes BG.
** The TED and the manually collected dataset contain contracts that may overlap. In the aggregates (total) we keep exclude the contracts from the manual dataset which we are certain are duplicated.

As manually collected data is not comprehensive, and it rarely contains exact information on the tendering procedure, we use only TED data for exploring corruption and state capture risks in the field of defence procurement. Table B2 in the appendix contains the most common CPVs for TED and manually collected data. As expected, the manually collected data from news outlets focuses disproportionately on large and valuable purchases of high-grade military equipment, maintenance and development. By contrast, the most common CPVs in the TED dataset are uniforms and ammunitions. This points to a considerable area of opportunity for increased transparency in the military procurement of non-sensitive (though less politically salient) highly standardized goods, which constitute the bulk of overall tenders.

4. Corruption Risk Indicators

To quantify the corruption risk at the contract level, we adapt two objective corruption risk indicators from the academic literature (Fazekas, Tóth, and King 2016). Such indicators count "red flags" in how a contract was awarded, capturing competition or transparency-limiting tricks that have been used to steer contracts to preferred winners. The first contract level indicator is single bidding: did the contract attract only a single offer from the private sector? This indicator considers only the outcome: whether there was competition for the contract. We plot the single bidding rates by country below.

FIGURE 4: SINGLE BIDDING PER COUNTRY, TED DATA, 2006-2016

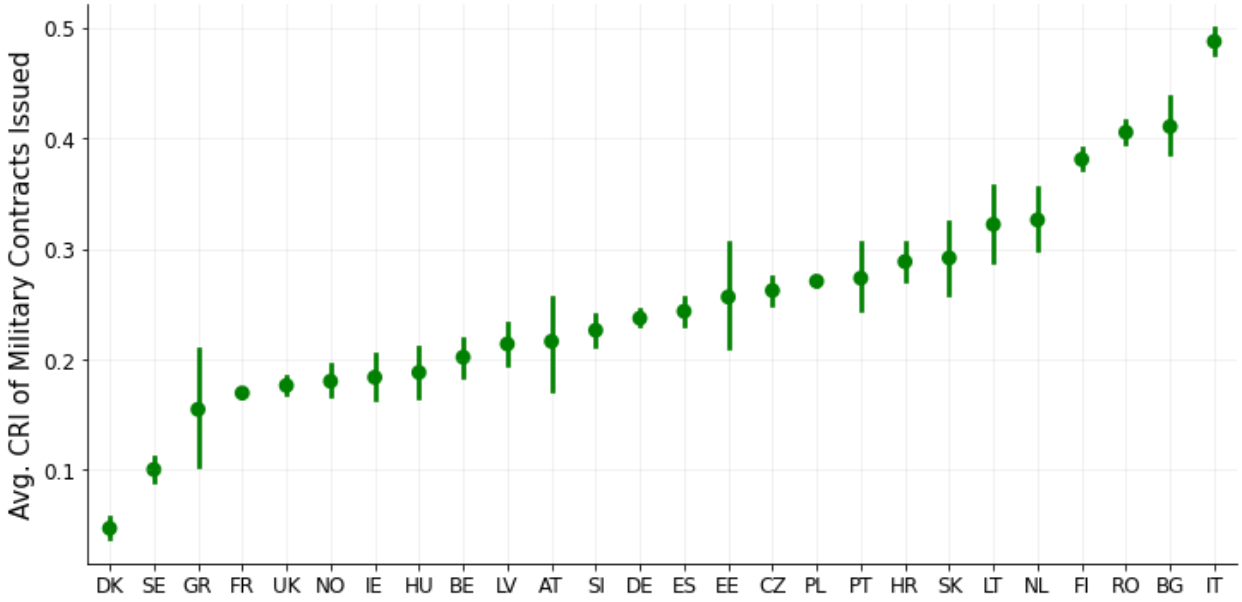


The second indicator we consider is a composite index of red flags. In addition to the single bidding rate, we consider:

- *Procedure type:* was the contract not awarded by an open competition (i.e. by direct negotiation or by an invitation-only procedure)?
- *Length of advertisement period:* was the time to submit bids notably short?
- *Evaluation criteria:* to what extent were the bid evaluation criteria subjective (i.e. referring to unmeasurable notions of quality rather than objective criteria such as price, length of warranty, etc.)
- *Call for tender publication:* was the call for bids published in the official national or European procurement journal?
- *Length of decision period:* was the duration of the decision period either very short (indicating a premediated decision) or very long (indicating possible legal challenges)?

We count the number of red flags for each contract (and divide by 6) to arrive at its *Corruption Risk Index* (CRI). For instance, a contract awarded to a single bidder with a very short time to submit bids would have a score of 2/6. The CRI has been amply used in the literature on corruption in public tenders. Fazekas and Kocsis (2020) find that contract CRI scores tend to be higher for contracts awarded to winners registered in tax havens (2009-2014). Similarly, they find that single-bidder and high CRI contracts are associated with higher prices. This indicator directly captures corruption as unwarranted barriers to entry to privilege well-connected contractors in detriment of potential competitors. We plot the average CRI scores for defence procurements in the following table.

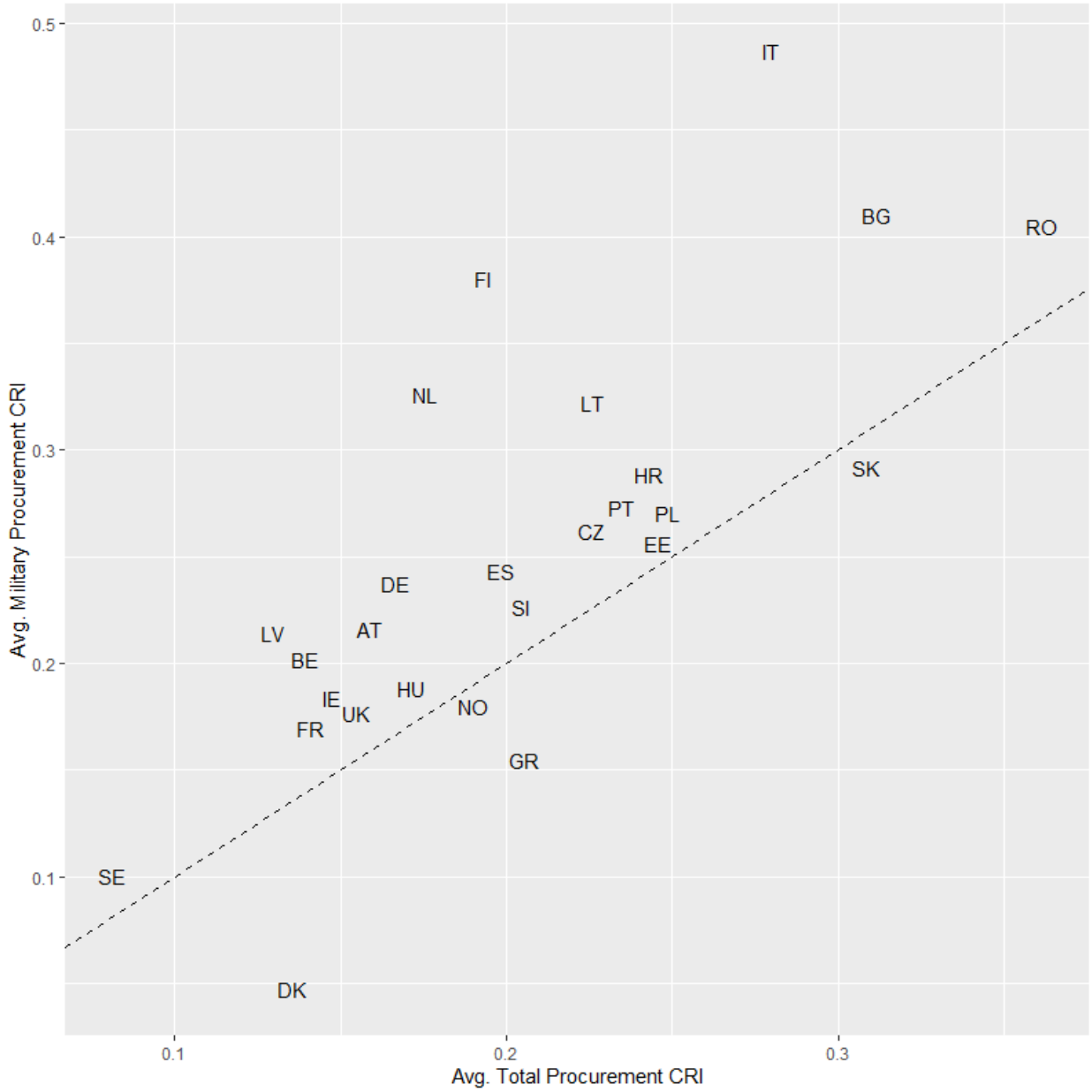
FIGURE 5: AVERAGE CORRUPTION RISK INDEX PER COUNTRY, TED DATA, 2006-2016



For both indicators, we observe significant heterogeneity in corruption risk across countries. In Denmark, less than 1 in 10 military-related procurements are awarded to a single bidder while in Italy, every second military contract is awarded in this way.

To better understand how military procurement differs from procurement in general in, we plot the average CRI score of each country's entire procurement market (including traditional products such as road repair, medicine, school lunches) against their average military procurement CRI. This provides us with a baseline for comparisons.

FIGURE 6: AVERAGE CORRUPTION RISK INDEX PER COUNTRY IN DEFENCE MARKETS AND GENERAL PUBLIC PROCUREMENT, TED DATA, 2006-2016



We draw two conclusions from this plot. The first is that in most countries military procurement contracts have higher corruption-risk scores than other contracts, most countries are above the 45-degree line. Second, there are significant outliers, indicating that military procurement carries significantly more (or less) corruption risk in certain countries. In Italy, Bulgaria, Finland and the Netherlands, military

procurement has significantly higher corruption risks than procurement in general. The opposite is true in Denmark: there military procurement contracts have less corruption risk than other kinds of procurement, on average.

Key Winners

Within each country there is significant heterogeneity in the corruption-risk scores of military contracts. Some buyer and supplier relationships seem significantly more corrupt than others. Here we present the top winners, by number of contracts won, for a selection of countries. We also report their average corruption risk indicator scores. We note that in some countries, the largest private sectors winners seem to have high corruption risk, while in others they have rather low corruption risk. This will motivate our network analysis of these markets in the following section.

TABLE 3: TOP 5 WINNERS IN ITALY, THE UK, FRANCE, AND GERMANY. TED DATA, 2006-2016

Winner Name	No. of Contracts	Av. CRI*	Single Bidding Rate*
	Italy		
Agustawestland Spa.	30	0.56	0.68
Selex Es Spa.	20	0.53	0.52
Oto Melara Spa.	17	0.49	0.49
Piaggio Aero Industries Spa.	13	0.56	0.77
Alfredo Grassi Spa.	12	0.39	0.17
	UK		
Mott McDonald Limited	23	0.05	0
Ch2M Hill United Kingdom	20	0.05	0
Lion Apparel System Limited	20	0.03	0.009
Hunter Apparel Solutions Ltd.	18	0.02	0
Parsons Brinckerhoff Ltd.	17	0.05	0
	France		
Lognavcm	78	0.08	0.01
Balsan	54	0.16	0.25
Mainco	50	0.09	0.003
Gk Professional	49	0.14	0.16
P Poinsot	40	0.11	0.08
	Germany		
Kraussmaffei Wegmann Gmbh. Co.	83	0.30	0.67
Rheinmetall Landsysteme Gmbh.	76	0.2	0.3
Ffg Flensburger Fahrzeugbau Gesellschaft Mbh.	63	0.19	0.1
Ruag Ammotec Gmbh.	59	0.32	0.51
Scharrer Konfektions Gmbh. Co. Kg.	44	0.17	0.07

* Note: When data for CRI or Single Bidder is unavailable (NAs), we impute the country average. The assumption being that lack of information of on a given tender implies that its corruption risk is at least at the level of the country's average.

5. Network analysis

The heterogeneity of corruption risk scores *within* specific national procurement markets for defence contracts raises several questions:

- How is corruption risk distributed within these markets?
- Is corruption risk clustered (i.e. are there groups of densely connected buyers and suppliers which are more corrupt than average)?
- Does corruption risk appear in the centre of the market, or rather in the periphery?

The tools of network science (Barabási 2016) can be fruitfully applied to give quantitative answers to these questions. We first map procurement markets as networks, noting that visual representations of the markets are themselves useful. We then develop measures to answer these questions.

We map military procurement markets as networks in the following way: nodes are buyers and suppliers of public contracts. They are connected by an edge if they have a contracting relationship, i.e. if buyer A contracts with supplier Z, they are connected in the network. In the visualizations below, gold nodes are buyers and black nodes are supplier. We colour the edges red if the average CRI of the contracts between the two nodes is at least one standard deviation above the market average. The nodes are placed using a physics-inspired algorithm: nodes are treated as charged particles which repel each other, while edges act as springs, pulling connected nodes closer to each other (Fruchterman and Reingold 1991). We visualize three national markets: Italy, the UK, and Germany. These are among the larger markets in our dataset and cover a range of corruption risk outcomes. The regularities we observe in their network structure suggests how we might compare all of the countries in our dataset using network-measures.

FIGURE 7: NETWORK OF BUYERS AND SUPPLIERS IN THE DEFENCE PROCUREMENT MARKET, ITALY, TED DATA, 2006-2016

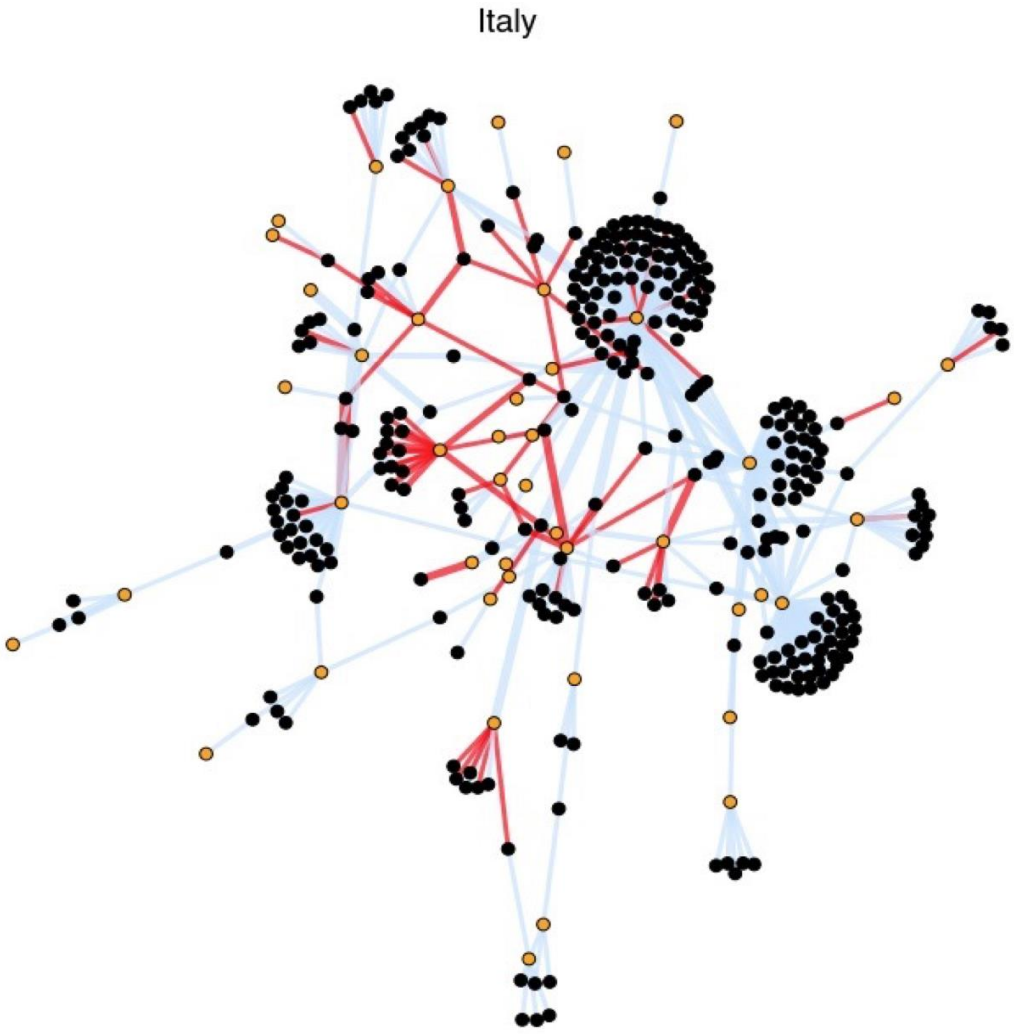


FIGURE 8: NETWORK OF BUYERS AND SUPPLIERS IN THE DEFENCE PROCUREMENT MARKET, UK, TED DATA, 2006-2016

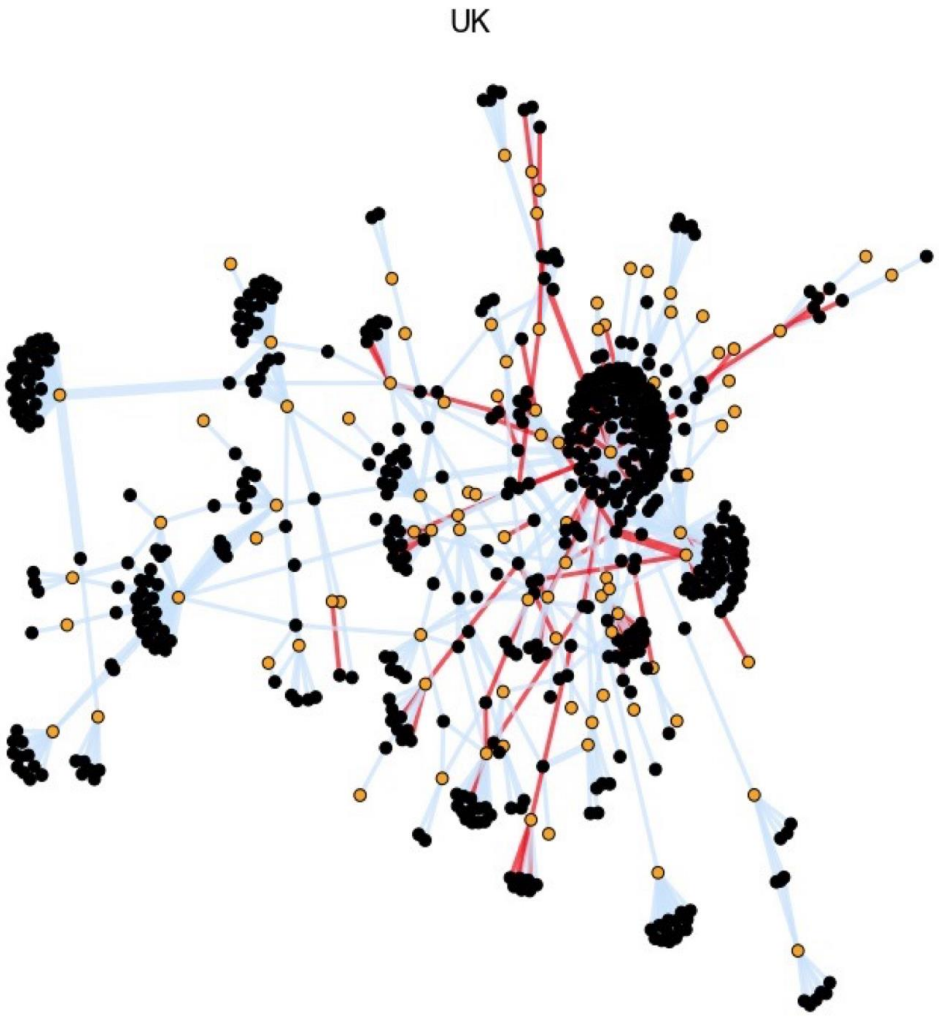
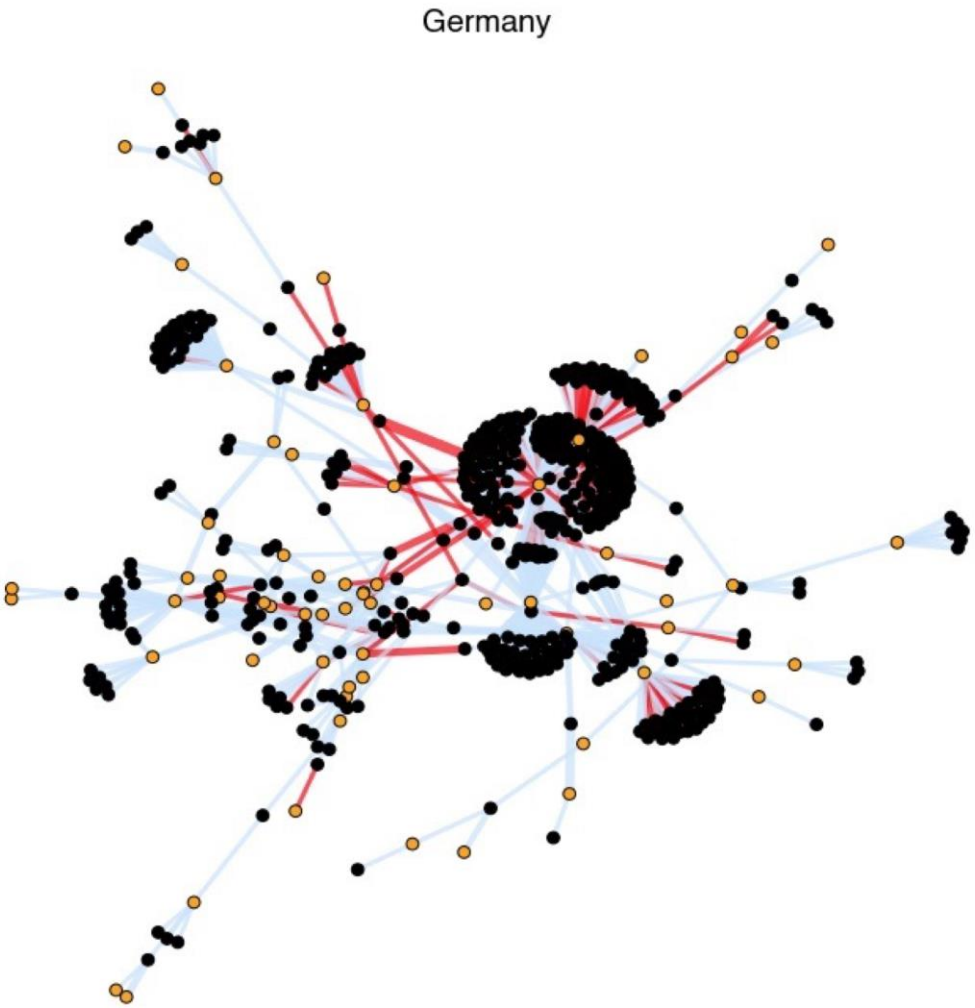


FIGURE 9: NETWORK OF BUYERS AND SUPPLIERS IN THE DEFENCE PROCUREMENT MARKET, GERMANY, TED DATA, 2006-2016

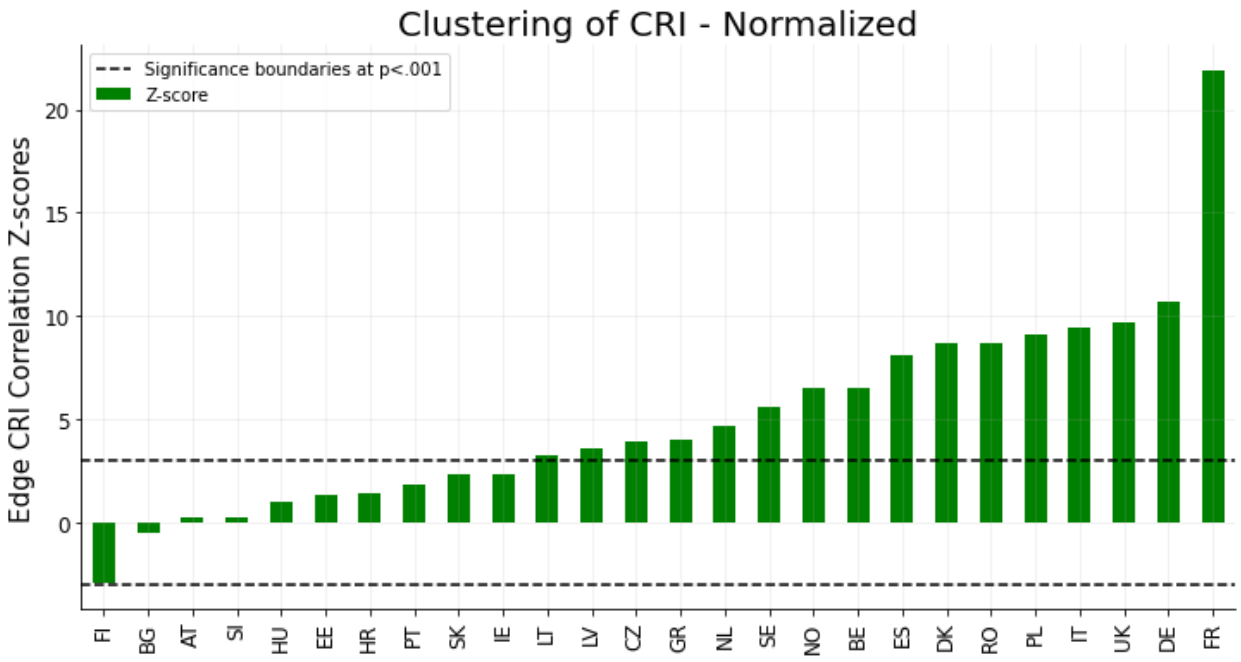


We can draw a few qualitative conclusions from the networks of Italy, UK, and Germany. The first is that corruption risks seem to be clustered: red edges seem more prevalent in certain parts of the network than others. The second is that corruption risks appear more common near the centre of the network. Finally, in all three countries there are different types of buyers: some are hubs issuing contracts to many suppliers, while others issue contracts to only a few suppliers. To make these notions more precise, we can use methods to quantify the clustering and centralization of corruption risks in procurement markets mapped as networks.

To calculate the clustering of corruption risk we calculate the average correlation of an edge's CRI with that of its neighbours. In other words, we quantify the extent to which knowing one edge's CRI lets me

predict the CRI of neighbouring edges. If the correlation is high, it means that neighbours of high CRI edges are more likely to have high CRI, and vice versa. We normalize the correlation using a permutation test, to enable comparisons between countries.

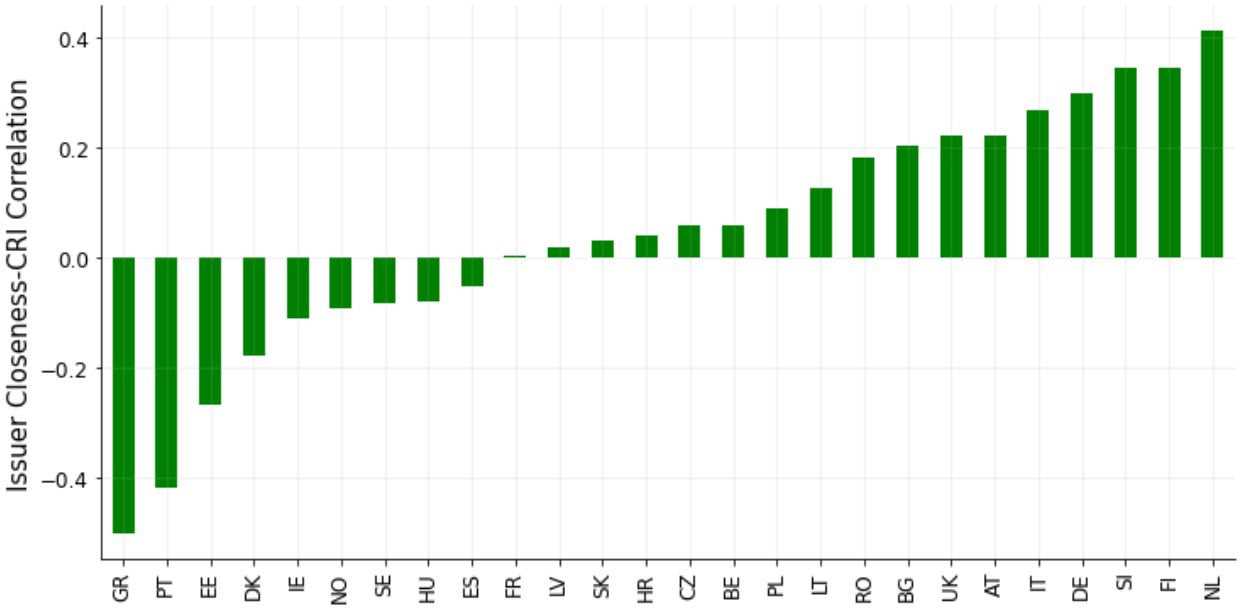
FIGURE 10: NORMALISED AVERAGE CORRELATION OF EDGES' CRI WITH NEIGHBOURS' CRI PER COUNTRY. TED DATA, 2006-2016



In the figure above we see that in most military procurement markets, corruption-risk is significantly clustered. This is especially true in the larger markets. This confirms our intuition from the network diagrams: if you find one red edge (corrupt relationship), it is likely that edges around that issuer node will also be red. This is in line with our expectations that corruption risks are not randomly distributed across issuer-winner relationships, but rather clustered around key institutions – see Fazekas & Toth (2014).

To quantify the idea that corruption risk seems more prevalent at the centre of the market, we calculate the so-called closeness centrality of each buyer and relate this with the average CRI of the contracts it issues. Closeness centrality is inversely proportional to a node's distance to all other nodes in the network. If one node is close to many other nodes, it is in some sense central in the network, while if it is very far from other nodes, it is in the periphery. In the table below we plot the correlation of buyer closeness centrality with its CRI. We find that in some countries such as the Netherlands, Finland, Slovenia and Germany, corruption risk is more prevalent in the centre of the market (indicated by a high correlation between buyer closeness and CRI). There are also countries where corruption risk is more prevalent in the periphery of the market such as Greece, Portugal and Estonia.

FIGURE 11: CORRELATION BETWEEN BUYERS' CLOSENESS CENTRALITY AND CRI PER COUNTRY. TED DATA, 2006-2016



In summary, network science methods enable us to map public procurement markets in an interesting way. They can also help us quantify intuitions about the distribution of corruption risk in a market. We find that in general, corruption risk is clustered, indicating systematic state capture rather than a random phenomenon.

6. Before-after analysis of the 81/2009/EC Directive

In the area of defence contracting, the most significant EU-level policy change of the last decades has been the adoption of the 2009/81/EC Directive on public procurement in the fields of defence and security. The directive has several goals[16], these are:

- Increasing competition in the European Defence Equipment Market (EDEM),
- Limiting the use of security-related exemptions by Member States,
- Promoting the wider use of negotiated procedures (with prior publication),
- Supporting consolidation across borders,
- Reducing duplications,
- Enhancing industrial specialisation.

These goals are accomplished through the regulation of the procurement process, as criteria for the restriction of competition are defined. For example, the directive sets rules for security-related

[16] https://ec.europa.eu/docsroom/documents/20376/attachments/2/translations/en/renditions/native

exclusions pertaining to security-of-supply or security-of-information. The Directive also applies specific rules to subcontracting – aiming to increase transparency and competition at all levels of the contracting process. The Directive also created a review system to check Member State compliance. The deadline for compliance at the national level was 20 August 2011. Most Member States only came into compliance after this deadline.

TABLE 4: DATE OF 81/2009/EC DIRECTIVE COMING INTO EFFECT PER COUNTRY

Member State	Directive Entry into Force
Austria	01/04/2012
Belgium	06/02/2012
Bulgaria	30/04/2012
Croatia	01/01/2012
Cyprus	23/12/2011
Czech	01/01/2012
Denmark	19/08/2011
Estonia	24/02/2012
Finland	01/01/2012
France	16/09/2011
Germany	14/12/2011
Greece	16/06/2011
Hungary	01/01/2012
Ireland	30/03/2012
Italy	16/01/2012
Latvia	16/11/2011
Lithuania**	21/08/2011
Luxemburg	01/01/2013
Malta	21/10/2011
Netherlands	16/02/2013
Poland	13/01/2013
Portugal	01/01/2012
Romania	01/10/2012
Slovakia	09/03/2012
Slovenia	30/12/2012
Spain	03/11/2011
Sweden	01/11/2011
United Kingdom	21/08/2011

Countries that complied with the deadline of 20/08/2011 are highlighted. ** Lithuania complied with the directive only one day after the deadline.

We are interested in analysing the impact of the Directive on military procurement outcomes. Recall that we had two criteria for labelling a contract from the TED database as military-related: if it listed a military-related CPV code, or if it was labelled as Directive-compliant. After a slow start, nearly two-thirds of our contracts had a Directive label by 2014. We compare the outcomes, including the number of bidders, share of domestic winners, and share of EU funded contracts, of military contracts awarded before and after the adoption of the Directive.

TABLE 5: SHARE OF CONTRACTS AWARDED UNDER THE PURVIEW OF 81/2009/EC DIRECTIVE COMPARED TO ALL DEFENCE CONTRACTS. TED DATA, 2006-2016

Year	Share Contracts Under Directive
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0.03
2013	0.35
2014	0.64
2015	0.64
2016	0.65

To make this comparison more robust, we must identify those contracts awarded before the Directive went into effect to which the Directive would have likely applied. We do this in the following way. We consider contracts awarded 365 days before and after the implementation of the Directive in each Member State. We consider those CPV codes under which all contracts issued are Directive compliant, following the Member State's implementation of the Directive. We find all contracts with the same CPV codes prior to Directive implementation, then we evaluate the differences in bidding.

A causal before-after analysis is out of reach because we cannot know which contracts prior to the adoption of the Directive would have fallen under the Directive. Nevertheless, we can consider some stylized facts about the potential impact of the directive. We have 7,792 contracts marked as following the Directive, the first issued in 2012 (~3% of contracts in our military-related dataset) up to 2016 (~65%).

Looking at the contracts we have identified as falling under the Directive, we obtain a clearer picture of which CPV codes are used in military procurement. Below is a table of all 4-digit codes for which we have at least 100 contracts.

TABLE 6: MOST FREQUENT CPV CODES USED IN CONTRACTS AWARDED UNDER THE 81/2009/EC DIRECTIVE. TED DATA, 2006-2016

CPV (4-digit)	Description	# of contracts
3473	Aircraft and jets	1357
5021	Aircraft repair and maintenance	766
5064	Warship repair and maintenance	333
3474	Aircraft equipment, training, simulators	297
3542	Military vehicle parts	234
7971	Security services	227
3533	Ammunition	207
3540	Military vehicles	195
5063	Military vehicle repair and maintenance	167
3581	Individual equipment	109
5060	Security and defence materials repair and maintenance services	106
5000	Repair and maintenance services	105
3552	Parts for warships	102
5065	Aircraft and missile repair and maintenance services	103

We analyse the impact of the directive at the buyer level, arguing that frequent issuers of contracts under the Directive can capture its effect in an indirect way: i.e. the Bundeswehr will not issue vastly more contracts after the directive is implemented.

We focus on the year (365 days) immediately prior to and following the adoption of the directive by country. Crucially, we only look at those issuers who issue at least 3 contracts under the directive by

the end of 2016. In other words, we only consider those government institutions that we can be quite sure were issuing defence related procurement contracts before the directive.

In the two periods immediately before and after the implementation of the directive, we calculate at the issuer level the:

1. Number of contracts issued (in our data)
2. Share of non-domestic winners.
3. Average number of bids received
4. Share of contracts funded by the EU
5. Single bidding rate
6. Average CRI score

TABLE 7: AVERAGE VALUE OF CRI, SINGLE BIDDING, SAME COUNTRY WIN RATE, NUMBER OF BIDS AND SHARE OF EU-FUNDED PROJECTS BEFORE AND AFTER THE 81/2009/EC DIRECTIVE COMING INTO EFFECT. TED DATA, 2006-2016

EU Global Averages	Pre-Directive	Post-Directive
CRI	0.28	0.20
Single Bidding	0.39	0.21
N. of contracts	227	726
N. of bids	3.1	3.6
Share of EU-funded	0.05	0.00

Across the EU we see small changes in the outcomes of large defence contractors with two exceptions:

1. The decrease in single bidding (resp. increase in average number of bids) is significant.
2. The number of contracts awarded in our data has greatly increased.

This second point is an important finding because it indicates that perhaps the directive improved the reporting of practices of issuers: they are more likely to report their contracts to our data source. It is unlikely that the directive caused such a large increase in defence procurement.

Country-level data

Country-level data confirm this notion. We find that the large defence issuers of specific countries simply did not report contracts to TED before the directive.

TABLE 8: RATE OF PROCUREMENT INDICATORS BEFORE AND AFTER THE 81/2009/EC DIRECTIVE COMING INTO EFFECT IN CEE. TED DATA, 2006-2016

	CRI		Single bidding		# of contracts		# of bids		Share EU funded	
after_directive	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**
Eastern Europe										
CZ	0.12	0.22	0.31	0.13	62.0	813.0	4.85	4.54	0.00	0.01
HU	0.50	0.24	1.00	0.57	3.0	95.0	1.00	1.86	0.00	0.00
SK	0.38	0.37	0.51	0.48	125.0	147.0	2.35	2.22	0.00	0.00
LT	NaN	0.28	NaN	0.20	NaN	349.0	NaN	5.77	NaN	0.00
LV	0.15	0.10	0.10	0.20	529.0	343.0	3.60	4.38	0.00	0.00
EE	0.18	0.18	0.19	0.17	105.0	467.0	4.32	5.46	0.00	0.00
PL	0.21	0.25	0.33	0.34	1948.0	5625.0	2.36	2.62	0.00	0.00
RO	0.43	0.45	0.45	0.41	161.0	579.0	2.84	2.42	0.00	0.00
BG	0.33	0.40	0.21	0.31	339.0	644.0	3.31	3.38	0.01	0.01

TABLE 9: RATE OF PROCUREMENT INDICATORS BEFORE AND AFTER THE 81/2009/EC DIRECTIVE COMING INTO EFFECT IN WESTERN EUROPE. TED DATA, 2006-2016

	CRI		Single bidding		# of contracts		# of bids		Share EU funded	
after_directive	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**
Western Europe										
FR	0.16	0.20	0.17	0.24	1585.0	2047.0	4.51	3.86	0.0	0.00
UK	NaN	0.26	NaN	0.38	NaN	120.0	NaN	2.90	NaN	0.00
DE	0.14	0.21	0.18	0.29	391.0	1706.0	6.04	4.40	0.0	0.03
IT	0.37	0.39	0.49	0.45	337.0	399.0	3.84	2.48	0.0	0.00
DK	0.11	0.14	0.29	0.21	12.0	73.0	2.00	2.85	0.0	0.00

A Matching Approach

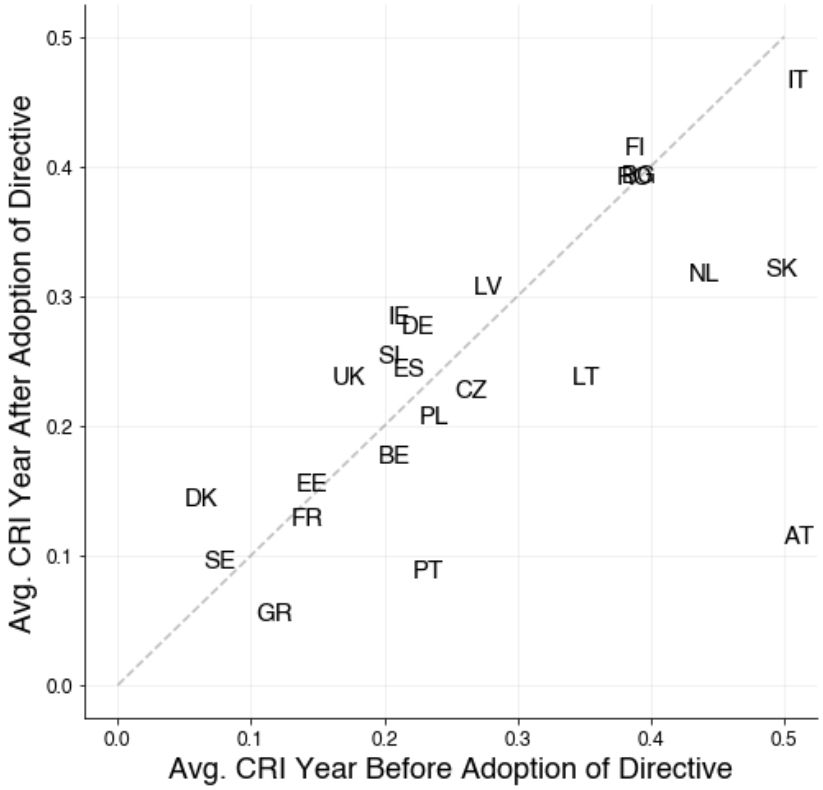
In order to get a more precise idea of the influence of the directive on contracting outcomes, we restrict ourselves to those contracts issued under CPV codes which are always covered by the Directive following its implementation. For example, all contracts in our database issued under the CPV code 35341000 (Parts of light firearms) after the dates of implementation were flagged as Directive-compliant. We identify 59 such CPV codes and 953 contracts issued with such a CPV code within a year of Directive implementation. 726 contracts were issued before, and 227 contracts were issued after the directive. This small set of contracts matched to CPV codes enables us to make a more rigorous comparison between contracting outcomes of the Directive.

In the table below we compare the rates of single bidding, CRI, same country winners, the average number of bids, the rate of contracts awarded by non-open procedures, and the number of contracts awarded without a call for tenders on this sample of the data. We use a Mann-Whitney U test to test the significance of the difference in means.

TABLE 10: RATE OF PROCUREMENT INDICATORS IN THE SAMPLE OF CONTRACTS WITH CPV CODES WHICH ARE ALWAYS COVERED BY THE DIRECTIVE. TED DATA, 2006-2016

Variable	Mean Pre-Directive	Mean Post-Directive	Mann-Whitney U	p-value
Single Bidding	0.39	0.21	62272	<.001
CRI	0.28	0.20	60866	<.001
Same country	0.93	0.97	79793	.019
#No. of Bids	3.10	3.60	79780	.23
Non-open Procedure	0.26	0.57	56829	<.001
No Call for Tenders	0.22	0.12	74261	<.001

FIGURE 12: AVERAGE CRI BEFORE AND AFTER THE ADOPTION OF THE DIRECTIVE



The results are in some cases quite striking. Single bidding falls by nearly half, while CRI falls significantly as well. The average number of bids received rises by .5 (though this is not statistically significant). Interestingly, while the number of contracts awarded without a call for tenders drops nearly by half, the rate of awards by non-open procedure more than doubles. This development might be driven by the Directive encouraging negotiated procedures, while chew cannot exclude the possibility that it reflects a shift in strategy of buyers who wish to steer contracts to specific firms. One potential remedy would be to expand the scope of the directive to more aggressively restrict the use of non-open procedure types such as invitation-only competitions.

Conclusions

We carry out a quantitative analysis of corruption risks and state capture risks in the field of defence procurement in Europe. To this effect, first, we collected data using official and alternative sources to tackle the challenges typical for this sector, namely the relatively low level of transparency compared to most other procurement markets. We found that the use of alternative sources such as news articles is ambiguous: while the lack of exact details limits the usability of data for research purposes, media often reports on the large value strategic purchases which are often not published on official tendering websites. As a consequence, alternative sources cover a larger share of total defence procurement expenditure than notices published on the official platform in many countries. In this sense, they increase transparency significantly, and they raise public interest towards defence procurement, which creates a pressure to publish better, more comprehensive official datasets in the long run.

We analysed the large database of contracts collected from Tenders Electronic Daily from several perspectives. We began by identifying the typical corruption risk in defence contracting, finding great heterogeneity across EU countries. For instance, while roughly every other military contract awarded in Italy from 2006 to 2016 was awarded to a single bidder, only one in twenty contracts in Denmark were awarded in such a way. This reflects the situation in public procurement more generally, though it is in some sense surprising given that military procurement is high profile and perhaps more internationally relevant than procurement of local roads or health services.

Within-countries, we observed a significant positive correlation between corruption risk in the military procurement sector and corruption risk in procurement more generally. In other words, corruption risk in military procurement closely reflects overall corruption risk patterns at the national level. Overall, military procurement risk is higher than other procurement sectors in nearly all European countries. The largest corruption risk premiums in military procurement over risk in other kinds of procurement exist in Italy, the Netherlands, Finland, and Bulgaria.

A significant advantage of measuring corruption risk using contracting data is that it enables micro-level analyses of key actors. By listing the corruption risk scores of top winning firms in different countries, we observed that distribution of corruption risk within countries can be quite heterogeneous. For instance, while the overall corruption risk rate of contracts awarded in Germany was moderate, some frequent winners had single bidding rates of over 50%, while others had single bidding rates below 10%. In Italy on the other hand, nearly all of the top winners had single bidding rates above 50%. This suggests that corruption risk is not randomly distributed in different markets.

We took another look at the distribution of corruption risks across the contracting relationships between buyers and suppliers using network analysis. By visualising the markets as networks, we could demonstrate more clearly what we claimed before: that corruption risk is not random, but rather clustered in the relationships of distinguished buyers and suppliers. Such networks offer analysts and the authorities a bird's eye view of the distribution of corruption risks in the market and state capture by implication. It also offers a framework to quantify the nature of corruption in a given market, for instance if it is more often present in the centre of a market or in its periphery. We found examples of both kinds of markets, underscoring that corruption risks manifest themselves in different ways in different

countries. We argue that a network map of markets provides a useful tool to understand these complex differences both at a glance and with a view to investigate them further. In other words, network methods are an effective monitoring tool, as well as a quantitative framework to understand the organization of corruption in procurement markets. As corruption and more generally state capture are phenomena which cannot be neatly characterized as either entirely micro or macro, network analysis is a useful lens through which they can be observed.

Finally, we considered how the most significant EU-level policy intervention in the market for defence procurement, the 2009/81/EC Directive, impacted corruption risk outcomes across the EU. Using a matching approach, we compare similar contracts awarded right before and after the implementation of the Directive at the national level, finding that corruption risks decreased following implementation. For example, the rate at which contracts were awarded to a single bidder halved. This observation comes with an important caveat: the number of non-open procedures (for instance direct-awards or invitation-only competitions) significantly increased. More work is needed to assess the impact of the Directive, but this finding suggests that while its requirements may have closed some avenues for favouritism, others remain open.

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Appendix A

TABLE A1: GOVERNMENT PROCUREMENT EXPENDITURE ON MILITARY DEFENCE PER COUNTRY, EU-28+EEA COUNTRIES (VALUE IN MILLION EUR)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
European Union 28	78547	81220	79482	79380	78064	80235	79992	80638	89592	91118	93659
Belgium	833	979	716	768	772	746	812	808	783	639	691
Bulgaria	185	173	93	294	120	108	124	163	171	162	145
Czech Republic	877	771	667	762	693	563	484	335	765	409	447
Denmark	1806	1798	1505	1601	1710	1961	1836	1502	1615	1693	1919
Germany	9061	10847	12644	12114	13229	15516	15257	14385	14525	15919	17858
Estonia	116	156	192	159	146	209	217	217	241	356	327
Ireland	144	166	105	92	87	81	87	161	194	201	122
Greece	2929	3707	3870	2591	1564	1251	929	1653	1470	757	1615
Spain	3834	3940	3444	3698	3425	2421	2618	1931	2874	3430	3022
France	12682	13226	14492	14376	13696	14504	15213	14467	16998	18746	18579
Croatia	176	270	174	187	220	216	198	176	221	195	179
Italy	4858	5925	7963	6388	6597	5239	4060	4934	5136	6649	6104
Cyprus	95	64	89	126	122	100	44	36	32	43	127
Latvia	160	178	79	101	97	75	82	99	114	208	256
Lithuania	148	131	100	71	82	87	87	100	176	228	296

Luxembourg	23	21	26	117	80	62	47	40	33	83	67
Hungary	729	499	358	418	306	337	321	268	295	420	621
Malta	4	6	18	12	18	14	11	24	36	17	8
Netherlands	2886	3138	3071	2536	2924	2214	2534	2404	2661	3267	3587
Austria	869	1263	656	529	564	539	671	638	588	698	700
Poland	3078	3430	1305	2064	2420	2130	2739	2250	2944	2739	3575
Portugal	571	703	971	1809	674	402	379	393	446	199	311
Romania	515	296	178	256	294	196	299	496	665	701	747
Slovenia	181	171	199	197	107	76	58	50	50	54	74
Slovakia	146	159	200	199	219	208	209	286	213	250	365
Finland	1422	1639	1633	1490	1467	1719	1759	1624	1592	1661	1704
Sweden	2747	2603	2207	2876	3222	3262	3576	3006	2670	2991	3035
United Kingdom	27472	24961	22527	23550	23211	26002	25342	28193	32084	28403	27182
Norway	2701	2795	2544	2494	3012	2831	2819	2765	2794	2883	3486
Switzerland	1629	1845	1895	1999	2372	2355	2424	2306	2628	2733	2874

Appendix B

TABLE B1: CPV CODES CONSIDERED DEFENCE-RELATED

CODE	EN	CODE	EN
35300000-7	Weapons, ammunition and associated parts	35613000-4	Unmanned aerial vehicles
35310000-0	Miscellaneous weapons	35613100-5	Unmanned combat aerial vehicles
35311000-7	Swords, cutlasses, bayonets and lances	35620000-6	Missiles
35311100-8	Swords	35621000-3	Strategic missiles
35311200-9	Cutlasses	35621100-4	Strategic anti-ballistic missiles
35311300-0	Bayonets	35621200-5	Intercontinental ballistic missiles
35311400-1	Lances	35621300-6	Submarine launched ballistic missiles
35312000-4	Gas guns	35621400-7	Intermediate range ballistic missiles
35320000-3	Firearms	35622000-0	Tactical missiles
35321000-0	Light firearms	35622100-1	Air-to-air missiles
35321100-1	Hand guns	35622200-2	Air-to-ground missiles
35321200-2	Rifles	35622300-3	Anti-ship missiles
35321300-3	Machine guns	35622400-4	Anti-submarines rockets
35322000-7	Artillery	35622500-5	Tactical anti-ballistic missiles
35322100-8	Anti-aircraft	35622600-6	Anti-tank guided missiles
35322200-9	Self-propelled artillery	35622700-7	Surface-to-air missiles
35322300-0	Towed artillery	35623000-7	Cruise missiles
35322400-1	Mortars	35623100-8	Air/ground/sea launched cruise missiles
35322500-2	Howitzer	35630000-9	Military spacecrafts
35330000-6	Ammunition	35631000-6	Military satellites
35331000-3	Ammunition for firearms and warfare	35631100-7	Communication satellites
35331100-4	Bullets	35631200-8	Observation satellites

35331200-5	Shells	35631300-9	Navigation satellites
35331300-3	Grenades	35640000-2	Parts for military aerospace equipment
35331400-7	Land mines	35641000-9	Structure and mechanical spare parts for military aerospace equipment
35331500-8	Cartridges	35641100-0	Engines and engine parts for military aerospace equipment
35332000-0	Ammunition for naval warfare	35642000-7	Electronic and electrical spare parts for military aerospace equipment
35332100-1	Torpedoes	35700000-1	Military electronic systems
35332200-2	Sea mines	35710000-4	Command, control, communication and computer systems
35333000-7	Ammunition for aerial warfare	35711000-1	Command, control, communication systems
35333100-8	Bombs	35712000-8	Tactical command, control and communication systems
35333200-9	Rockets	35720000-7	Intelligence, surveillance, target acquisition and reconnaissance
35340000-9	Parts of firearms and ammunition	35721000-4	Electronic intelligence system
35341000-6	Parts of light firearms	35722000-1	Radar
35341100-7	Gunmetal pipe fittings	35723000-8	Air defence radar
35342000-3	Parts of rocket launchers	35730000-0	Electronic warfare systems and counter measures
35343000-0	Parts of mortars	35740000-3	Battle simulators
35400000-8	Military vehicles and associated parts	35800000-2	Individual and support equipment
35410000-1	Armoured military vehicles	35810000-5	Individual equipment
35411000-8	Battle tanks	35811100-3	Fire-brigade uniforms
35411100-9	Main battle tanks	35811200-4	Police uniforms
35411200-0	Light battle tanks	35811300-5	Military uniforms
35412000-5	Armoured combat vehicles	35812000-9	Combat uniforms
35412100-6	Infantry fighting vehicles	35812100-0	Camouflage jackets
35412200-7	Armoured personnel carriers	35812200-1	Combat suits
35412300-8	Armoured weapon carriers	35812300-2	Combat gear
35412400-9	Reconnaissance and patrol vehicles	35813000-6	Military helmets

35412500-0	Command and liaison vehicles	35813100-7	Helmet covers
35420000-4	Parts of military vehicles	35814000-3	Gas masks
35421000-1	Mechanical spare parts for military vehicles	35815000-0	Garments for anti-ballistic protection
35421100-2	Engines and engine parts for military vehicles	35815100-1	Bullet-proof vests
35422000-8	Electronic and electrical spare parts for military vehicles	35820000-8	Support equipment
35500000-9	Warships and associated parts	35821000-5	Flags
35510000-2	Warships	35821100-6	Flagpole
35511000-9	Surface combatant	45111310-4	Dismantling works for military installations
35511100-0	Aircraft carriers	45216200-6	Construction work for military buildings and installations
35511200-1	Destroyers and frigates	45216220-2	Military bunker construction work
35511300-2	Corvettes and patrol boats	45216230-5	Military shelter construction work
35511400-3	Amphibious crafts and ships	45216250-1	Trench defences construction work
35512000-6	Submarines	45222200-1	Engineering work for military installations
35512100-7	Strategic submarine nuclear fuelled	71355200-3	Ordnance surveying
35512200-8	Attack submarine nuclear fuelled	72231000-3	Development of software for military applications
35512300-9	Attack submarine diesel fuelled	73400000-6	Research and Development services on security and defence materials
35512400-0	Unmanned underwater vehicles	73410000-9	Military research and technology
35513000-3	Mine warfare and auxiliary ships	73420000-2	Pre-feasibility study and technological demonstration
35513100-4	Mine hunter/minesweeper	73421000-9	Development of security equipment
35513200-5	Auxiliary research vessel	73422000-6	Development of firearms and ammunition
35513300-6	Auxiliary intelligence collection vessel	73423000-3	Development of military vehicles
35513400-7	Auxiliary hospital; cargo; tanker; ro-ro vessel	73424000-0	Development of warships
35520000-5	Parts for warships	73425000-7	Development of military aircrafts, missiles and spacecrafts
35521000-2	Hull and mechanical spare parts for warships	73426000-4	Development of military electronic systems
35521100-3	Engines and engine parts for warships	73430000-5	Test and evaluation

35522000-9	Electronic and electrical spare parts for warships	73431000-2	Test and evaluation of security equipment
35600000-0	Military aircrafts, missiles and spacecrafts	73432000-9	Test and evaluation of firearms and ammunition
35610000-3	Military aircrafts	73433000-6	Test and evaluation of military vehicles
35611100-1	Fighter aircrafts	73434000-3	Test and evaluation of warships
35611200-2	Fighter-bomber/ground attack aircrafts	73435000-0	Test and evaluation of military aircrafts, missiles and spacecrafts
35611300-3	Bomber aircrafts	73436000-7	Test and evaluation of military electronic systems
35611400-4	Military transport aircrafts	75211300-1	Foreign military-aid-related services
35611500-5	Training aircrafts	75220000-4	Defence services
35611600-6	Maritime patrol aircrafts	75221000-1	Military defence services
35611700-7	Tanker aircrafts	80600000-0	Training services in defence and security materials
35611800-8	Reconnaissance aircrafts	80610000-3	Training and simulation in security equipment
35612100-8	Combat helicopters	80620000-6	Training and simulation in firearms and ammunition
35612200-9	Anti-submarine warfare helicopters	80630000-9	Training and simulation in military vehicles
35612300-0	Support helicopters	80640000-2	Training and simulation in warships
35612400-1	Military transport helicopters	80650000-5	Training and simulation in aircrafts, missiles and spacecrafts
35612500-2	Search and rescue helicopters	80660000-8	Training and simulation in military electronic systems

TABLE B2: MOST COMMON CPV CODES FOR TED AND MANUALLY COLLECTED DATA (2007-16)

Manual Data			TED Data		
CPV	**Description**	**N. of Contracts**	**CPV**	**Description**	**N. of Contracts**
50650000	Repair and maintenance services of military aircrafts, missiles and spacecrafts.	30	34731000	Parts for aircraft.	1162
79417000	Safety consultancy services.	30	35811200	Police uniforms.	706
50640000	Repair and maintenance services of warships.	27	50210000	Repair, maintenance and associated services related to aircraft and other equipment.	623
35520000	Parts for warships.	15	35811300	Military uniforms.	619
50630000	Repair and maintenance services of military vehicles.	13	35420000	Parts of military vehicles.	489
35810000	Individual equipment.	12	35400000	Military vehicles and associated parts.	450
73424000	Development of warships.	12	45216200	Construction work for military buildings and installations.	434
80600000	Training services in defense and security materials.	11	35812000	Combat uniforms.	401
35612400	Military transport helicopters.	10	35811100	Fire-brigade uniforms.	399
45216200	Construction work for military buildings and installations.	10	35330000	Ammunition.	382

Appendix C

Entity Deduplication Method

In computer science, this task is known as deduplication or entity resolution. As the contracting database contains millions of contracts, we draw on the computer science (more specifically information retrieval) literature for a state-of-the-art, maximally automated solution. The aim is to train an algorithm to be able to tell if two records refer to the same entity as well as a human.

Deduplication is a well-studied issue and is applied in familiar technologies such as auto-complete and web search. The procedure can be broken into five steps: pre-processing, learning the optimal record similarity measure, choosing which records to compare, grouping similar records, and identifying a threshold for merging records.

1. Pre-processing

Records from our database include name, address, town, postal code, and country fields. We process each field using standard methods like lowercasing all characters and removing punctuation. This decreases the number of records within discarding any entities: it is highly unlikely that punctuation or case distinguishes different institutions.

2. Learning the optimal record similarity measure

Next, given a hypothetical pair of records, we can calculate a variety of distance measures for each field. For example, string edit distance counts how many characters have to be changed to transform one record's name into another record's name. We combine several measures of distance for each field to obtain a weighted composite measure of the distance between two records by using a machine learning technique known as active learning.

The method first samples a few thousand pairs of records. It learns which combinations of similarity across the fields are highly suggestive of a match: for instance, if two buyer records share the same postcode and address, and their names are only one character apart, it is highly likely that they are referring to the same entity. The algorithm then asks the user for input on the pairs of records on which it is unsure. Every time the user verifies that a pair of records is a match or not the algorithm improves. Research shows that even on very large matching tasks, one hundred such verifications cause a drastic improvement in the deduplication process.

3. Choosing which records to compare

With this formula for determining the similarity of two records, the method then turns to the entire set of records. If one considers 1,000 records, there are nearly 500,000 possible pairs of records to compare. This relationship scales quadratically: from 100,000 records one can create 10,000,000,000 pairs. We narrow the field using a method called blocking. Blocking groups records by some similarity such as sharing the same first three characters or having the same number of words in their name. We construct multiple blocks with the goal of applying our record similarity measure only within blocks: we do not waste our time comparing records that do not have some very general features in common. By again

using active learning, we find the optimal set of blocks to maximize accuracy while minimizing comparisons.

4. Grouping similar records

Once we have calculated the similarity scores for all pairs of records in all blocks, we use a hierarchical clustering method to determine which records we should actually consider duplicates. This clustering has a threshold parameter which governs how similar two records should be to be considered a match.

5. Selecting a threshold for merging records

Deduplication methods can make two kinds of errors: false positives and false negatives. A false positive match occurs when the method claims that two records refer to one entity, when in fact they are distinct. A false negative match occurs when the method fails to suggest that two records referring to the same entity are a match. There is a natural tradeoff: strictly avoiding false positives increases false negatives and vice versa. We strike a balance to minimize the total error rate.

We implement this process using open-source software: the entire code is written using the Python programming language and the Dedupe library. We share our script. On a relatively powerful desktop computer, the process takes one day to run for buyers and, as there are more suppliers than buyers, two days for suppliers.