WHY SHOULD WE MAKE EU PUBLIC PROCUREMENT MORE TRANSPARENT?

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This study has been commissioned by **The Greens/EFA Group in The European Parliament**.

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Executive summary and recommendations

- The aim of this study is to describe and analyse benefits and costs of increased transparency, interoperability, and machine-readability of public procurement data in the European Union. A special focus is given to the subsequent usage of machine learning algorithms in investigating fraud and corruption in public procurement.
- Public procurement is a prominent way of spending public resources in the European Union. The public procurement market is worth about 31% of general government expenditure in the European Union (equivalent of about 2 trillion euros; European Commission, 2017).
- The academic evidence shows convincingly that public procurement markets suffer from a number of issues such as corruption, political connections, and collusions. These issues cause large inefficiencies on the market.[1]
- Higher transparency and the provision of interoperable open public procurement data in machine-readable format are likely to help in eliminating these inefficiencies.
- The interoperability of public procurement registers and other registers such as a company register and registers of politically exposed persons is another important element in strengthening the efforts to eliminate the inefficiencies.
- The public procurement data currently published on the European level are of low quality with many missing and incorrect values and it suffers from a number of other limitations. First, contract notices and contract award notices are not automatically merged, which makes it difficult[2] to find, for example, the final price of a public procurement contract that we observe among contract notices. Second, the current reporting system is not linked to other datasets (for example, firm-level datasets or data about procuring authorities). Last, the reporting system does not cover the whole procurement process, i.e. there is no information about the project implementation. All this information would be useful in monitoring and control of the public procurement market.
- Higher publicizing standards and transparency in public procurement are shown to lead to significant savings for the public sector. Coviello & Mariniello (2014) find that due to the higher publicity standard of procurement announcements in Italy, the final prices declined by 7% of the estimated costs and the number of bidders increased by 9.3%.

[1] For example in 2019, the European Anti-Fraud Office (OLAF) recommended recovery of 485 million EUR paid from the budget of the European Union based on its fraud investigation (OLAF, 2020).
[2] It is feasible, but virtually impossible for an ordinary computer user to do with more than a couple of public procurement contracts.

- A more extensive and machine readable procurement data publication can be used by law enforcement agencies, public and private auditors as well as by the civic society and other volunteers to improve the efficiency of public procurement.
- Machine learning algorithms are effective in detecting potentially corrupt public procurement contracts as well as in detecting situations with conflicts of interests (firms with political connections). Corruption and political connections are associated with a lower procurement efficiency – higher costs and no quality improvements.
- Extensive online monitoring by the public and non-governmental organizations (NGOs) investigating collusion and corruption have been found to be associated with a reduction in the chance of collusive behaviour of procurement suppliers and with a decline in prices (Baranek et al., 2020).
- From a policy perspective, this study concludes that the thresholds for publication in the European Union procurement system should be lowered, the quality of the data should be better controlled and enforced, the public procurement datasets should be linked to other administrative datasets such as company registries and datasets from statistical offices and Eurostat, the whole procurement process should be covered including the information about the project implementation.

Contents

1. Introduction

The aim of this study is to describe and analyse the potential role of transparent and interoperable open public procurement data in machine-readable format in the European Union. A special focus is given on how transparency can help in improving procurement outcomes such as reducing prices and how it can help in preventing corruption and fraud detection. The study also provides motivation for the establishment of a common standard for open data[3] in machine-readable format[4] on public procurements, which would ensure easier and more effective control of public procurement throughout the European Union.

Public procurement is a prominent way of spending public resources – worth about 29% of general government expenditure in developed countries. Currently public authorities in the European Union spend about 14% of the overall GDP via public procurement contracts. This is equivalent to approximately 2 trillion euros (European Commission, 2017). This makes any possible improvements on these markets extremely important for the citizens' well-being.

In this study, I argue and provide evidence from the academic literature that higher levels of transparency and the accessibility of public procurement data in a machine readable format are likely to lead to lower prices, and generally better control over fair and efficient public procurement. The interoperability of public procurement registers and other registers such as a company register and registers of politically exposed persons is another important element in strengthening these efforts to eliminate inefficiencies caused by fraud, corruption, and other issues on the public procurement market in the Union. Such data from these inter-linked registers can be used by the public as well as law enforcement agencies and auditors to detect fraud and corruption.[5]

Besides the opportunity for public scrutiny, the recent availability of detailed public procurement data in some countries led to a boom in (academic) research of these markets. The academic evidence shows convincingly that the markets suffers from a number of issues such as collusion, corruption, and a lack of information. The issues cause large inefficiencies.

Collusion appears to be a widespread issue in public procurement throughout the world (Kawai & Nakabayashi, 2014; Conley & Decarolis, 2016; De Leverano 2019; Baranek et al. 2020). Transparency

[3] Open data means data that are available freely to anyone without restrictions.
[4] Machine-readable format means a format that can be read automatically by a computer. Data in such format must be structured. It includes formats such as CSV (comma-separated values), XML (extensible markup language) or JSON (JavaScript Object Notation), but does not include, for instance, PDF documents.
[5] Defining a new standard for publishing of public procurement data is beyond the scope of this study. An inspiration for such a standard can be found in The Open Contracting Data Standard (OCDS) - https://standard.open-contracting.org/.

and monitoring by the public can be a strong tool to eliminate collusive behaviour and its adverse effects (Baranek et al., 2020).

There is extensive evidence on the political influence (Faccio, 2006; Titl & Geys, 2019; Baltruinaite, 2020; Baranek & Titl, 2020) and corruption (see e.g. Andreyanov et al., 2019) in public procurement. The political influence causes misallocation of public procurement contracts (Titl & Geys, 2019; Baltruinaite, 2020), and higher prices which are not compensated by any improvement in the quality (Baranek & Titl, 2020). More generally, politically connected firms are estimated to generate substantial welfare loss for the society – up to 1.9% of GDP according to Khwaja & Mian (2005).

Recent academic evidence points out to the importance of transparency on these markets in achieving better performance. Transparency and higher publicity requirements on public procurement markets have been linked to lower prices, more competition less corruption and collusion[6] (Baranek et al., 2020; Mazrekaj et al. 2020; Coviello & Mariniello, 2014). Furthermore, the lack of transparency (in form of anonymously owned procurement contract winners) is associated with overpriced procurement contracts (Titl, 2020) and the manipulation of cost estimates around de-minimis thresholds (Palguta & Pertold, 2017). This extensive academic work from Czechia, Italy, and Ukraine as well as from the whole Union provides arguments for the data transparency on the public procurement markets.

Recently, a growing body of academic literature and policy reports highlights the potential role of algorithms and machine learning in detecting collusion and corruption in public procurement. An algorithm is a set of rules to perform a task/solve a problem (for example, finding a corrupt public procurement contract). A machine learning algorithm is then an algorithm that learns on its own from experience and data how to perform a given task. Baranek et al. (2021), Ferwerda et al. (2017), Decarolis & Giorgiantonio (2020), Mazrekaj et al. (2021) show that machine learning[7] and other algorithms can be effectively used to detect collusion and corruption in public procurement. The key condition for a successful application of machine learning algorithms is availability of data of high quality. In the case of public procurement contracts in the European Union, this is not satisfied. And hence, open public procurement data in machine-readable format presents an untapped opportunity for the European Union to improve the public sector efficiency.

The structure of this study is as follows. In Section 2, I describe the existing transparency regulation affecting public procurement contracts in the Union with a special subsection dedicated to privacy

[6] Corruption is not used in a legal meaning, but rather to describe a broad group of activities that appear not to be in line with basic principles such as fairness.

[7] Machine algorithms are also shown to be useful and strong in predicting other outcomes such as stock prices, jail-or-release decisions, mortality, fraud, medical diagnosis, and many others.

concerns related to an increased level of transparency and the actual implementation. The extent and the quality of the datasets that are currently published are also described. Section 3 presents selected academic articles that provide strong evidence of how an increased transparency and machine learning algorithms can lead to better outcomes and improve possibility of discovering irregularities in public procurement contracts. And, in Section 4, I conclude and present the policy recommendations coming from the analysis.

2. An overview of the existing open data and transparency regulation in public procurement in the EU

There are three core legal sources on the European level regarding public procurement contracts:

1. Directive 2014/24/EU on public procurement (repealing Directive 2004/18/EC)
2. Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors (repealing Directive 2004/17/EC),
3. and Directive 2014/23/EU on concessions.

These outline difference procurement procedures, the specification when they can be used, criteria for the award, and different other aspects of public procurement. They also include rules on publication and transparency.

The core principles of public procurement in the Union outlined in Directive 2014/24/EU are transparency, equal treatment, non-discrimination, and proportionality.[8] The first one can be directly achieved by implementing a common standard for open data in machine-readable format on public procurements that would be extended also below the threshold. The following two might be achieved indirectly by increasing monitoring opportunities. And the last helps us to assess how much more transparency could be enforced.

These directives apply only to the public procurement contracts above the so-called de minimis thresholds.[9] These thresholds differ for different types of contracts, different procuring authorities and other aspects (e.g., whether a contract is state-subsidized). The most important difference is made between

[8] Article 15 of Directive 2014/24/EU states *"contracting authorities shall treat economic operators equally and without discrimination and shall act in a transparent and proportionate manner".*

[9] Note that the basic principles of the European law such as equal treatment, proportionality and so on apply even below the de minimis thresholds.

- the thresholds for public sector supplies and services on the one hand (144,000 EUR or 221,000 EUR depending on whether the procuring authority is a part of the central government or not),
- and the threshold for public works on the other (5,548,000 EUR).[10]

Public works include largely construction contracts. The thresholds are the same across the Union with no regard to the price level and the levels of corruption.

Compulsory publication

Public procurement contracts in the Union with a value above the de minimis threshold have to be published in Official Journal of the European Union - the Tenders Electronic Daily (TED) portal.[11] Historical information since 2006 are available.[12] First, a contract notice is published according to Article 49 of Directive 2014/24/EU. A contract notice is a notification that provides information about an upcoming contract. It includes information necessary for firms to prepare and submit a bid. In Appendix of this study, you can see an overview of information to be included in contract notices according to the Part C of Annex V of Directive 2014/24/EU. Currently, there are compressed daily updated files available for download with award notices in XML format. One can also access CSV files containing all contract (award) notices from a particular year.

Second, after the evaluation is finished and the contract award decision is made, contract award notices are published no later than 30 days after the conclusion of a contract or of a framework agreement. A contract award notice contains information about the supplier that was awarded the public procurement contract at hand and other information as set out in Annex V part D of Directive 2014/24/EU (see Appendix for the overview of the information to be included in the contract award notice). Contract award notice shall be published in accordance with Article 51 of the directive. There are certain exceptions to this rule such as in the case of framework agreements (Article 33).[13] Finally, certain information may be withheld if the publication would impede law enforcement or was contrary to the public interest.

[10] Note that this is not a full list of the de minimis threshold, it should simply give the reader the core idea about the size of thresholds.
[11] https://ted.europa.eu/TED/main/HomePage.do
[12] Historical information are not deleted.
[13] Award notices are then sent in groups quarterly.

Voluntary publication

Procurement authorities may publish notices for public contracts that are not subject to the publication requirement outlined above. This provides a procurement authority with an opportunity to increase competition by publicizing also the public procurement contracts below the threshold European-wide (see the reasoning in Section 3.1).

Member states often impose additional requirements for publication for below de-minimis threshold contracts. The requirement differ significantly across the European Union. In countries such as Portugal, the minimum value after which a contract has to be published is 0 or a very small amount. However, it is 134,000 EUR in Austria, Germany, and the Netherlands. This creates big differences in data accessibility across the European Union. And even in the member states where there is a lower threshold, i.e. the data for a large share of public procurement contracts are available, one has to find a local public procurement system and understand how it works before being able to use and/or analyze the data. One European-wide procurement system would facilitate the access to this information for all stakeholders. It is important to note that lower levels of transparency in countries such as Germany and the Netherlands cannot be easily justified by non-existence of corruption. See, for instance, the corruption scandals surrounding the construction of one of the Berlin's airports[14] and the reports about corruption and collusion in the Dutch Construction sector (Van Den Heuvel, 2005; for a similar line of arguments, see Mendes & Fazekas, 2017).

[14] https://www.economist.com/europe/2020/10/15/berlins-long-delayed-airport-is-finally-opening

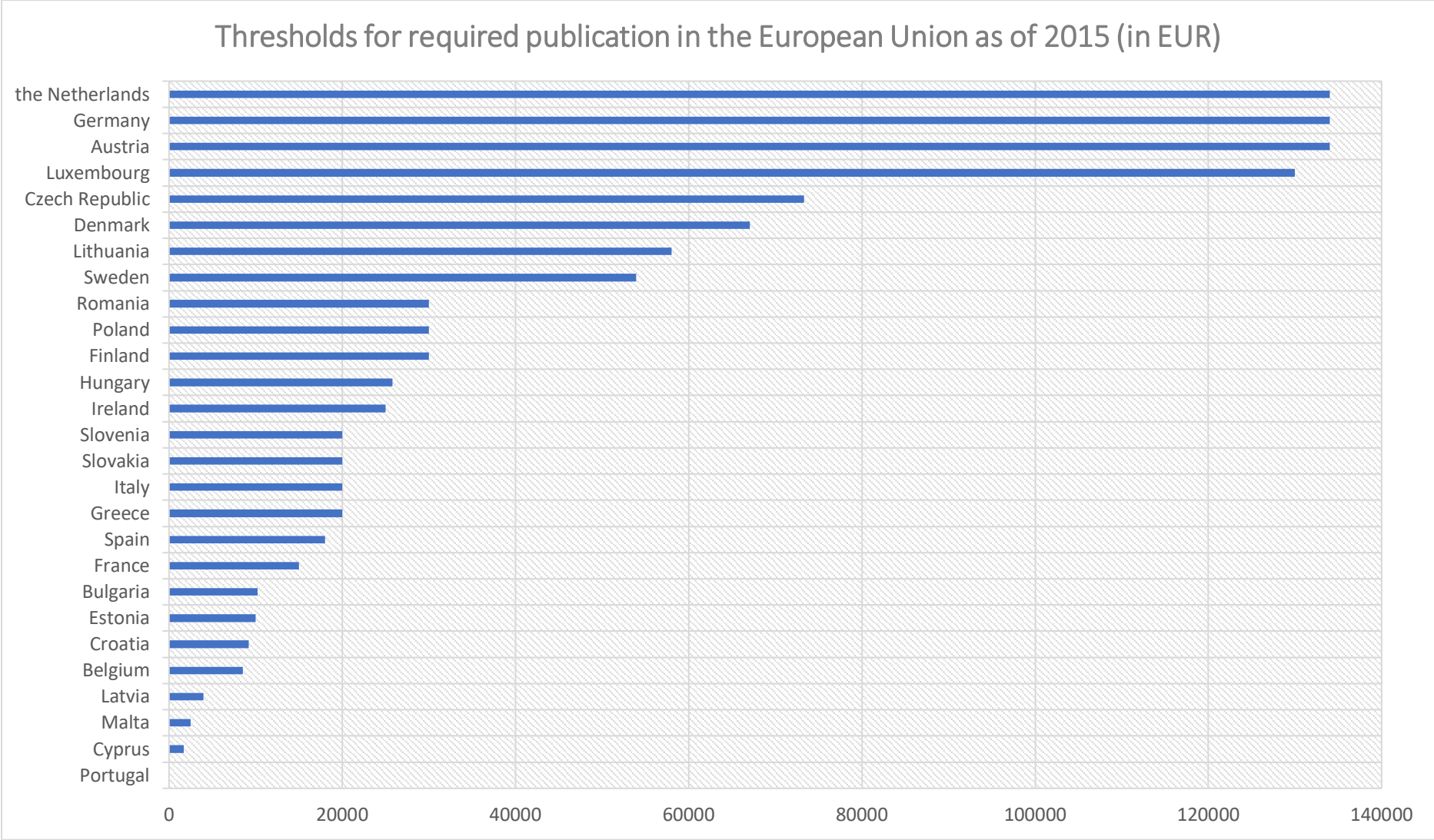

FIGURE 1: Thresholds (minimum values) for required publication in the European Union as of 2015 (in EUR), source: author based on Mendes & Fazekas (2017).

2.1 The current data availability and quality

There are three core datasets published in Tenders Electronic Daily (TED)[15]:

1. contract notices (CNs),
2. contract award notices (CANs),
3. and voluntary ex-ante transparency notices (VEATs).

To analyze potential issues with the datasets that are currently available, I have downloaded the freely available csv files with contract notices and award notices. The documentation[16] for the dataset states that *"the data is provided "as is". The source of the data is unverified output from contracting authorities or entities across Europe. It is not uncommon for data to be input … or be missing, and thus great care must be taken with data management and interpretation. Please note that due to resource constraints the European Commission is regrettably not able to provide support in analysing the data"*, i.e. the Commission is well aware of the limitations of the data.

Contact notices and contract award notices datasets contain public procurement contracts (either in the stage before the contract award or after the award) that have to published according to the directive and those that were published voluntarily. Article 4 of the Directive lays out the thresholds above which contract notices have to be published. Currently, the thresholds are 144 000 EUR for the supply and service contracts listed in Annex XIV to the directive and EUR 5 548 000 for works contracts (largely construction works). The share of the value of awarded public procurement contracts in TED data on the total public procurement spending in each member state is in Figure 2.[17] The value of awarded public procurement contracts is calculated as a sum of final prices of all public procurement contracts from the TED contract award notices. The total public procurement spending is calculated using the shares of public procurement GDP available from OECD database. The data from 2017 are used. Using a different year or time period would not substantively change the results.

The differences between coverage between member states are substantial. On the one hand, it is particularly low in some Western European countries such as in Belgium, Germany, and the Netherlands. The coverage is on the other hand relatively higher in countries such as Lithuania, Hungary[18], and Slovenia. The fact that a procurement contract is in the dataset does not mean that

[15] https://ted.europa.eu/TED/main/HomePage.do

[16] https://data.europa.eu/euodp/repository/ec/dg-grow/mapps/TED%202020/TED(csv)_data_information_v3.3.pdf

[17] The share is defined as $\frac{the\ value\ of\ awarded\ public\ procurement\ contracts}{the\ total\ public\ procurement\ spending}$.

[18] The high share of published public procurement contracts in Hungary might appear surprising in the light of recent corruption-related scandals in the country. It is necessary to keep in mind that transparency is not the only aspect influencing the quality of public procurement process. The capacity of governments in general is an important factor. Thus, given the issues with the rule of law in Hungary (see the report on the rule of by European

the information about the contract is complete or sufficient. The data points are often missing as discussed in detail below.

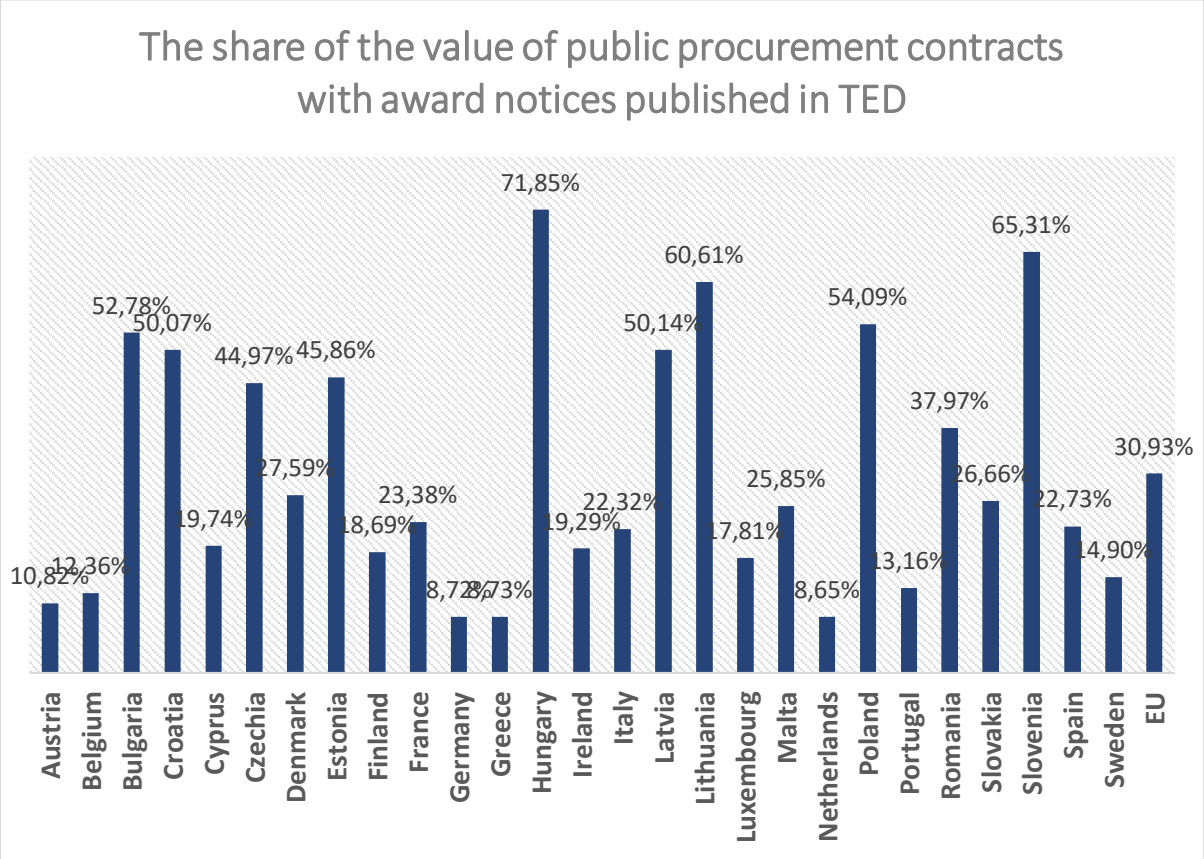

FIGURE 2: The share of the value of public procurement contracts with award notices published in 2017 in TED; source: author's calculation based on TED data.

Contract notices

The dataset of contract notices should generally contain information sufficient for bidding firms to prepare their offers.[19] The issue with the data is their quality. Let us take an example of the year 2017 (other recent years do not differ much, the quality was worse in the past though). There were 705,561[20] contract notices (including notices of lots that are not separate contracts[21]) published in 2017 according to the TED data. For 45.9% of these contract notices the estimated value was not in the data. For 39.8% of the notices, the evaluation criteria, which can be also very important for potential bidders, were missing. And for a staggering 60%, the unique identifier of the buyer (company

Commission, 2020), higher level of transparency are likely insufficient to mitigate corruption and/or improve procurement outcomes (for a discussion of the extent of corruption and state capture in Hungary, see Fazekas & Tóth, 2016). The high share of published procurement contracts in Hungary cannot be easily interpreted as an argument against transparency.

[19] Of course, one can argue that the description for some public procurement contracts should be better, but that is beyond the scope of this study.

[20] I excluded 1,558 cancelled contracts.

[21] There were 211,850 unique public procurement contract notices.

identification number) was missing. The data are of low quality in other aspects as well. Even when a value is filled in, weird and unlikely information is provided. To give an example, Communauté d'agglomération Sud Sainte Baume, which is a group of municipalities in France, was procuring environmental training and tutorial services for 9,999,999,999.00 EUR. If every citizen in this administrative unit received such training, it would mean that everyone receives trainings worth 163,738 EUR in a period of 24 months. Note that this is more than the GDP per capita of this administrative unit. The data are full of such issues and although the Commission is aware of these limitations (see Hercher, 2014[22] for further examples), they were not solved.

The extent of missing values differs across member states. In Figure 3, I present the rate of missing values of estimated prices (values), information about evaluation criteria, and unique identifiers of buyers. The rate of missing prices is about 80% in many member states (see Austria, Belgium, Lithuania, Malta, the Netherlands, and others). The rate of missing value for unique identifiers of buyers is even higher in many countries.[23] Overall, it appears that some new member states such Bulgaria, Czechia, Croatia, and Slovakia publish more complete data.

Contract award notices

The dataset of contract award notices suffers from similar issues. While countries such as Latvia, Lithuania, Romania, and Slovenia report the final prices, the number of bidders, and the information whether a contract was subsidized from the Union funds well, many countries fail to report very often. Details are provided in Figure 4. For example, Bulgaria, Greece, Malta, and Portugal do not report well whether a public procurement contract was subsidized or not in 40 to 60% cases. Malta and Sweden fail to report final prices in about 35% cases.

This suggests that reporting should be better enforced in order to make the data better usable and generally more transparent. However, the main issue with the current situation is that various pieces of information are not required. There is no information about other bidders and their offers. There is no access to the actual text of the winning offer (parts that include personal information or confidential information can be remove). Processing and publishing texts of offers might be costly and that is why it may be reasonable to require it only above the de minimis thresholds.

[22] https://data.europa.eu/euodp/repository/ec/dg-grow/mapps/20140429_ESWG_Data_Quality.ppt

[23] Note that there can still be the name and/or the address of the buyer, but no unique identifier that could be used easily to match this data with company registry and other datasets.

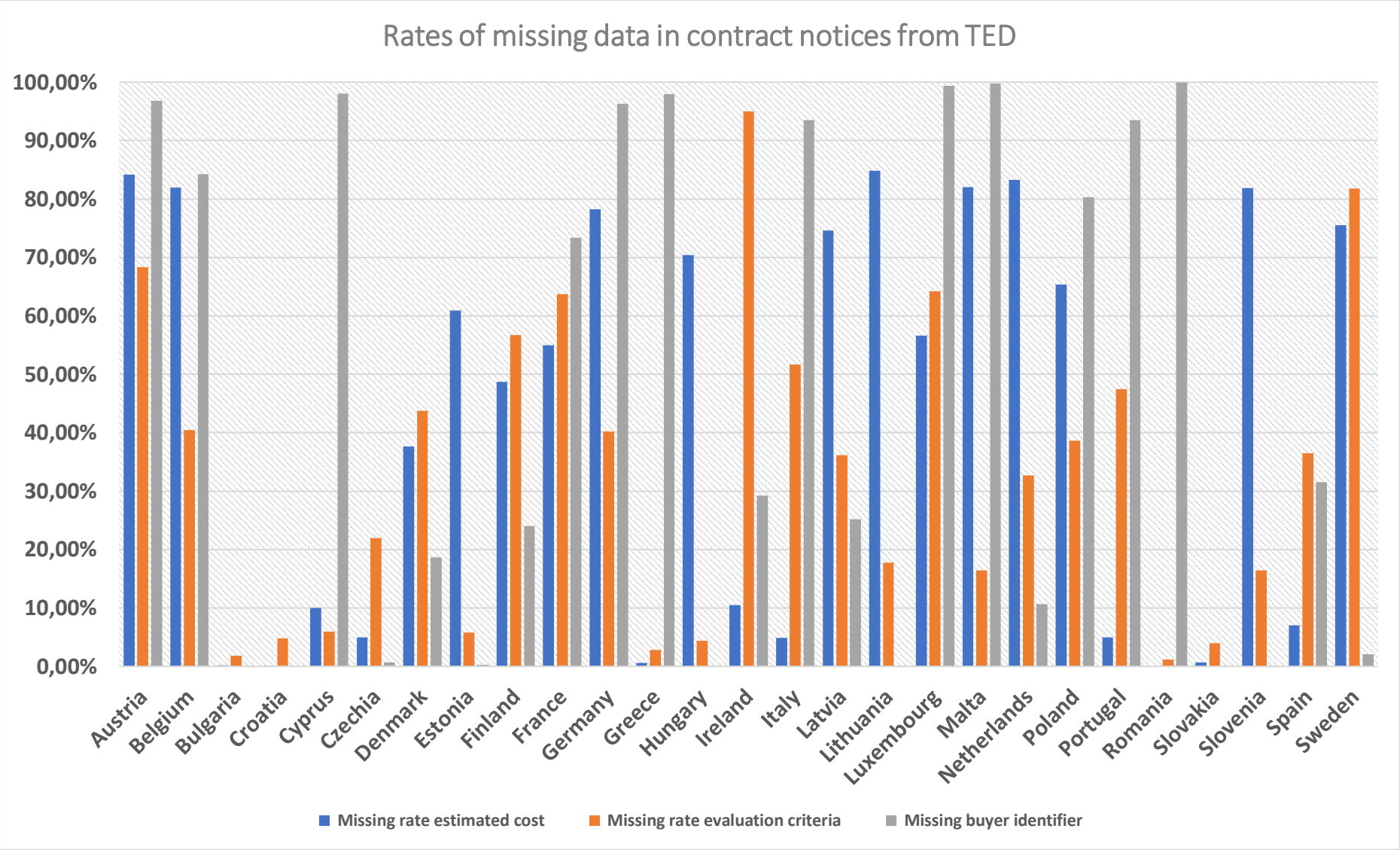

FIGURE 3: Rates of missing data in contract notices from TED in 2017, source: author's calculation based on TED data.

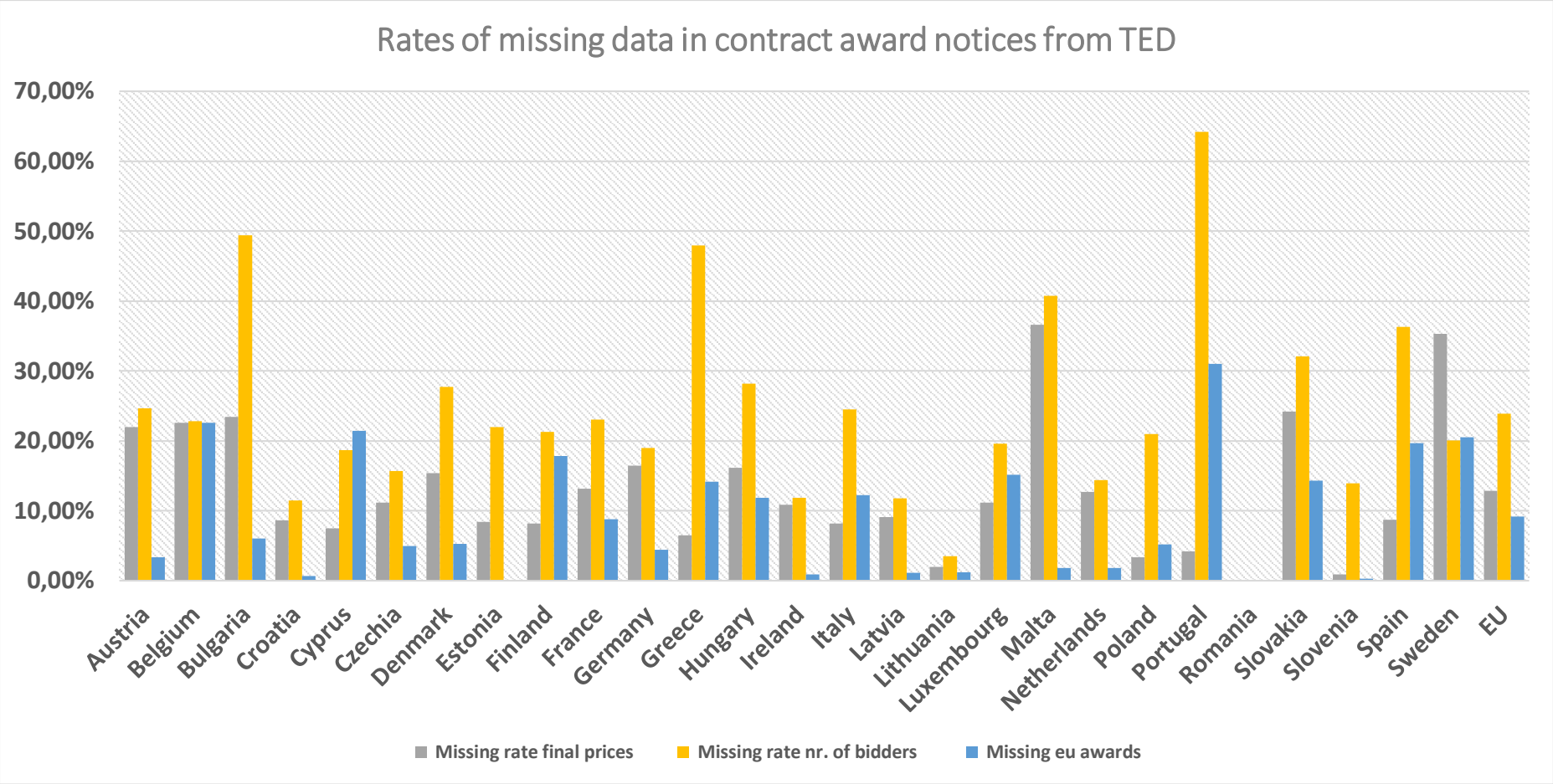

FIGURE 4: Rates of missing data in contract award notices from TED in 2017, source: author's calculation based on TED data.

Member States

Member States publish information about public procurement contracts also themselves and although this study focuses on the information provided on the Union level, it might be useful to compare the extent of transparency with the member states. In Table 1, I present such information about data availability across Member States and in comparison with the information published on the European level (see column EC). The table shows big differences among states and also that generally there is a lack of information about additional funding sources, buyer' details, competition dates, other bidders, bid disqualification, administrators related information and so on.[24] A potential improvement in the publication standard at the European level is an opportunity the differences and also often the lack of information provision.

[24] Such big difference persist also for the completeness of information published on TED.

		Austria	Belgium	Bulgaria	Cyprus	Croatia	Czechia	Germany	Denmark	Estonia	Spain	Finland	France	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Latvia	Malta	Netherlands	Poland	Portugal	Romania	Sweden	Slovenia	Slovakia	EC
Contract related	Title	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
	Procedure type	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
	Negotiated procedure reason	X		N/A			X	X	X						X				X			X		X	N/A		N/A	X	X
	Description	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	
	Type (service/goods/construction)	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X
	Size (above/below EU threshold)	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X
	Location of performance	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X
	Variants accepted	X	X	X		X				X	X	X	X		X			X	X		X	X	X	X	X			X	X
	Deposits	X	X	X	X			X			X			X	X			X				X	X	X	X		X	X	X
	Electronic auction used	X	X	X	X	X	X	X		X	X		X	X	X			X	X			X	X	X	X		X	X	X
	Framework agreement	X	X	X	X		X	X		X	X		X	X	X			X	X			X	X	X	X		X	X	X
	Award criteria	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
	Main object/CPV code	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X
	Announcement ID	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X	X	X	X	X	X		X	X	X
	Contract ID	X	X	X	X		X			X	X	X	X	X		X	X	X	X	X	X	X						X	
	Is it a DPS (Dynamic Purchasing System)	X	X	X			X	X					X		X			X	X			X	X	X	N/A		X	X	X
Dates	Call for tender publication date	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X
	Bid deadline date	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X
	Documentation deadline date	X	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X	X		X	X	X
	Contract award notice publication date	X	X	X	X		X			X	X		X	X	X	X	X	X		X	X	X	X	X	X		X	X	X
	Date of last update								X																				
	Estimated starting date	X	X	X	X		X	X	X		X			X	X			X		X		X		X	X		X	X	X
	Estimated completion date	X	X	X	X		X	X	X	X	X			X	X			X	X	X		X		X	X		X	X	X
	Award decision date	X	X	X	X		X			X	X		X	X	X	X	X	X		X	X	X	X	X	X		X	X	X
	Completion date			X											X														
	Cancellation date	X	X	N/A	X		X		X		X			X	X			X		X		X					X	X	X

		Austria	Belgium	Bulgaria	Cyprus	Croatia	Czechia	Germany	Denmark	Estonia	Spain	Finland	France	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Latvia	Malta	Netherlands	Poland	Portugal	Romania	Sweden	Slovenia	Slovakia	EC
Requirements	Personal requirements	X	X	X	X		X	X		X	X		X	X	X			X	X	X		X	X	X	X		X	X	X
	Economic requirements	X	X	X	X		X	X		X	X		X	X	X			X	X	X		X	X	X	X		X	X	X
	Technical requirement	X	X	X	X		X	X		X	X		X	X	X			X	X	X	X	X	X	X	X		X	X	X
Documentation	Is the documentation payable	X		X			X	X		X				X	X			X		X	X	X		X	X			X	X
	Documentation price	X		X			X	X		X				X	X			X		X	X			X	X			X	X
	Documentation location	X	X	X	X			X	X	X	X	X			X	X		X	X	X	X	X	X	X	X				X
	Documentation is directly linked	X			X			X	X	X	X			X		X			X		X	X							
Funding	Covered by GPA (Government Procurement Agreement)	X	X	X			X	X	X	X	X		X	X				X	X	X		X		X	N /			X	X
	Name of funding source						X							X										X	X			X	
	Funded by the EU	X	X	X	X		X	X		X			X	X	X			X	X	X	X	X	X	X	X		X	X	X
	Funding programme	X		X	X		X	X		X				X	X			X		X			X		X		X	X	X
	Amount contributed from each source																												
	Percentage contributed from each source																												
Buyer information	Awarded by a group of buyers																												
	Purchased by a central purchasing authority					X									X						X				N		N		
	Buyer name	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
	Purchased for other authority	X	X	X	X			X	X	X		X	X		X			X		X	X	X			X		X		X
	Main activity of the buyer	X	X	X	X	X	X	X	X	X	X		X	X	X			X		X		X	X	X	X		X	X	X
	Type of the buyer	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X	X	X	X		X	X	X
	Public buyer	X	X	X	X	X		X	X	X	X	X		X	X			X	X	X				X	X		X		
	Subsidized buyer																												
	Sectoral buyer																												
	Buyer's ID	X	X	X			X	X		X	X	X				X	X	X	X	X	X	X	X	X			X	X	
	Buyer's address	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X

		Austria	Belgium	Bulgaria	Cyprus	Croatia	Czechia	Germany	Denmark	Estonia	Spain	Finland	France	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Latvia	Malta	Netherlands	Poland	Portugal	Romania	Sweden	Slovenia	Slovakia	EC
Bidder/Winner information	Winner's name	X	X	X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
	Winner's address	X	X	X	X		X	X		X	X		X	X	X			X	X	X		X	X	X	X		X	X	X
	Winner's ID			X						X	X					X	X	X		X				X				X	
	Other bidder's name			X											X						X								
	Other bidder's address														X														
	Other bidder's ID			X																									
	Information on bidder limitation	X		X			X	X		X			X		X			X	X	X		X	X		X		N/A		X
	Est. no. of winners if framework agreement			X									X		X			X		X					X				X
	Consortium																				X						N/		N/
	Is subcontracted?		X	X			X	X		X			X		X			X	X	X		X		X	X		X	X	X
	Subcontractor's name			N/																	X				N/					
	Subcontractor's share		X	N/			X			X			X		X			X		X		X					X	X	X
	Bidder related documents																				X								
Bids	No. of bids received	X	X	X	X		X			X	X		X		X			X	X	X	X	X	X	X	X		X		X
	No. of valid bids received												X															X	
	No. of bids received electronically		X				X								X			X				X					X		X
	Bid disqualification																						X						
	Reason for bid disqualification																												
Prices	Est. contract value	X	X	X	X		X	X	X	X	X			X	X			X	X	X		X	X	X	X		X	X	X
	Final contract value		X	X	X		X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
	Bid values														X						X								
	Total amount paid at contract completion			X											X									X					
	Highest bid value		X				X				X				X			X		X	X		X						X
	Lowest bid value		X				X				X				X			X		X	X		X						X

		Austria	Belgium	Bulgaria	Cyprus	Croatia	Czechia	Germany	Denmark	Estonia	Spain	Finland	France	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Latvia	Malta	Netherlands	Poland	Portugal	Romania	Sweden	Slovenia	Slovakia	EC
Cancellation/ correction	Is the tender cancelled	X	X	X			X			X	X	X	X	X	X		X	X		X	X	X	N/	X			X	X	X
	Cancellation reason	X		N/	X		X		X		X			X	X			X		X			N/		N/		X	X	
	Any correction issued	X	X	X	X					X	X	X	X	X	X		X	X		X	X	X	X	X	X		X		X
Other information	Administrator														X												N/		
	Supervisor																										N/		
	Specifications Creator														X												N/		
	Court proceedings			X									X		X									X					
	Court interventions			X											X				X					X					
	Appeal body	X	X	X	X		X	X	X	X	X		X	X	X			X	X	X	X	X		X	X				X
	Mediation body name		X										X		X			X		X		X							X

TABLE 1: X= INFORMATION IS AVAILABLE; N/A=INFORMATION AVAILABILITY COULD NOT BE CONFIRMED; BLANK=INFORMATION IS NOT AVAILABLE; SOURCE: CINGOLANI ET. AL 2016.

2.2 Policy and enforcement gaps currently constraining data transparency in public procurement in the EU

The current data transparency in public procurement is limited. First, the quality of published data is very low, the information that should be provided is often missing or incorrect. As presented in Section 2.1, the member states largely fail to enforce publication required in the directive 2014/24/EU. Particular member states are doing significantly worse than others, but no member state publishes data of a satisfactory quality. The datasets suffer from missing values, values that are very unlikely, and clearly impossible. An important issue is that often unique identifiers of procuring authorities as well as suppliers are missing (in certain member states, the unique identifier of a buyer is virtually never included). The low quality prevents stakeholders from being able to effectively use them.

Second, public procurement contracts below the de-minimis thresholds do not have to published and are often missing completely in the TED datasets. Such public procurement contracts are published in various national platforms, or not published at all. As shown in Figure 2, in a number of member states such as Austria, Germany, Greece and the Netherlands, the share of value of public procurement contracts published in the European-wide system is only about 10% of the total value of public procurement contracts in the respective member states. This means that an EU citizen cannot get information in a simple manner about 90% of the value of public procurement contracts in these member states. Note that in some of them, a non-negligible share of public procurement contracts is subsidized from the European Union Funds.

Third, the current way of publication does not automatically merge contract notices and contract award notices. This makes it difficult for anyone to find out, for example, the final price of a public procurement contract from the notices. It is two separate files (notices and award notices) and matching is cumbersome.

Third, the current datasets are not interoperable with other datasets such as company registries or other datasets form statistical offices. This prevents to large extent effective control of potential conflicts of interests and other issues as well as simple control of correctness (the example from above of a group of municipalities procuring services 9,999,999,999.00 EUR, which is significantly more than the GDP of the administrative area, could have been easily discovered automatically using other datasets).

Last, the current reporting system does not cover the whole process. On the European level, we do not have good information about changes in public procurement contracts such as renegotiations and so on. Renegotiations are linked to higher chances of firms with political connections winning

(Brogaard et al., 2020). Moreover, we do not have any information about neither the actual implementation nor ex-post performance. Such implementation reporting systems exist on national level in Bulgaria, Estonia, Italy, and Portugal (Mendes & Fazekas, 2017).

2.3 Privacy concerns related to open data and transparency regulation in public procurement.

This study argues for higher transparency in public procurement in the European Union. A higher level of transparency may bring concerns related to privacy, and confidentiality, technical and trade secrets. This section discusses these concerns as well as the regulations that might limit processing and publication of procurement related data.

There are generally two core issues that relate to privacy concerns: personal information (General Data Protection Regulation, henceforth GDPR), and confidentiality, technical and trade secrets.

Privacy and GDPR

Personal data is protected as a fundamental right in the European Union (Article 8 of the Charter of fundamental rights of the European Union), thus, handling personal data is subject to various rules that ensure its protection. The most prominent one is the Regulation EU 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (GDPR). As its title and Article 1 provide, this Regulation lays down rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data, which means that these rules are not applicable to any other data than data of natural persons. Since GDPR concerns protection of personal data of natural persons, it does not constitute a large obstacle in relation to public procurement data, which largely concern legal persons' data. Nevertheless, personal information, for example, of key employees can be required in a bid for a public procurement contract.

According to Article 2 (3) GDPR, for the processing of personal data by the Union institutions, bodies, offices and agencies, Regulation (EC) No 45/2001 applies. This regulation has been repealed and replaced by the Regulation (EU) 2018/1725 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data. Although a different regulation, it follows the same principles and similar systematics as the GDPR. It is nevertheless crucial to take this regulation into account as processing data with regard to the TED portal falls into the responsibility of EU institutions.

To maximize the scope of protection of personal data, the GDPR uses broad definitions for a variety of relevant terms in Article 4. For example, personal data means any information to an identified or identifiable person. The definition of processing is *"any operation or set of operations which is*

performed on personal data or on sets of personal data, whether or not by automated means, such as collection, recording, organisation, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction". The definition basically covers every sort of usage of personal data by participants in a procurement process such as collection of personal data by the contracting authorities, publishing them on national portals, forwarding them to the Publication Office of the European Union and the publication by the Publication Office (for the latter, the Regulation (EU) 2018/1725 is applicable). The contracting authorities and the Publication Office act as controller of data in the sense of Article 4 (7) GDPR who determine purpose and means of the personal data.

Processing personal data by contracting authorities is only lawful if it is permitted by the GDPR. This is the case if

- the data subjects have given consent to the processing
- or, more importantly in the scale of procurement, processing is necessary for the performance of a contract to which the data subject is party or in order to take steps at the request of the data subject prior to entering into a contract (e.g. collecting data as proof of fulfillment of the criteria),
- or, processing is necessary for compliance with a legal obligation to which the controller is subject,
- or, processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller (Article 6 (1) b, c, e, (3) GDPR).

Obligations such as the publication of personal information emerge from the directives on public procurement along with the annex fulfilling, the transformed national laws and the purpose of transparency as public interest.

Publishing private data generally has its legitimate objective in transparency regarding public funds, as the Court of Justice of the European Union acknowledges.[25] It enables citizens to participate more closely in the decision-making process and guarantees that the administration enjoys greater legitimacy and is more effective and more accountable to the citizen in a democratic system. However, the legal basis for publishing personal data in contract award notices needs to, besides pursuing a legitimate goal, be necessary to fulfill that object as well as to balance the objective with the fundamental right to the protection of personal data respectively the fundamental right to respect for his private life (Article 7 of the Charter of the fundamental rights of the European Union). More

[25] CJEU C-92/09, C-93/09, 68-71.

precisely, it might be possible that the current directives' requirements on mandatory publications are too poor to ensure enough transparency. Therefore to protect financial interest of the Union, it might be necessary to publish more (private) information, even if the supplier is a private person. This brings a conflict between maximum transparency and protection of privacy, which has to be examined under the regard of proportionality. The final decision on this balance would come from the European Court of Justice. This study cannot find the right balance between transparency and protection of privacy, however, it appears that the current level of transparency is insufficient to protect the financial interest of the Union and its Member States. However, the more the legal basis demands for publication of further private information, the higher the risk that the legal basis is disproportionate to the above mentioned fundamental rights. Particularly, if a supplier's political affiliation should be exposed by publishing accordant information, it might be too invasive. Article 9 (1), (2) g GDPR provides a special regime on processing such sensitive data, which allows its processing under stricter rules. It requires a very well-balanced legal basis.

Additionally, principles relating to processing of personal data must be respected, as depicted in Article (5) GDPR. Data shall be processed lawfully, fairly and in a transparent manner in relation to the data subject, and only to a specifically determined purpose. Further, data shall be kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the personal data are processed as well as its storage shall be limited. Protection against unauthorized or unlawful processing and against accidental loss, destruction or damage, shall be provided by using appropriate technical or organizational measures.

Therefore, the GDPR guarantees certain rights to the data subject, which are to be respected by the contracting authorities, the Publication Office as well as the processors (Article 4 (7) GDPR) who act on the controllers' behalf (e.g. firms who operate publication websites).

The data subject is entitled to have transparent information on the manner and the purpose of the data collection, the exact processing procedure, the rights the data subject can exercise (Articles (12) to (15) GDPR). To ensure those transparency principles on data processing, contracting authorities need to share this information with the eventual suppliers as soon as possible by making data collection criteria available before the procurement process begins.

Further rights of the data subject are: right to rectification of wrong data (Article 16), right to erasure ("right to be forgotten", Article 17), unless the processing is necessary to the extent for compliance with a legal obligation which requires processing by Union or Member State law to which the controller is subject or for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller, right to restriction of processing (Article 18), except for

reasons of important public interest of the Union or of a Member State, right to object data processing (Article 21) unless the controller demonstrates compelling legitimate grounds for the processing which override the interests, rights and freedoms of the data subject or for the establishment, exercise or defense of legal claims.

However, these rights again underlie restrictions if conditions from Article 23 are met. These are Union or Member State law to which the data controller or processor is subject may restrict by way of a legislative measure the scope of the obligations and rights provided for in Articles 12 to 22 and Article 34, as well as Article 5 in so far as its provisions correspond to the rights and obligations provided for in Articles 12 to 22, when such a restriction respects the essence of the fundamental rights and freedoms and is a necessary and proportionate measure in a democratic society to safeguard important objectives of general public interest of the Union or of a Member State, in particular an important economic or financial interest of the Union or of a Member State, including monetary, budgetary and taxation a matters, public health and social security.

As stated in recital 78 of the GDPR, the principles of data protection by design and by default should also be taken into consideration in the context of public tenders (Article 24 and 25 GDPR). These principles serve the purpose of data protection by taking appropriate technical and organizational measures, so that obligations especially concerning security of the personal data, including protection against unauthorized or unlawful processing and against accidental loss, destruction or damage are met. Contracting authorities have to safeguard they fulfill these requirements as well as their processors.

GDPR also provides a way of handling personal data in some cases. Article 25 of GDPR specifies that while taking into account the purpose of processing and other issues, pseudonymization is can be a mean to *"integrate the necessary safeguards into the processing in order to meet the requirements of this Regulation and protect the rights of data subjects."* Pseudonymization is a data process that makes it impossible to attribute the data to a specific private individual while the data remain suitable for data analysis such as the machine learning detection of fraud. It can involve, for instance, replacing unique identifiers and names with reference numbers so that the data record cannot be attributed an individual. This procedure can be used also in case of public procurement data if necessary.

The publication of contract notices and contract award notices in the current form has to meet requirements provided by the GDPR. If additional information was published, these requirements and GDPR principles (e.g. data minimization) would again have to be followed. An example of such requirement could be personal information from CVs of the key employees enclosed to a public

procurement offer. Such information identifying specific persons would have to be removed or pseudonymized.

Confidentiality, technical or trade secrets

Another principle of procurement, that limits the principle of transparency, is confidentiality. As stated in Article 21 of 2014/24/EU, unless otherwise provided in this Directive or in the national law to which the contracting authority is subject, in particular legislation concerning access to information, and without prejudice to the obligations relating to the advertising of awarded contracts and to the information to candidates and tenderers set out in Articles 50 and 55, the contracting authority shall not disclose information forwarded to it by economic operators which they have designated as confidential, including, but not limited to, technical or trade secrets and the confidential aspects of tenders.

According to the 2016/943/EU directive on trade secrets, which also includes technical know-how, trade secret means it is secret in the sense that it is not, as a body or in the precise configuration and assembly of its components, generally known among or readily accessible to persons within the circles that normally deal with the kind of information in question it has commercial value because it is secret it has been subject to reasonable steps under the circumstances, by the person lawfully in control of the information, to keep it secret. Its disclosure is illegal unless its disclosure is required or allowed by Union or national law.

However, considering the intention of EU lawmakers, the protection of confidentiality rather far-reaching. Following the recital 18 of the trade secrets directive, confidentiality rules shall apply even if a trade secret disclosure is lawful as it notably mentions the directives on public procurement. Also, Article 21 2014/24/EU allows economic operators to designate any information as confidential, even aspects of tenders.

On the other hand, contracting authorities are obliged to publish contract notices and contract award notices with the content provided in Article 49 and 50. But, as previously mentioned, where the publication of information would impede law enforcement, it can be withheld. This must apply both to EU laws and national laws that are in accordance with the EU laws. Information may also be withheld if its publication would otherwise be contrary to the public interest, would harm legitimate commercial interests, or might prejudice fair competition between economic operators. This can include the commercially confidential information of private law undertakings. There may also be some interest in protecting a contracting authority's future negotiating stance.[26]

[26] Title II Rules on Public Contracts. Brussels Commentary on EU Public Procurement Law. Ed. Michael Steinicke and Peter L. Vesterdorf. : Hart/Nomos, 2018. 373–778, p. 576

In line with the general principles of interpretation of EU law, withholding information must be interpreted restrictively and with regard to the principle of proportionality, so that a contracting authority must make a specific assessment of the circumstances of each case, weighing transparency against confidentiality. Maintaining confidentiality must also take account of whether the information is available or can be expected to be made available by other means.[27]

Further transparency can be safeguarded if the catalogue of mandatory information dissemination gets extended. That way, contracting authorities would be put in the situation which requires weighing the suppliers' interest on confidentiality against the fundamentally prior principle of transparency. Yet, the extension of this publication requirements would have to be in accordance with the principle of proportionality.

3. The examples of efficient monitoring built on using open data

In this section, I describe how filling up the transparency gaps outlined above are likely to lead to lower prices and how it would create opportunities for the detection of corruption and fraud in public procurement. The following subsection present arguments and academic evidence of benefits of increased transparency. Later in this section (in Subsections 3.2 and 3.3), I briefly the describe the process of the implementation of machine learning to detect fraud/corruption and other potential usage of machine learning within public procurement.

3.1 Benefits of increased transparency

There are three key areas in which transparency helps to improve procurement outcomes. First, higher publicity standards improve accessibility of information for potential suppliers. This is a key step to ensure competition, which is related to lower prices and higher quality offers. In Subsection 3.1.1, I describe causal evidence of such effects of transparency on the Italian public procurement market (based on Coviello & Mariniello, 2014). There are no sufficient standards in the Union to ensure that information are provided to the firms for below-the-thresholds contracts, for which the European rule for publicizing apply.[28] For the above-the-threshold contracts, the standards are sufficient only in theory. In practice, the data are often of poor quality.

Second, the availability of high quality procurement data in real time can be used by law enforcement authorities to increase the effectiveness of investigation and to minimize opportunities for fraud and

[27] Title II Rules on Public Contracts." Brussels Commentary on EU Public Procurement Law. Ed. Michael Steinicke and Peter L. Vesterdorf. : Hart/Nomos, 2018. 373–778, p. 598-599.
[28] Many member states publish some of these procurement contracts in (sub)national systems.

corruption (Ferwerda et al., 2017; Decarolis & Giorgiantonio, 2020, Mazrekaj et al., 2020). To do so, machine learning algorithms can be used. The algorithms have recently attracted lots of attention and have been found to improve predictions of various economic policy outcomes including poverty (Blumenstock, 2016; Jean, et al., 2016), stock prices (Antweiler & Frank, 2004), financial crises (Ward, 2017), jail-or-release decisions (Kleinberg et al., 2018), and mortality (Puterman, et al., 2020). The key condition for a successful application of machine learning algorithms is availability of data of high quality. In case of public procurement contracts in Europe, this is not satisfied.

In Subsection 3.1.2, I describe three case studies to support the argumentation about the usefulness of a standardized high quality procurement data for investigation of fraud and corruption. The basic idea is that high quality data about procurement can be used to make accurate predictions about which public procurement contracts are potentially problematic. The most common predictors are related to discretionary mechanisms such as the most economically advantageous offer [29] or negotiated procedures and the length of the timespan for firms to prepare their bids, the amount of missing information in contract award notices in TED, and the existence of the obligations involving access to the tender documentation and the worksite inspection. The prediction cannot be used to directly prosecute any company, however, the academic literature shows that the accuracy of more than 80% can be achieved (in Decarolis & Giorgiantonio, 2020 achieves even higher almost 100% accuracy in detecting corruption in public procurement). This could significantly improve the efficacy of investigation as the algorithms provide very tips, which public procurement contracts likely to be fraudulent, corrupt, or otherwise problematic. Law enforcement authorities should find misconduct in at least 4 out 5 procurement contracts that were identified by the algorithms. Finally, the investment in such algorithms is very low as they are readily available in software packages such as R. The only requirement is the availability of a training dataset of prosecuted companies – each law enforcement authority should have access to such data. The training dataset is used by the algorithm to learn how to make predictions as accurately as possible and it does not have to be large. Mazrekaj, Schiltz & Titl (2020) show that as little as 100 such cases are likely to be sufficient for an accuracy rate of 80%. Such data are currently not available in sufficient quality on the European level.

Third, the general public such as volunteering citizens and NGOs are successful in monitoring the procurement markets and this monitoring leads to improved procurement outcomes (a longer discussion based on academic literature is provided in Subsection 3.1.3). If the public is concerned with how the public resources are spent and the law enforcement authorities cooperate with public, citizens and NGOs can use the publicly available procurement data and monitor how effectively the

[29] This means that other criteria rather than only price are used to evaluate bids in the procurement contract.

public resources are spent and whether it has been done in accordance with the law. An efficient way how to facilitate the monitoring by the public is to provide high quality procurement data and to build a robust online platform, in which anyone can in detail study public procurement contracts, the offers made by the winning suppliers and so. This had been done in Ukraine and the code for such an extensive online monitoring system is open-source, available for free. The online monitoring platform is called Dozorro.[30] To the present day, there has been no European wide system of such parameters.

3.1.1 Publicizing standards and prices on public procurement markets: the evidence from Italy

Between the years 2000 to 2005 in Italy, all public procurement contracts with a value above the threshold of 500,000 euros must have been published in the Regional Official Gazette and two provincial newspapers (Coviello & Mariniello, 2014). Public procurement contracts with a value below the threshold may have been published only in the premises of the public administration. This setting provides an opportunity to evaluate the effect of better publication of public procurement announcements. From this point of view, the required publication of above-the-EU-threshold public procurement contracts should generally have the same effects. The fact that public procurement contracts below-the-EU-threshold are either published in a less widely accessible form or are not published, may result in less efficient public procurement spending.[31]

A simple cheap system that would allow each procurement authority to publish public procurement announcements online in a European wide system would likely be beneficial. Coviello & Mariniello (2014) find that due to the publication of procurement announcements in 2 newspapers and the Regional Official Gazette, the prices declined by 7% of the estimated costs.[32] The mechanism behind the price reduction is the increased competition. The number of bidders increased by 9.3% due to the increased publicity standard for the above-the-Italian-threshold public procurement contracts. Note that these estimates should not be confused with correlation or simple summary statistics, but it is based on causal evidence. This means that these results can be interpreted such that the price reduction is a direct consequence of the increase publicity standard.

There is similar evidence of a direct link between an increase in publicity standards and the reduction in prices from Japan and the State of Oklahoma. Ohashi (2009) finds that higher transparency in public

[30] It is available on https://dozorro.org/. The e-procurement platform itself is available on http://prozorro.com/ (also in English).
[31] For public procurement contracts below a certain value, it is likely beneficial (welfare improving) if there is not that many firms submitting bids unless bidding is sufficiently simple. In the current system, having dozens of bids submitted for a small contract would result in large costs on the sides of firms (preparing their bids) as well as the public sector (evaluating the bids). Note that a bid is not simply a price, but it can include extensive paper work specifying the solution, the details about the firm that submits the et cetera.
[32] The estimated cost is here equal to reserve price.

procurement led to an increased competition and a decline in costs by about 8%. Similar conclusions were reached using the data from the Department of Transportation in Oklahoma (De Silva et al.. 2008).

A well-functioning (e-)procurement publication system would lead to better public procurement market outcomes. A larger share of public procurement contracts in the Unions is not published or is published in various (sub)national procurement reporting systems, which makes it more difficult for firms to find public procurement announcements relevant for them.

3.1.2 How machine learning can help to find political connections and the role of red flags

The availability of high quality public procurement data would also provide an opportunity for the law enforcement to find frauds and corruption more effectively. Below, I describe the findings of academic papers showing that machine learning algorithms can be useful in detecting corruptions and other issues in public procurement.

The detection of political connected firms and corruption in public procurement

Politically connected firms are linked to higher prices, lower competition and the misallocation of public procurement contracts (Baltruinaite, 2020, Goldman et al. 2013, Baranek & Titl, 2020, Titl & Geys, 2019). That is why it is probably very important for public authorities to know which companies are likely to have political connections. Mazrekaj et al. (2020) suggest how to use machine learning techniques to identify politically connected firms.

On a unique dataset of all contracting firms from the Czech Republic with various forms of political connections, they show that over 85% of firms with political connections can be accurately identified using publicly available data (from the company registry and similar).

This is a great opportunity for the public sector as the investigation efforts can get more targeted. Similarly, Decarolis & Giorgiantonio (2020) show that quantitative indicators in combination with machine learning methods (especially random forests) are effective in detecting corruption. They use a sample of Italian public procurement road works to verify the efficacy of using these indicators to detect corruption (judiciary cases and police investigations for corruption-related crimes). Decarolis & Giorgiantonio (2014) find that the most effective indicators are those related to discretionary mechanisms such as the most economically advantageous tender (MEAT) or negotiated procedures. In a MEAT method of procurement assessment, public officers have more leeway and can, thus, potentially influence the choice of a winner as they choose criteria that will be used to evaluate bids and also the weights of the criteria. In a negotiated procedure, the contracting authority approaches one or more potential suppliers and negotiate the terms of the contract with them only. This again

gives procurement officers more leeway in selecting the winner of procurement contract than other methods and procedures. The usage of both appears to be a strong predictor of corruption. Other important predictors[33] include the minimum number of days during which the contract notice is published and the existence and characteristics of the obligations involving access to the tender documentation and the worksite inspection (the more demanding requirements, the more likely the winner is corrupt). Using a random forest, they achieve more than 99.9% accuracy in predicting that there was corruption in a public procurement contract (less than 0.1% false positive) and 91.8% accuracy in predicting that there was no corruption in a public procurement contract (8.2% false negative).

Corruption detection on the European level

On a smaller dataset of public procurement contract from the whole Union, Ferwerda et al. (2017) shows that using relatively simple indicators can predict occurrence of corruption in public procurement. The strongest indicators include shortened span for bidding process, the size of a contract, substantial changes in the scope of the project after award, amount of missing information in the contract award notices. This again suggests that the availability of standardized public procurement datasets can be used for criminal investigations as it helps investigators to choose the right sample of potentially suspicious public procurement contracts that should be further investigated. In other words, a higher efficacy of corruption investigation can be achieved if the right data are available.

3.1.3 The Oversight by the public: evidence from Ukraine

The standardised machine readable data can also be effectively used by volunteers, activists, (anti-corruption) NGOs and so on. However, these NGOs cannot operate without high quality data. To demonstrate what possible effects of higher transparency and of a good procurement monitoring tool for the public is, let us take an example from Ukraine.

In 2015, Ukraine introduce e-procurement system called Prozorro followed by an online motoring platform called Dozorro. Every citizen and NGO can submit a review of a contract and also so-called abuse reports that are then investigation by the appropriate authorities can be launched. Baranek et al. (2020) document that this new system of supervision reduces the chance of collusive behaviour of procurement suppliers and pushes prices down by 20.6%.

[33] Note that the strength of a predictor might not be clearly defined for each method and that the strength of a particular predictor might vary for different methods.

3.2 The Implementation of machine learning for fraud and corruption detection

Similar algorithms as implemented on the national level in Czechia and Italy (and likely others) can be used also on the European data. These algorithms include classification trees, random forests, LASSO (least absolute shrinkage and selection operator) and ridge regressions and so on. The classification tree algorithms consider possible splits of predicting variables and choose the splits to maximize prediction accuracy. The simplest (fictional) example of a decision tree for predicting corruption in public procurement could be: if the value of a contract is above 200 million EUR, then there is corruption; otherwise there is no corruption. For this example, I have chosen the threshold 200 million EUR randomly. The algorithm would choose the threshold to maximize prediction accuracy. The actual decision trees may include more splits and more predictors. Random forest is a method based on decision trees. It combines information from several decision trees to increase accuracy of predictions. LASSO and ridge regressions are extensions of a standard regression method. Generally, the advantage of these methods is that they limit the influence of weak predictors (so it helps with predictor selection) and by that it enhances accuracy compared to the standard regression.[34]

The results of using machine learning to detect collusion might be limited, because of the lack of the data about a larger share of public procurement contracts and many missing and wrong values. Nevertheless, the algorithms can be implemented without large investments as they are generally available in free programming languages/statistical packages such as Python and R. It is necessary to highlight that these algorithms can be used only as tools by the law enforcement. They can help increasing efficacy of investigation and targeting cases that should be investigated but cannot prosecuted anyone. This has to remain in hands of human prosecutors.

Let us assume that we want to use a machine learning algorithm for detection of corruption in public procurement. Next to the dataset of public procurement contracts (and ideally also other firm-level data and procuring-authority level data), one would need a sample of public procurement contracts with proven corruption. This could be a sample of a few hundreds of prosecuted cases of corruption in public procurement. The sample of corrupt public procurement contracts combined with a sample of public procurement contracts in which no corruption was found, would then serve as a training sample. A machine learning algorithm would learn on the training sample how to “recognize”/predict whether there is corruption in a particular public procurement. The algorithm would on its own choose which predictors (i.e. characteristics of public procurement contracts, such as values, types of

[34] This study cannot serve as a source of a comprehensive overview of these statistical methods. I would refer the reader to statistical textbooks and academic articles for further details. A good source would be, for example, Hastie et al. (2009).

contract, procurement procedure used, characteristics of the suppliers etc.) are strong and useful in predicting corruption. The algorithm could then be used on new public procurement contracts or public procurement contracts that have not been investigated yet, and it would give a strong indication whether it is worth investing time of prosecutors to investigate the particular contract. As shown in the previous section, a high prediction accuracy from 80% up to close to 100% can be achieved. The accuracy depends on the quality and completeness of the data available. As such, the algorithm would pick and select likely problematic public procurement contracts, which would save money for the prosecutors. Note that if suppliers learned how the algorithm works and changed their behaviour to avoid being predicted as potential corrupt, a simple remedy is to take more recent sample of prosecuted procurement contracts and let the algorithm being trained again, which would likely improve the predictions and made avoiding being identified difficult.

This is not a complete description of the implementation rather a brief description of what data would be needed and how the procedure would work. It should serve as an illustration that even with the current data some fraud and corruption detection can be done.

3.3 Other potential usage of machine learning to improve public procurement

The machine learning algorithms and more generally artificial intelligence (henceforth, AI) can be and, in some countries, are already used to improve public procurement ex-ante and not only ex-post – i.e. not only to detect (and punish) misconduct but also to prevent it. The necessary condition is better data quality and availability.

In the pre-tender stage, machine learning can be used to identify potential suppliers. García Rodríguez et al. (2020) suggests an algorithm that automatically discovers suitable suppliers using Spanish datasets. The validity test shows that the winning company is among firms recommended by the algorithm in 24% to 38% of the public procurement contracts. Being able to attract more suitable competitors is likely to reduce costs. This has been more generally documented by Baranek (2020). He shows that the adoption of an online software solution that helps finding similar procurement contracts , and information about potential suppliers, leads to the choice of higher quality suppliers. This again suggests that applying machine learning algorithms on large procurement contract datasets would likely lead to better public procurement in the European Union.

Finally, already during the tendering stages, machine learning algorithms and AI can be used for early detection of corruption, a future breach of contract, and cost overruns as shown by Gallego et al. (2020) on the public procurement data from Columbia. Again, the accuracy of predictions is

dependent on the quality of underlying datasets. This once more highlights the need for better procurement data that cover more public procurement contracts in the European Union.

4. Conclusion and recommendations

This study identifies a number of gaps in the enforcement and policies regarding transparency in public procurement and it provides case studies based on academic evidence to prove the value added for the public sector and the European citizens' in increasing transparency in public procurement.

Public procurement contracts with a lower value are published voluntarily, published in various national platforms, or not published at all. To ensure availability of public procurement data from the whole European Union, the thresholds for publishing announcements should be lowered and data about all public procurement contracts above the new thresholds should published in the new central public procurement platforms.

Most procuring authorities have to anyway already keep records of the information about below the threshold public procurement in some way. If the records are not currently electronic, it is in any case ideal to start with electronic record keeping as soon as possible. Is a good practice and trend for the public administration in general. Therefore, there should not be large additional costs if all procuring authorities replace various national systems with a unified publication system on the European level. Note that if the procurement platform is linked to other IT systems such as accounting systems (where all spending has to appear), this can be done to some extent automatically and should actually save public officers' work.

The current way of public procurement contracts' publication on the European level (i.e. in the Tenders Electronic Daily – TED) is unsatisfactory. A number of improvements could be made. First, the quality of public procurement data available in TED is very low for a number of member states a no member state achieves a satisfactory quality of the reported data. The number of missing and clearly incorrect values is very high. A quality control system should be established and enforced.

Second, contract notices and contract award notices are not automatically merged. This makes it difficult for anyone to find out for example the final price of a public procurement contract from a contract notice. It is published in two separate files and matching is cumbersome. A new procurement platform should do this automatically. The data from such public procurement platform should be interoperable with other registers such as company registers and registers of politically exposed persons to strengthen the efforts to eliminate inefficiencies caused by fraud, corruption, and other issues on the public procurement market in the Union.

The current dataset are not merged with other datasets such as company registries or other dataset form statistical offices. This prevents to large extent effective control of potential conflicts of interests and other issues as well as simple control of correctness (the example from above of a group of

municipalities procuring services 9,999,999,999.00 EUR, which is significantly more than the GDP of the administrative area, could have been easily discovered automatically using other datasets).

Finally, in the European Union, the current reporting system does not cover the whole procurement process. It would increase transparency and hugely improve opportunities for the public control over public procurement contracts if the information about the ex-post changes to the contracts, the implementation, and the ex-post performance were included.[35]

[35] Previous analyses on the need of open public procurement data reach similar conclusions, see for instance Mendes & Fazekas (2017).

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Appendix

Article 52 of the directive 2014/24/EU

Publication at national level

1. Notices referred to in Articles 48, 49 and 50 and the information contained therein shall not be published at national level before the publication pursuant to Article 51. However, publication may in any event take place at the national level where contracting authorities have not been notified of the publication within 48 hours after confirmation of the receipt of the notice in accordance with Article 51.

2. Notices published at national level shall not contain information other than that contained in the notices dispatched to the Publications Office of the European Union or published on a buyer profile, but shall indicate the date of dispatch of the notice to the Publications Office of the European Union or its publication on the buyer profile.

3. Prior information notices shall not be published on a buyer profile before the dispatch to the Publications Office of the European Union of the notice of their publication in that form. They shall indicate the date of that dispatch.

Annex V of of the directive 2014/24/EU

INFORMATION TO BE INCLUDED IN NOTICES

PART A

Information to be included in notices of the publication of a prior information notice on a buyer profile

1. Name, identification number (where provided for in national legislation), address including NUTS code, telephone, fax number, email and internet address of the contracting authority and, where different, of the service from which additional information may be obtained.
2. Type of contracting authority and main activity exercised.
3. Where appropriate, indication that the contracting authority is a centralised purchasing body; or that any other form of joint procurement is or may be involved.
4. CPV codes.
5. Internet address of the 'buyer profile' (URL).
6. Date of dispatch of the notice of the publication of the prior information notice on the buyer profile.

PART B

Information to be included in prior information notices

(as referred to in Article 48)

I. Information to be included in all cases

1. Name, identification number (where provided for in national legislation), address including NUTS code, telephone, fax number, email and internet address of the contracting authority and, where different, of the service from which additional information may be obtained.
2. Email or internet address at which the procurement documents will be available for unrestricted and full direct access, free of charge.

   Where unrestricted and full direct access, free of charge, is not available for the reasons set out in the second and third subparagraph of Article 53(1), an indication of how the procurement documents can be accessed.
3. Type of contracting authority and main activity exercised.
4. Where appropriate, indication that the contracting authority is a centralised purchasing body or that any other form of joint procurement is or may be involved.
5. CPV codes; where the contract is divided into lots, this information shall be provided for each lot.
6. NUTS code for the main location of works in case of works contracts or NUTS code for the main place of delivery or performance in supply and service contracts; where the contract is divided into lots, this information shall be provided for each lot.
7. Brief description of the procurement: nature and extent of works, nature and quantity or value of supplies, nature and extent of services.
8. Where this notice is not used as a means of calling for competition, estimated date(s) for publication of a contract notice or contract notices in respect of the contract(s) referred to in this prior information notice.
9. Date of dispatch of the notice.
10. Any other relevant information.
11. Indication whether the contract is covered by the GPA.

II. Additional information to be supplied where the notice is used as a means of calling for competition (Article 48(2))

1. A reference to the fact that interested economic operators shall advise the authority of their interest in the contract or contracts.
2. Type of award procedure (restricted procedures, whether or not involving a dynamic purchasing system, or competitive procedures with negotiation).
3. Where appropriate, indication whether:
   (a) a framework agreement is involved,
   (b) a dynamic purchasing system is involved.
4. As far as already known, time-frame for delivery or provision of products, works or services and duration of the contract.

5. As far as already known, conditions for participation, including:

   (a) where appropriate, indication whether the public contract is restricted to sheltered workshops, or whether its execution is restricted to the framework of protected job programmes,

   (b) where appropriate, indication whether the provision of the service is reserved by law, regulation or administrative provision to a particular profession,

   (c) brief description of selection criteria.

6. As far as already known, brief description of criteria to be used for award of the contract.

7. As far as already known, estimated total magnitude for contract(s); where the contract is divided into lots, this information shall be provided for each lot.

8. Time limits for receipt of expressions of interest.

9. Address where expressions of interest shall be transmitted.

10. Language or languages authorised for the presentation of candidatures or tenders.

11. Where appropriate, indication whether:

   (a) electronic submission of tenders or requests to participate will be required/accepted,

   (b) electronic ordering will be used,

   (c) electronic invoicing will be used,

   (d) electronic payment will be accepted.

12. Information whether the contract is related to a project and /or programme financed by Union funds.

13. Name and address of the body responsible for review and, where appropriate, mediation procedures. Precise information concerning time limits for review procedures, or, if need be, the name, address, telephone number, fax number and e-mail address of the service from which this information may be obtained.

PART C

Information to be included in contract notices

(as referred to in Article 49)

1. Name, identification number (where provided for in national legislation), address including NUTS code, telephone, fax number, email and internet address of the contracting authority and, where different, of the service from which additional information may be obtained.

2. Email or internet address at which the procurement documents will be available for unrestricted and full direct access, free of charge.

   Where unrestricted and full direct access, free of charge, is not available for the reasons set out in the second and third subparagraphs of Article 53(1), an indication of how the procurement documents can be accessed.

3. Type of contracting authority and main activity exercised.

4. Where appropriate, indication that the contracting authority is a central purchasing body or that any other form of joint procurement is involved.

5. CPV codes; where the contract is divided into lots, this information shall be provided for each lot.

6. NUTS code for the main location of works in case of works contracts or NUTS code for the main place of delivery or performance in supply and service contracts; where the contract is divided into lots, this information shall be provided for each lot.

7. Description of the procurement: nature and extent of works, nature and quantity or value of supplies, nature and extent of services. Where the contract is divided into lots, this information shall be provided for each lot. Where appropriate, description of any options.

8. Estimated total order of magnitude of contract(s); where the contract is divided into lots, this information shall be provided for each lot.

9. Admission or prohibition of variants.

10. Time-frame for delivery or provision of supplies, works or services and, as far as possible, duration of the contract.

    (a) In the case of a framework agreement, indication of the planned duration of the framework agreement, stating, where appropriate, the reasons for any duration exceeding four years; as far as possible, indication of value or order of magnitude and frequency of contracts to be awarded, number and, where appropriate, proposed maximum number of economic operators to participate.

    (b) In the case of a dynamic purchasing system, indication of the planned duration of that system; as far as possible, indication of value or order of magnitude and frequency of contracts to be awarded.

11. Conditions for participation, including:

    (a) where appropriate, indication whether the public contract is restricted to sheltered workshops, or whether its execution is restricted to the framework of protected job programmes,

    (b) where appropriate, indication whether the provision of the service is reserved by law, regulation or administrative provision to a particular profession; reference to the relevant law, regulation or administrative provision,

    (c) a list and brief description of criteria regarding the personal situation of economic operators that may lead to their exclusion and of selection criteria; minimum level(s) of standards possibly required; indication of required information (self-declarations, documentation).

12. Type of award procedure; where appropriate, reasons for use of an accelerated procedure (in open and restricted procedures and competitive procedures with negotiation);

13. Where appropriate, indication whether:

    (a) a framework agreement is involved,

    (b) a dynamic purchasing system is involved,

(c)an electronic auction is involved (in the event of open or restricted procedures or competitive procedures with negotiation).

14. Where the contract is to be subdivided into lots, indication of the possibility of tendering for one, for several or for all of the lots; indication of any possible limitation of the number of lots that may be awarded to any one tenderer. Where the contract is not subdivided into lots, indication of the reasons therefor, unless this information is provided in the individual report.

15. In the case of a restricted procedure, a competitive procedure with negotiation, a competitive dialogue or an innovation partnership, where recourse is made to the option of reducing the number of candidates to be invited to submit tenders, to negotiate or to engage in dialogue: minimum and, where appropriate, proposed maximum number of candidates and objective criteria to be used to choose the candidates in question.

16. In the case of a competitive procedure with negotiation, a competitive dialogue or an innovation partnership, indication, where appropriate, of recourse to a staged procedure in order gradually to reduce the number of tenders to be negotiated or solutions to be discussed.

17. Where appropriate, particular conditions to which performance of the contract is subject.

18. Criteria to be used for award of the contract or contracts. Except where the most economically advantageous offer is identified on the basis of price alone, criteria representing the most economically advantageous tender as well as their weighting shall be indicated where they do not appear in the specifications or, in the event of a competitive dialogue, in the descriptive document.

19. Time limit for receipt of tenders (open procedures) or requests to participate (restricted procedures, competitive procedures with negotiation, dynamic purchasing systems, competitive dialogues, innovation partnerships).

20. Address to which tenders or requests to participate shall be transmitted.

21. In the case of open procedures:

(a) time frame during which the tenderer must maintain its tender,

(b) date, time and place for the opening of tenders,

(c) persons authorised to be present at such opening.

22. Language or languages in which tenders or requests to participate must be drawn up.

23. Where appropriate, indication whether:

(a) electronic submission of tenders or requests to participate will be accepted,

(b) electronic ordering will be used,

(c) electronic invoicing will be accepted,

(d) electronic payment will be used.

24. Information whether the contract is related to a project and/or programme financed by Union funds.

25. Name and address of the body responsible for review and, where appropriate, mediation procedures. Precise information concerning deadlines for review procedures, or if need be, the

name, address, telephone number, fax number and email address of the service from which this information may be obtained.

26. Date(s) and reference(s) of previous publications in the *Official Journal of the European Union* relevant to the contract(s) advertised in this notice.

27. In the case of recurrent procurement, estimated timing for further notices to be published.

28. Date of dispatch of the notice.

29. Indication whether the contract is covered by the GPA.

30. Any other relevant information.

PART D

Information to be included in contract award notices

(as referred to in Article 50)

1. Name, identification number (where provided for in national legislation), address including NUTS code, telephone, fax number, email and internet address of the contracting authority and, where different, of the service from which additional information may be obtained.

2. Type of contracting authority and main activity exercised.

3. Where appropriate, indication whether the contracting authority is a central purchasing body or that any other form of joint procurement is involved.

4. CPV codes

5. NUTS code for the main location of works in case of works contracts or NUTS code for the main place of delivery or performance in supply and service contracts.

6. Description of the procurement: nature and extent of works, nature and quantity or value of supplies, nature and extent of services. Where the contract is divided into lots, this information shall be provided for each lot. Where appropriate, description of any options.

7. Type of award procedure; in the case of negotiated procedure without prior publication, justification.

8. Where appropriate, indication whether:

   (a) a framework agreement was involved,

   (b) a dynamic purchasing system was involved.

9. Criteria referred to in Article 67 which were used for award of the contract or contracts. Where appropriate, indication whether the holding of an electronic auction was involved (in the event of open or restricted procedures or competitive procedures with negotiation).

10. Date of the conclusion of the contract(s) or of the framework agreement(s) following the decision to award or conclude it/them.

11. Number of tenders received with respect of each award, including:

(a)number of tenders received from economic operators which are small and medium enterprises,

(b) number of tenders received from another Member State or from a third country,

(c) number of tenders received electronically.

12. For each award, name, address including NUTS code, telephone, fax number, email address and internet address of the successful tenderer(s) including

(a) information whether the successful tenderer is small and medium enterprise,

(b)information whether the contract was awarded to a group of economic operators (joint venture, consortium or other).

13. Value of the successful tender (tenders) or the highest tender and lowest tender taken into consideration for the contract award or awards.

14. Where appropriate, for each award, value and proportion of contract likely to be subcontracted to third parties.

15. Information whether the contract is related to a project and /or programme financed by Union funds.

16. Name and address of the body responsible for review and, where appropriate, mediation procedures. Precise information concerning the deadline for review procedures, or if need be, the name, address, telephone number, fax number and email address of the service from which this information may be obtained.

17. Date(s) and reference(s) of previous publications in the *Official Journal of the European Union* relevant to the contract(s) advertised in this notice.

18. Date of dispatch of the notice.

19. Any other relevant information.

(Parts E to J excluded)

Annex VII of of the directive 2014/24/EU

DEFINITION OF CERTAIN TECHNICAL SPECIFICATIONS

For the purposes of this Directive:

(1)‘technical specification’ means one of the following:

(a)in the case of public works contracts the totality of the technical prescriptions contained in particular in the procurement documents, defining the characteristics required of a material, product or supply, so that it fulfils the use for which it is intended by the contracting authority; those characteristics include levels of environmental and climate performance, design for all requirements (including accessibility for disabled persons) and conformity assessment, performance, safety or dimensions, including the procedures concerning quality assurance, terminology, symbols, testing and test methods, packaging, marking and labelling, user

instructions and production processes and methods at any stage of the life cycle of the works; those characteristics also include rules relating to design and costing, the test, inspection and acceptance conditions for works and methods or techniques of construction and all other technical conditions which the contracting authority is in a position to prescribe, under general or specific regulations, in relation to the finished works and to the materials or parts which they involve;

(b) in the case of public supply or service contracts a specification in a document defining the required characteristics of a product or a service, such as quality levels, environmental and climate performance levels, design for all requirements (including accessibility for disabled persons) and conformity assessment, performance, use of the product, safety or dimensions, including requirements relevant to the product as regards the name under which the product is sold, terminology, symbols, testing and test methods, packaging, marking and labelling, user instructions, production processes and methods at any stage of the life cycle of the supply or service and conformity assessment procedures;

(2) 'standard' means a technical specification, adopted by a recognised standardisation body, for repeated or continuous application, with which compliance is not compulsory, and which is one of the following:

(a) 'international standard' means a standard adopted by an international standardisation organisation and made available to the general public,

(b) 'European standard' means a standard adopted by a European standardisation organisation and made available to the general public,

(c) 'national standard' means a standard adopted by a national standardisation organisation and made available to the general public;

(3) 'European Technical Assessment' means the documented assessment of the performance of a construction product, in relation to its essential characteristics, in accordance with the respective European Assessment Document, as defined in point 12 of Article 2 of Regulation (EU) No 305/2011 of the European Parliament and of the Council [1];

(4) 'common technical specification' means a technical specification in the field of ICT laid down in accordance with Articles 13 and 14 of Regulation (EU) 1025/2012;

(5) 'technical reference' means any deliverable produced by European standardisation bodies, other than European standards, according to procedures adapted to the development of market needs.

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[1] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (OJ L 88, 4.4.2011, p. 5).

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