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Green Is Less Greedy

Competition, Corruption, and Productivity in Green Public Procurement in Bulgaria

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Abstract

Although green public procurement has been established as a desirable policy goal across the globe, especially in the European Union, its scope and impacts remain severely understudied. This paper provides insights into the prevalence and structure of green public procurement in Bulgaria, which is a sustainability laggard within the European Union and hence a least likely champion of green public procurement. The paper also estimates the impacts of green procurement on traditional procurement and economic outcomes: competition, corruption risks, and overall productivity. Using novel data and more comprehensive methods than previous studies, the analysis finds that green public procurement amounted to about 10 to 20 percent of total public procurement spending in Bulgaria in 2011–19. Most descriptors and requirements of green public procurement are found in titles, technical requirements, and product descriptions. Green criteria in award criteria texts, which are mainly used for flagging green public procurement in the literature, have been marginal in comparison. Green public procurement is estimated to improve competition for government contracts among firms, for example by increasing the prevalence of market entrants by 3 to 7 percentage points. Green public procurement contracts are also less prone to corruption risks. For example, they are 0.6 to 1.5 percentage points less likely to receive a single bidder. Finally, green public procurement enhances the efficiency of resource allocation in the economy by helping to channel public resources to more productive firms, for example to those that have 14 percent higher labor productivity. This effect is at least in part explained by the positive interaction between green public procurement and the lower risk of corruption. The findings strengthen the case for pursuing green public procurement goals as they offer synergies with traditional public procurement goals.

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Green Is Less Greedy: Competition, Corruption, and Productivity in Green Public Procurement in Bulgaria

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1. Introduction

Public procurement, the highly regulated process through which governments buy goods and services, accounts for about 12 percent of global GDP (about 11 trillion USD) per year (Bosio et al., 2020) or about one-third of general government spending among OECD countries and potentially even more in low- and middle-income countries (OECD, 2019). While traditionally, primary expectations towards public procurement systems have been about value for money, efficiency, economy, and integrity; policy goals expanded in the last 10 years around the globe, in particular in Europe. So-called strategic procurement objectives have been added to the list of expectations, chief among them being sustainability, climate change, and environmental impact (Lundberg & Marklund, 2013; Testa et al., 2016; Grandia & Kruyen, 2020; Adam, Fazekas & Zellmann, 2021). Green public procurement (GPP) is increasingly institutionalized as a policy tool while remaining voluntary within the EU. As mentioned in the EU handbook on green public procurement (2016), most EU countries have formulated GPP National Action Plans. While each of the traditional and strategic procurement objectives is desirable on its own, there might be notable trade-offs and synergies among them, of which policy makers need to be aware. However, there is a particular paucity of evidence on how different policy objectives interact with each other.

In order to fill this gap, this paper

- Estimates the extent and structure of green public procurement
- Analyzes its potential unintended consequences for other public procurement policy objectives, in particular competition, corruption, and efficiency.

To the best of our knowledge, it is one of the first studies to comprehensively measure the prevalence and structure of GPP and its relation to a wide range of public procurement outcomes.

GPP is defined as a process that seeks to procure goods, services, and works with reduced environmental impact throughout their lifecycle. The primary objective of GPP is to purchase environmentally friendly products and services that minimize various environmental impacts. The paper discusses the various options for integrating green considerations into the tendering process and emphasizes the importance of comprehensively analyzing GPP from product descriptions to assessment criteria.

A priori, the relationship between GPP, on the one hand, and competition, corruption and efficiency in public procurement, on the other hand, is not clear. Stricter environmental requirements or standards and the considerable increase in financial resources devoted to green economic activities in EU countries may restrict market entry and promote rent-seeking. At the same time, procurement procedures for green purchases may be under more scrutiny by public officials or attract new firms to participate in public procurement. It is, however, essential to understand to what extent and under which conditions GPP can positively or negatively affect key public procurement outcomes in order to avoid potential negative impacts on the efficiency and quality of procured supplies, services and works.

While the ideal research design would incorporate all European Union (EU) member states; in this research, we limit the analysis to Bulgaria where we have a comprehensive and good quality dataset on public tenders as well as participating companies. Bulgaria can be considered as the least likely case for championing GPP, as the country is particularly challenged in achieving traditional procurement objectives such as competition, integrity, and efficiency (Fazekas et al., 2022). It is one of the poorest and highest corruption risk countries in the EU and is converging to the EU average only very slowly (World Bank, 2022).

The results show that GPP amounted to about 10%-20% of total public procurement spending in Bulgaria in 2011-2019. Most GPP descriptors and requirements are found in titles, technical requirements and product descriptions. Green criteria in award criteria texts, which are mainly used for flagging GPP in the literature, are marginal in comparison. This means that GPP is about what is bought rather than how it is bought; for example, buying electric cars, rather than buying cars by assigning extra scores for lower emissions. Overall, we find that GPP has a beneficial impact on key procurement objectives and the allocative efficiency of resources in the economy. GPP improves competition through encouraging new firm entry and hence lowering the market share of winning suppliers by 3-7 percentage points. Moreover, it also lowered the share of local winners by about 2 percentage points, pointing at a stronger nationwide marketplace. GPP contracts are associated with lower corruption risks, such as lower single bidding probability of 0.6-1.5 percentage points. Finally, GPP contracts are awarded to more productive firms. Among all firms obtaining public procurement contracts, GPP contracts are awarded to firms with 14% higher labor productivity. The productivity effect is even stronger among GPP contracts that have a low risk of corruption: 19% higher labor productivity and 6% higher total factor productivity. The results can either be driven by the more competitive procedures applied to green contracts or by more productive firms being able to better comply with the green criteria and technology requirements. In either case, GPP enhances the allocative efficiency of resources towards more productive firms in the economy.

Our contributions are fourfold. First, we firmly establish that green and sustainability considerations are largely present in what is procured rather than how the winning bidder is selected. Hence, GPP manifests itself largely in buying particular products (e.g., renewable electricity rather than electricity from fossil fuels) and establishing minimum requirements (e.g., organic certified food rather than any kind of food). Second, we show that comprehensively searching for GPP contracts in line with EU green public procurement guidelines yields a high portion of GPP in total public procurement spending (10%-20% annually), even in the EU country with the lowest GDP per capita, Bulgaria. Third, we establish that GPP presents an opportunity to foster competition, integrity and efficiency in public procurement *in addition to* pursuing green and sustainable goals. Buying environmentally friendly products enables new companies to enter the public procurement market, which has the potential to break up “old boy” and potentially corrupt networks. Fourth, the positive relationship between green public procurement and more competitive procurement practices helps in channeling public resources to more productive firms, supporting the economy’s allocative efficiency and thus overall private sector productivity growth.

2. Literature review

2.1 Defining green public procurement

GPP is defined as "a process, whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission, 2008). Scholars have expanded upon this definition, recognizing GPP as a policy tool by encouraging changes in production and consumption patterns towards greener products and services (Lundberg and Marklund, 2013; Cheng et al., 2018).

The primary objective of GPP is to purchase environmentally friendly products and services that minimize various environmental impacts, including deforestation, greenhouse gas emissions, waste, and air, water, and soil pollution (European Commission, 2016). In GPP, contracting authorities make deliberate choices to opt for greener alternatives of goods and services. For instance, instead of procuring a fleet of diesel-powered vehicles, GPP encourages the purchase of electric vehicles to reduce greenhouse gas emissions.

Contracting authorities have two approaches to achieve green objectives. First, they can establish a quantitative outcome, such as limiting the level of carbon emissions that the good, service, or work can produce, leaving it to the supplier to determine the specific means of achieving that outcome (Lundberg and Marklund, 2013). Second, they can prescribe a particular technology, process, system, or material that reduces the environmental impact of the procured goods, services, and works (Grandia and Kruyen, 2020). This would be the case, for example, when procuring wood products sourced from legally harvested and sustainably managed forests or acquiring energy-efficient products.

To align the products, services, and works to be procured with the desired environmental outcomes, contracting authorities have various options to include what we refer to as "green criteria" in the tendering process (Igarashi, de Boer, and Michelsen, 2015; Cheng et al., 2018). Green criteria can be integrated at different stages, including the object of the tender, technical specifications, selection or exclusion criteria, award criteria, and contract performance clauses, regardless of the awarding method (Cheng et al., 2018; Grandia and Kruyen, 2020).

Green criteria can be mandatory or optional, depending on their incorporation into the procurement process (Lundberg et al., 2015). When green considerations are included as the subject of the procurement or as a technical requirement, or as a selection or exclusion criteria, they become mandatory, and suppliers must meet them to participate in the tender process (Igarashi, de Boer, and Michelsen, 2015; Cheng et al., 2018). Suppliers that cannot meet these criteria are not eligible to be considered at the evaluation stage. On the other hand, green aspects can be optional for bidders when incorporated as award criteria, being weighed against price and other quality criteria (Igarashi, de Boer, and Michelsen, 2015; Cheng et al., 2018). In this case, meeting the green criteria increases the likelihood of being awarded the contract. Additionally, green criteria can be included as contract performance clauses, which are mandatory for the post-award stage and encourage suppliers to adapt their production to meet green criteria during the contract implementation (World Bank, 2021).

A comprehensive understanding of the various options for integrating green considerations into the tendering process is critical for accurately identifying GPP (Igarashi, de Boer, and Michelsen, 2015). Focusing solely on one type of green criterion, such as award criteria, or one type of environmental outcome, such as energy efficiency, may underestimate the scope of GPP and overlook other contracts that incorporate different forms of GPP. To fully capture the extent of GPP implementation, it is important to consider the diverse ways it can be integrated throughout the procurement process. Notably, our approach based on a keyword search algorithm is as comprehensive as possible given data limitations; it accounts for green criteria at all stages of the tendering process and capturing quantitative outcomes as well as the use of green technology, processes, or materials.

2.2 GPP adoption

The adoption of GPP as a strategy for environmental sustainability and sustainable development, particularly in the EU, has gained traction, with various countries implementing GPP National Action Plans (Adam, Fazekas, and Zellmann, 2021). However, the extent of GPP adoption varies significantly across European nations, with Denmark, Norway, Sweden, and the UK showing higher prevalence (Cheng et al., 2018). Studies highlight that factors like public buyer type, governance quality, and supply type influence GPP implementation (Michelsen and de Boer, 2009; Testa et al., 2012; Rosell, 2021). The influence of buyer type on GPP adoption tends to show mixed effects, while countries with higher development levels and better governance quality often embrace GPP more extensively. Supply type also appears to affect GPP adoption as it is more likely to be integrated into supplies rather than services or works contracts. Challenges persist, including the perceived higher costs of green products/services and limited awareness among procurement professionals, acting as barriers to GPP adoption (Cheng et al., 2018; Chiappinelli and Seres, 2021).

2.3. Impact of GPP on procurement outcomes and economic growth

This section enumerates diverse arguments around the impacts of GPP on competition, corruption and economic efficiency in order to put forward testable, clear hypotheses.

First, GPP may initially represent an entry barrier, limiting the choices for contracting authorities to a small number of economic operators when the green markets are not mature (European Commission, 2015). However, where a well-established green market exists, GPP can attract the entry of new companies into public procurement (Lundberg and Marklund, 2009). Nonetheless, in the long run, if the incentives for entry into the green market are not sustained, GPP may again have a negative impact on competition by reinforcing the market power of incumbents and deterring market entry.

The design of green requirements or expectations also determines firms' decision to participate in the procurement process (Lundberg et al., 2015). Participation decreases when the requirements become more stringent or less clear. It is assumed that the costs of adjustment are likely to increase with the number, type, and complexity of green requirements, thus reducing participation (Lundberg et al., 2015). In this sense, green requirements that are already met by existing suppliers or green requirements that require lower supplier investments may increase participation. Cheng et al. (2018) predict that the effect of GPP on competition further depends on the characteristics of the suppliers, as some firms may face greater barriers in adapting to green criteria, particularly small and medium-sized firms.

Moreover, the influence of public buyers on overall market dynamics can affect competition in GPP. When a contracting authority lacks market power, firms may refrain from responding to green expectations in tenders (Lundberg, Marklund & Brännlund, 2009). However, when green public procurement demand is high relative to the rest of the product market, GPP can increase competition (Cheng et al., 2018). More broadly, public market share in the total market, the size of the contracting authority, joint procurement, and framework agreements may positively influence the entry of firms into procurement markets that incorporate green requirements. In a dynamic, longer-term perspective, GPP can incentivize the industry to develop green products and services where public purchasers represent a larger share of the total product market (e.g., construction, health services, or transport) (European Commission, 2016).

Taken together, GPP has a conditional and context dependent impact on competition with largely negative competitive impacts in countries with less developed green markets, such as Bulgaria. Hence, we hypothesize:

> *H1: Green public procurement is expected to weaken competition, through limitations to market entry.*

Second, a substantial strand of the public procurement literature focuses on measuring corruption risks, favoritism and rent-seeking in public procurement and identifying its determinants (Williams & Tillipman, 2024). However, little attention has been paid to the threat of corruption due to GPP, even though the introduction of additional, competition restricting requirements in a range of markets has been shown to increase risks (Katona & Fazekas, 2024).

The presence of environmental considerations in procurement creates room for favoritism and corruption through presenting market entry barriers, increasing complexity and ambiguity in tenders. Based on the above discussion, when GPP introduces market entry barriers, corruption risks are expected to increase as organizing and enforcing informal deals among fewer participants are easier. Moreover, the corrupt use of GPP-related entry barriers may additionally favor incumbents and hence strengthen established corrupt networks (for a broader discussion see: Campos et al., 2010).

Environmental considerations related to innovative and unfamiliar technologies make the procurement process more complex and ambiguous (Halonen, 2021; Butler et al., 2022). As a consequence, procurement officials have more discretionary power and room for the corrupt exploitation of complexity and lack of standardization. Such discretionary powers provide the basis for designing restrictive and tailored requirements in tender documents to exclude potential competitors and favor specific tenderers (Lu and Wang, 2022). However, discretion in public procurement does not automatically translate into higher corruption, in high capacity, meritocratic bureaucracies, it may even foster better procurement outcomes (Bosio et al., 2022).

Furthermore, subjective, hard-to-quantify evaluation criteria can be introduced through green considerations, creating an additional margin for manipulating contract award (Fazekas and Kocsis, 2020; Decarolis and Giorgiantonio, 2022). However, recent evidence suggests that the weighting of environmental criteria in awarding contracts remains low in many cases, limiting their influence on firms' behavior (Grandia and Kruyen, 2020).

Uncertainty and ambiguity brought about by new products and business processes can undermine essential considerations for cost-effectiveness and allow for higher extra profits for the corrupt. When pricing is more uncertain, corrupt buyers can collude with firms to push prices unreasonably high, yet claim that no corrupt overpricing took place (Lundberg and Marklund, 2013; Halonen, 2021). Applying these arguments to Bulgaria where corruption is endemic and hence established corrupt networks are likely to take advantage of opportunities presented by GPP, we hypothesize:

> *H2 Green public procurement is expected to increase corruption risks, through enabling more restrictive tendering conditions.*

Third, green considerations in public procurement are expected to impact firm productivity in the short term through at least two channels: selection and investment. Less competitive and higher corruption risk in procurement has been shown to lead to less allocative efficiency and thus lower productivity growth in the economy (Brugués, Brugués and Giambra 2024). Thus, if GPP presents a market entry barrier and increases corruption risks, it can contribute to the selection of less productive firms as suppliers of green products. By contrast, if GPP follows more competitive procurement procedures and practices, it can thus enhance the economy's allocative efficiency by channeling more resources to more productive firms. Moreover, the compliance with green product and process criteria in public procurement contracts may require more sophisticated technology, which may attract more productive firms to compete for green contracts. The relationship between GPP and firm productivity is thus ambiguous, unless the allocation of GPP contracts follows more competitive practices that are less prone to corruption risk. Building on the previous two hypotheses, we hypothesize:

> *H3: If green public procurement is associated with less competition and high corruption risks, it is expected to allocate public resources to less productive firms.*

3. Methodology

3.1 Data

Two public procurement data sources were used for the analysis, following Fazekas et al. (2024). First, all tenders and contracts were collected from the historic national e-procurement portal, AOP (http://www.aop.bg//). Second, all publications from the new national e-procurement portal, EOP (https://app.eop.bg) were collected too. The collection and processing were performed using automated web-scrapers and data cleaning algorithms, in line with the opentender.eu data collection infrastructure (Fazekas et al, 2024). Database building algorithms were adapted to the specificities of the source websites and data repositories. The combined national public procurement dataset includes 148,637 contracts for the period 2011-2019, characterized by 129 variables. Micro-level company data was also matched to the processed public procurement dataset, using standardized company IDs and when those were missing, using company name and address. The details of data collection and processing are outlined in Annex 1.

Measuring the impact of public procurement on private sector growth requires representative firm-level data that can be linked to the procurement transaction data through unique firm identifiers. We thus employ a large firm-level panel dataset with such unique identifiers in Bulgaria from 2010-18 from Orbis which is a commercial database provided by Bureau van Dijk. The data are collected from the national offices of the Registrar of Companies. They include accounting data and information from firms' balance sheets. For Bulgaria, the Orbis data cover all formal firms, independent of their size, in all economic activities apart from agriculture. The effective sample of joint non-missing information for all production function variables in Bulgaria comprises over 4 million firm-year observations, implying almost 500,000 firms per year. We follow the integrated control function approach of De Loecker and Warzynski (2012) to estimate the unbiased measures for the output elasticities of inputs, allowing to compute total factor productivity. We also compute labor productivity as the log of value added per worker. We measure output as real value added. Capital, labor, and intermediate inputs are measured as real fixed tangible assets, the total number of employees, and total material costs. We also account for firms' age and firms and (partially) state-owned enterprises (SOEs).[1] We deflate the nominal variables using detailed 2-digit NACE code producer price indices.

3.2 Identifying green public procurement

Precisely identifying GPP in all its diverse forms is a key goal of this paper, which is challenging on its own. The above GPP definition encompasses a range of products, processes and considerations. It can relate to climate and sustainability goals solely; or more broadly, focusing on energy efficiency improvements, sustainable waste management or emission control, and waste and pollution reduction. Many of these considerations became part of public procurement markets long before GPP goals rose to the fore. For example, energy efficiency improvements are framed as an environmental consideration as part of GPP, yet they were pursued on purely cost-saving grounds for a very long time. In this sense, some of the GPP products we identify are not necessarily new but reclassified as being part of GPP and hence receiving far larger budget

[1] We create a dummy variable for SOEs if the state owns at least 10 percent of the firm through direct or indirect ownership resulting from the investments of SOEs in private firms.

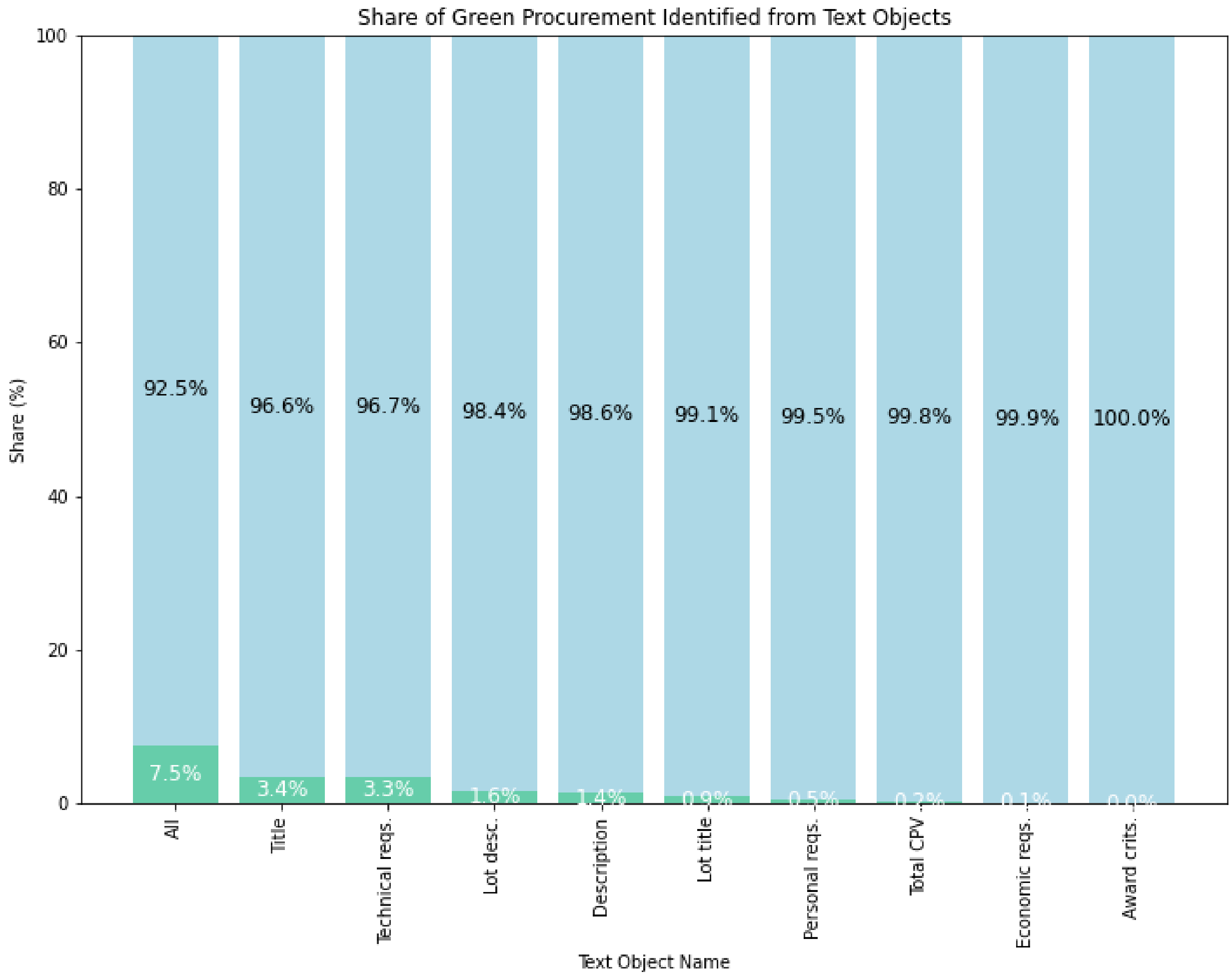
allocations and public interest. Yet, most GPP we identify are genuinely novel (e.g., solar panels) or modified products (e.g., electric vehicles).

To identify diverse GPP tenders and contracts, we apply the following algorithm. First, we use keyword-based matching on the tenders' text fields. The keywords were identified based on the relevant literature and consultations with World Bank public procurement specialists. Second, we use the standardized Common Procurement Vocabulary[2] (CPV) product classification codes to supplement the keyword method, by pointing at predominantly green-oriented products such as solar panels or electric vehicles. The full list of the keywords and CPV codes can be found in Annex 4. The output of such a matching algorithm is a binary variable indicating whether a procurement is green or not. It identifies around 6,500 GPP tenders and 11,000 green contracts (all contracts awarded for GPPs) between 2011 and 2019 in Bulgaria.

To show the added-value of looking for green considerations in a range of procurement documents and text fields (e.g., title, technical requirements), Figure 1 depicts the distribution of identified green contracts according to text field type and product codes. The figure establishes that green procurement accounts for 7.5 percent of the total number of contracts awarded. The majority of matches with relevant keywords are found in the procurement title and technical requirements. It is worth noting that the share of GPP matches in the award/assessment criteria is relatively low, which is attributed to award criteria data quality rather than the absence of relevant keywords. Notably, while the prevalent method for identifying GPP in the literature is through CPV codes, in the case of Bulgaria, the share of GPP contracts identified using CPVs is less than 0.5 percent, highlighting the advantage of using our more comprehensive approach.

[2] For details see: https://single-market-economy.ec.europa.eu/single-market/public-procurement/digital-procurement/common-procurement-vocabulary_en.

Figure 1: Share of GPP identified in text description of procurement and CPVs, Bulgaria, 2011-201



To the best of our knowledge, this combined keyword and product code-based search method is novel and more comprehensive than other methods in the literature. Nevertheless, it remains very difficult to precisely identify GPP contracts based on the high-level definitions and guidelines by the EU. The approach adopted in this paper certainly leads to a lower bound estimate of GPP prevalence.

3.3 Measuring procurement and firm outcomes

As the paper looks to identify the impact of GPP on a range of outcomes, this section defines the indicators used to measure public procurement competition, corruption risks and company productivity.

In order to assess competition in public procurement from different angles, we followed a recent literature review (Adam, Sanchez & Fazekas, 2021) and calculated four indicators:

- **Number of bids.** The number of bids submitted (capped at 15 bids) in a tender (by lot if there are multiple lots) is the most straightforward, most widely used indicator of competition in procurement auctions. More bidders indicate stronger competition.
- **Local supplier.** When the winning bidder is local, it suggests that competition was restricted to a smaller set of bidders hailing from the locality of the buyer.[3] The local indicator takes the value of "1" when the supplier and buyer are from the same location (measured at NUTS 3 level), and "0" otherwise.
- **Winning share.** High market shares of selected suppliers may indicate that there is insufficient competition on a market leaving dominant players unchallenged. Hence, the winning share indicator is calculated as a share of the number of contracts won by suppliers within a year on the same market (market defined at 2-digit CPV).
- **New firm.** We directly measure the entry of new firms into the market, tracking H1 and its underlying mechanisms. When a market entrant wins a government contract, we assess that competition was better. The indicator new firm takes the value 1 when the supplier did not win a contract in any of the previous years. The market was defined as 2-digit CPV.

To evaluate the overall level of competition, we developed a composite competition indicator that combines the four individual competition indicators: the number of bids, local supplier, winning share, and new firm. The composite indicator is the simple arithmetic average of these four indicators after standardizing them so that they fall in the 0-1 range with higher values indicating stronger competition. To standardize the indicators, we make sure they all have the same direction (e.g. higher value means more competition) and rescale them to 0-1 range. The standardization formula used here is standardized_value=value-min/max-min. This rescales the values so that the minimum is 0 and the maximum is 1.

To approximate high level corruption in public procurement, that is the deliberate restriction of open competition benefitting a connected bidder, we develop two proxy indicators. The first one is rather simple: single bidding. which takes the value of 1 when only 1 bid was submitted for a tender-lot 0 otherwise. It captures the high-risk situation where all potential competitors but one was excluded or deterred from the tender. The second corruption risk indicator is a composite score which considers not only single bidding but a range of other risk factors hence aiming to minimize false positives coming from using single bidding on its own. The composite score is called the Corruption Risk Indicator (CRI) and it represents the arithmetic average of the validated individual risk indicators: single bidding, non-publication of call for tenders, non-open procedure types, suspiciously short advertisement period, suspiciously short decision period, and buyer's dependence on supplier (the definition of individual red flags can be found in Annex 5). The CRI is a risk indicator that identifies public procurement practices for which corruption

[3] Please note that the prevalence of local suppliers naturally varies across sectors and product markets, for example depending on transportation costs. This does not bias our use of this indicator as the models will control for economic sector, allowing us to make comparisons between green and non-green contracts within sectors.

tends to happen more often, however, it does not point at corruption definitely. It allows for consistent comparisons across time, sectors, regions, and organizations and can be further expanded and related to using additional corruption proxies. For the ease of interpretation, CRI is calculated on the contract level after each individual risk indicator is standardized to 0: non-risky and 1-risky (sometimes an intermediate risk level is added, 0.5). Hence, CRI falls between 0 and 1, with 1 representing the highest observed corruption risk and 0 the lowest.

We match the unique identifiers of all firms awarded with any type of public procurement contract with the same identifiers in the firm administrative dataset. The combined dataset allows to estimate if GPP contracts are allocated to more or less productive firms. First, we estimate if firms awarded with green public procurement contracts are more productive than firms with a comparable size, age, and ownership structure competing in the same 4-digit sector but not awarded with a state contract. We estimate if the productivity differential changes for GPP contracts carrying a lower risk of corruption. Second, we restrict the sample to firms that obtained a public procurement contract to estimate if GPP contracts are more often allocated to more productive firms than other state contracts. We also estimate the impact of corruption risk in public procurement on the productivity of the awarded firm and the interaction effect between green and corruption-risk contracts.

3.4 Identifying the impact of green procurement on procurement and firm outcomes

Identifying the causal impact of green procurement on public procurement and firm outcomes, thus testing our hypotheses, is challenging due to reverse causality, omitted variable bias and sample selection. We discuss each of them in detail offering our best strategy for reliable and robust estimation.

First, reverse causality arises where government entities implement GPP in response to a competitive market environment in order to stimulate innovation, attract environmentally conscious suppliers, or improve public perception. In other words, competitive markets would cause the choice of GPP rather than the other way around. We consider this scenario unlikely as GPP is mainly driven by exogenous influences deriving from EU Directives and national sustainability policies and budget allocations.

The second challenge is omitted variable bias, as numerous factors beyond green procurement may influence the level of competition. To mitigate this bias, we employ two methodological approaches: regressions on a matched sample (double robust regression) and fixed effects regression models. First, in order to apply matching we used Coarsened Exact Matching (CEM) methods which groups contracts based on observed covariates and pairs green and non-green contracts achieving a high degree of similarity across the two groups and hence minimizing confounding due to observed covariates (Iacus et al, 2012). The covariates used for matching are

- Buyer type (e.g., central government body, regional/local entity)
- Contract type (goods/works/services)
- Product market (2-digit CPV code)
- Buyer location (NUTS3)
- Supplier location (NUTS3)
- Tender year.

In the second step, we run regression models on the matched samples, including control variables:

- Contract value (categorized as deciles)
- Buyer size: total value of contracts awarded annually.

Individually and taken together, these control variables account for observable contract and organization characteristics that are likely to impact public procurement outcomes such as competition and corruption risks, but also on the use of GPP. For example, green contracts may be more frequent in larger markets where suppliers may also face more bidders. Such market characteristics are accounted for by including buyer and supplier location, buyer size and product market category. Similarly, larger tenders may be more amenable to green procurement as they are able to absorb higher investment costs of using new technologies. This is controlled for by including contract value in the regressions.

The comprehensive information on public procurement transaction data in Bulgaria is thus critical to identify the impact of green public procurement on procurement and firm outcomes.

The second modeling approach tackling challenges to causal identification we deployed is interacted fixed effects - market * year - regressions on the contract level, including the same set of control variables as for matching. The extensive set of fixed effects are designed to capture a wide range of unobserved variables, in addition to controlling for observable confounders. In essence, the fixed effects regressions allow us to identify the impacts of GPP in very narrowly defined spaces, within any particular combination of market-years. By implication, our impact estimates should be interpreted as within market changes while also controlling for any time-dependent external shocks. Looking at matched regressions and fixed effects regressions in tandem allows us to put forward complementary solutions to identifying casual effects. The matching allows for a tighter comparison on observables while the fixed effects regressions account for a variety of unobservable effects. If both modeling approaches lead to the same substantive conclusions, we can draw robust conclusions regarding our hypotheses.

The third challenge to drawing generalizable and robust conclusions regarding our hypotheses lies in potential selection bias; that is the sample used for the analysis may not accurately represent the entire population of interest. To address this, we use data from the whole population of published government contracts in Bulgaria from 2011 to 2019. We carefully identify green procurement contracts within this dataset through both market CPVs and tender text searches. Both green procurement contracts and the remaining Bulgarian public procurement contracts are expected to adequately represent the total population of contracts during this period, with the exception of small value contracts below mandatory reporting thresholds.

The relation between GPP and firm productivity

As with other types of public procurement contracts, the relation between GPP and firm productivity can be subject to reversed causality. For example, a positive relation can either be driven by more competitive procedures applied to green contracts, or by attracting more productive firms with more sophisticated technology or management practices to bid since they are able to better comply with the green criteria and technology requirements. Irrespective of the direction of causality, however, a positive relation implies that public procurement allocates resources to more productive firms improving the allocative efficiency of resources among firms in the economy which contributes to private sector productivity growth.

Arguments against the allocative efficiency result would thus need to be based on an omitted variable bias in that unobservable factors need to exist that are correlated with more productive firms being awarded GPP contracts for reasons other than those firms' productivity drivers such as their technology or management. One such factor may be the application of more or less competitive procurement practices. In contrast to most previous studies, however, the combined firm-public procurement dataset allows to observe the degree of competition and corruption risk in the applied (green) public procurement procedures. As it will be shown later, we find that GPP is associated not only with higher firm productivity but also with the application of more competitive procurement practices in Bulgaria. Moreover, the lower the corruption risk of the awarded GPP contracts is, the stronger the positive GPP-productivity nexus is. This suggests that green public procurement contributes to the allocative efficiency of resources in the economy—also attracting more productive firms to bid for state contracts independent of the applied procurement practices would further strengthen the allocative efficiency channel.

Notably, the rich data allow us to further restrict the productivity comparison to the subset of firms awarded with (any type of) public procurement contracts. We can thus assess if firms awarded GPP contracts are more productive than firms awarded non-GPP contracts that operate in the same 4-digit sector and have comparable characteristics such as size, age, and ownership structures. The only difference is thus that the treated firms' contracts include green procurement criteria while control firms' contracts do not. One would thus need to reason that an omitted factor correlated with firm productivity and green criteria in public contracts exists, other than the applied procurement practices or the awarded firms' (or sectors') characteristics including their technology or management quality. We argue that this is unreasonable, and, hence, that GPP improves the allocative efficiency of resources raising economic growth, either by resulting in the application of more competitive procurement practices or by attracting more productive firms to bid for state contracts.

Taken together, we make use of a wide range of theoretically sound dependent variables and methodologically robust modeling approaches to investigate the impacts of green public procurement. While none of these methods are perfect on their own, taken together they can point at likely causal relationships.

4. Results

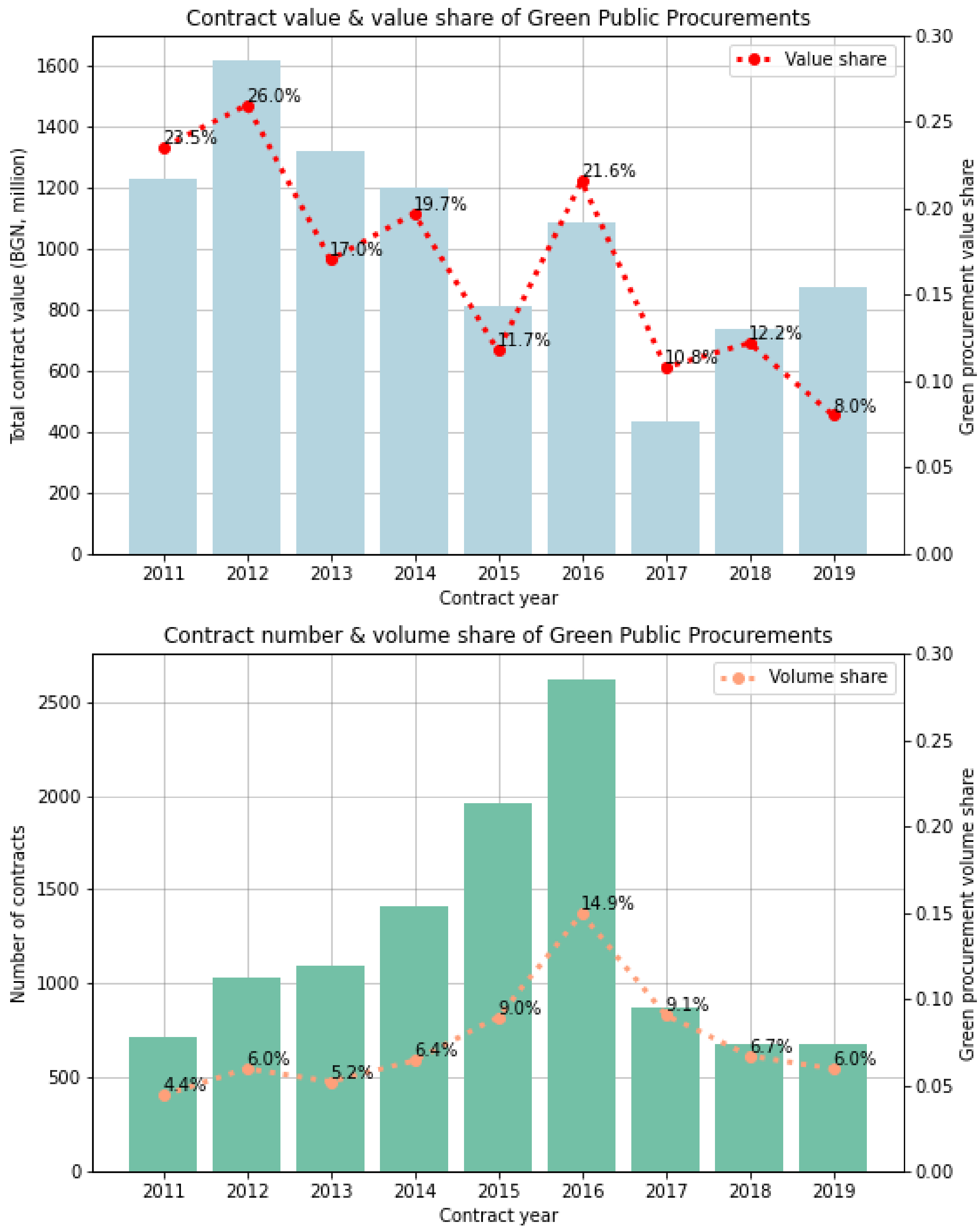
4.1. Scope and distribution of green procurement

Given the paucity of evidence on the scope and distribution of green procurement, especially in Bulgaria, which is considered an EU laggard in this domain, we first enumerate basic descriptive facts. This section underpins the claims that GPP is surprisingly large in Bulgaria and that green considerations are predominantly present in product descriptions rather than assessment criteria, contrary to the focus of previous research.

The value of GPP as a share of total public procurement spending ranged between 26% and 8% throughout 2011-2019 in Bulgaria (Figure 2). GPP spending share was closer to 20% throughout 2011-2016, while there was a notable drop to about 10% in the 2017-2019 period. Any of these prevalence figures are considerably higher than prior estimates using assessment criteria only for identifying GPP (compared with for example: Badell & Rosell (2021) who find GPP adoption in the EU between 3% and 8% throughout 2009-2019).

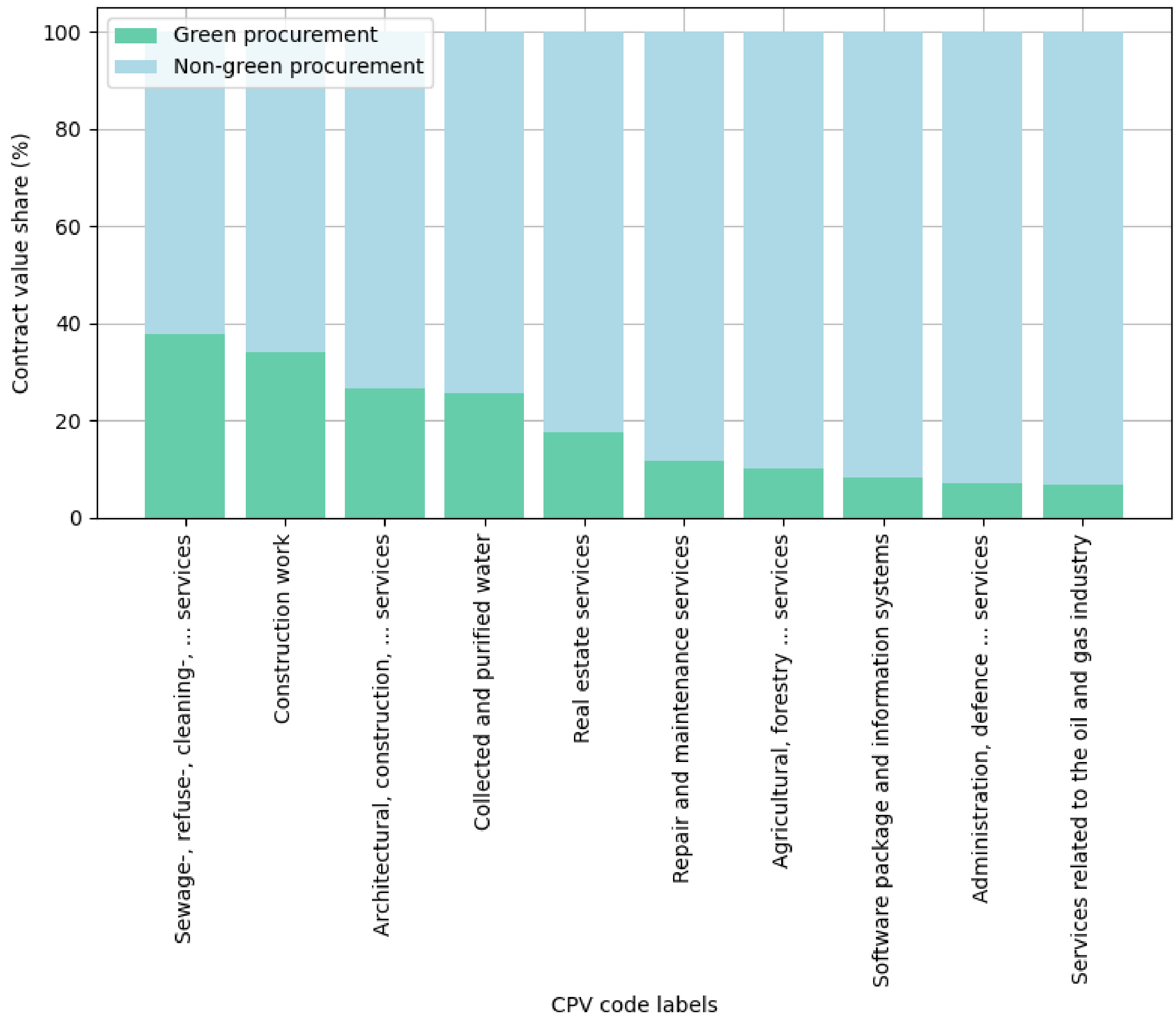
In contrast to total GPP spending, the share of green contracts in the total number of contracts (i.e. volume share) is considerably lower, ranging between 4% and 15%. This suggests that green contracts tend to be larger than average. Nevertheless, we also observe a drop in green contract numbers following 2016.

Figure 2: Yearly contract value and volume distribution of Green Public Procurements, Bulgaria, 2011-2019



The annual average figures, however, mask a wide variation in GPP across sectors. Figure 3 shows the CPV sector divisions that have the highest share of GPP spending. Not surprisingly, the highest value share, around 38 percent, can be attributed to the “Sewage-, refuse-, cleaning-, and environmental services” division followed by “Construction work” (around 28%) and “Collected and purified water” (24%). Nonetheless, the majority of markets have a much smaller share of GPPs, as shown by the fact that the share of GPPs below the top 5 sectors is less than 10 percent.

Figure 3: Contract value share of top 10 CPV sectors with Green Public Procurement contracts, Bulgaria, 2011-2019



4.2. Green public procurement and competition in public procurement

To examine the impact of GPP on competition, we separately report the regressions for the four individual competition indicators (number of bids, local winner, winning share, and new firm) as well as the composite competition indicator created out of them. We first show the double robust regressions on matched samples and then those on the interacted fixed effects regressions (year*market).

The regression results on the matched sample strongly, albeit not unequivocally, contradict hypothesis H1 (Table 1). The prevalence of local suppliers goes down by 2.4 percentage points and the market share of the winner also declines by 6% with GPP. The prevalence of new, market entrant firms goes up with GPP by 7 percentage points. We find a small, insignificant impact on the number of bidders. Taken together, there is a strong and statistically significant increase in overall competition.

Table 1. GPP impact on competition: Regression results on the matched sample, Bulgaria, 2011-2019

Regression results (years 2011-2019), matched samples

	Dependent variable:				
	n of bids	local	winning share	new firm	competition indicator
	ols	*logistic*	*ols*	*logistic*	*ols*
	(1)	(2)	(3)	(4)	(5)
Green procurement	0.003	-0.024***	-0.056***	0.071***	0.067***
	(0.040)	(0.005)	(0.003)	(0.024)	(0.002)
Constant	3.725***	0.822***	0.349***	-0.041	0.378***
	(0.046)	(0.006)	(0.004)	(0.027)	(0.002)
Observations	65,489	65,489	65,489	65,489	65,489
R^2	0.004		0.012		0.033
Adjusted R^2	0.003		0.012		0.033
Log Likelihood		-35,756.340		-44,731.200	
Akaike Inf. Crit.		71,538.670		89,488.400	
Residual Std. Error (df = 65476)	3.457		0.288		0.169
F Statistic (df = 12; 65476)	19.900***		65.021***		187.889***

Note: *p<0.1; **p<0.05; ***p<0.01
Controls added: contract size, buyer size (cat)

The results from our alternative specification using interacted fixed effects reveal a largely similar picture (Table 2). GPP improves competition, albeit effect sizes and significance levels vary. Notably, the number of bids is predicted to significantly and substantially increase, by 0.14 additional bidder, in the Year*Market FE model, while the effect is small and insignificant on the matched sample. Furthermore, GPP's impact on local winner turns insignificant and small. These differences suggest that the impact of the number of bids and local suppliers on GPP might be sensitive to the particular control group in question. This might indicate considerable unobserved heterogeneity in non-GPP contracts. Effect sizes, albeit remaining significant, are smaller for winner market share and new firms. As a result of these individual differences, the estimated GPP impact on the composite competition indicator is considerably smaller, while remaining significant.

Table 2. GPP impact on competition: FE regression results, Bulgaria, 2011-2019

Regression results (years 2011-2019); Year*Market FE

	Dependent variable:				
	n of bids	local	winning share	new firm	competition indicator
	ols	*logistic*	*ols*	*logistic*	*ols*
	(1)	(2)	(3)	(4)	(5)
Green procurement	0.144***	0.003	-0.010***	0.0345***	0.015***
	(0.032)	(0.035)	(0.002)	(0.027)	(0.002)
Constant	0.550	-22.765	0.317	3.338	0.895***
	(2.921)	(2,469.772)	(0.220)	(3,965.354)	(0.154)
Observations	122,710	122,710	122,710	122,710	122,710
R^2	0.204		0.464		0.320
Adjusted R^2	0.200		0.461		0.316
Log Likelihood		-43,754.100		-62,208.090	
Akaike Inf. Crit.		88,776.200		125,684.200	
Residual Std. Error (df = 122076)	2.802		0.212		0.148
F Statistic (df = 633; 122076)	49.346***		166.819***		90.737***
Note:	*p<0.1; **p<0.05; ***p<0.01				
	Included controls not shown are: Buyer location, Buyer type, Supl. location, Contract type, Year FE*Market FE, Contract value deciles,				

Overall, the findings suggest that competition increases with GPP through a series of intertwined mechanisms. GPP typically implies the purchase of novel products (e.g. solar panels) or established products with novel features (cars with electric engines). Hence, GPP requires novel skills and capacities which are often not available among the established suppliers, making market entry and the participation of firms beyond the buyer's locality imperative. These new entrants do not typically gain a monopoly position in the market and are more likely to engage in competition with multiple firms compared to non-green tenders. While the number of bids may go up, it is not necessarily the case. As new products are purchased some competitors may be driven out of the market making the net effect of GPP on bidder numbers null. In some of these markets, the availability of suppliers capable of providing green products remains limited, highlighting the need for market building.

4.3. Green public procurement and corruption risks

To assess the impact of GPP on corruption risks, two dependent variables were used in the same regression set-ups as before: the binary single bidding indicator and the composite Corruption Risk Index (CRI). Both models consistently demonstrate the same direction of coefficients and significance, albeit with slight variation in coefficient values. On average, both CRI and single bidding rates decrease as a result of GPP. Specifically, GPP tends to reduce CRI by 0.07 in the matched sample regression and by 0.04 in the Year*Market FE regression. Furthermore, the prevalence of single bidding decreases by 1.5 and 0.6 percent point respectively, in the presence of green public procurement (Table 3 and Table 4).

Table 3. Results of the regression analysis (matched samples) for Green Public Procurements, Bulgaria, 2011-2019

Regression results (years 2011-2019), matched samples

	Dependent variable:	
	cri	singleb
	ols	*logistic*
	(1)	(2)
Green procurement	-0.069^{***}	-0.015^{***}
	(0.003)	(0.005)
Constant	0.396^{***}	0.438^{***}
	(0.004)	(0.006)
Observations	65,489	65,489
R^2	0.018	
Adjusted R^2	0.018	
Log Likelihood		-43,842.600
Akaike Inf. Crit.		87,711.210
Residual Std. Error	0.264 (df = 65476)	
F Statistic	101.816^{***} (df = 12; 65476)	
Note:	*p<0.1; **p<0.05; ***p<0.01	
	Contract type, procedure type, buyer size (cat)	

Table 4. Results of the FE regression analysis for Green Public Procurements, Bulgaria, 2011-2019

Regression results (years 2011-2019); Year*Market FE

	Dependent variable:	
	cri	singleb
	ols	*logistic*
	(1)	(2)
Green procurement	-0.040***	-0.0057***
	(0.002)	(0.005)
Constant	0.993***	1.383***
	(0.202)	(0.453)
Observations	122,710	122,710
R^2	0.434	
Adjusted R^2	0.431	
Log Likelihood		-71,478.370
Akaike Inf. Crit.		144,224.700
Residual Std. Error	0.194 (df = 122076)	
F Statistic	148.134*** (df = 633; 122076)	
Note:	*p<0.1; **p<0.05; ***p<0.01	
	Included controls not shown are: Buyer location, Buyer type, Supl. location, Contract type, Year FE*Market FE, Contract value deciles	

Contradicting H2, our models point at GPP decreasing corruption risks rather than increasing them. In addition, considering the relationship between competition and corruption risks, especially single bidding, we find a consistent story: GPP strengthens competition and through that also decreases corruption risks. This indicates that companies entering public procurement due to GPP make corruption less likely while also weakening incumbents' market power.

4.4. Green public procurement and firm productivity

The combined firm and public procurement administrative dataset allows to estimate if GPP contracts are allocated to more or less productive firms. First, we estimate if firms awarded with green procurement contracts are more productive than firms with a comparable size, age, and ownership structure competing in the same 4-digit sector but not awarded with a contract. We also test whether the strength of that relation depends on corruption risks involved in GPP practices.

Table 5 shows that firms awarded public procurement contracts in Bulgaria are more productive, suggesting that, overall, state contracts channel public resources to more productive firms (columns 1 and 4). Similarly, firms awarded GPP contracts have a higher

TFP and labor productivity than privately-owned firms which operate in the same 4-digit sector and have a comparable firm size and age, but did not obtain a public procurement contract (columns 2 and 5). Importantly, firms awarded GPP contracts with a high risk of corruption—for which at least 3 of the 6 indicators for uncompetitive procurement practices apply—are not more productive in terms of TFP than their same-sector competitors (column 3). In other words, GPP is associated with higher TFP and labor productivity only if corruption risks in the awarded contracts are low to moderate. The results imply that the impact of green procurement in reducing corruption risk in public contracts supports the allocative efficiency in the economy by channeling resources to more productive private sector firms.

Table 5. Productivity differentials between firms awarded with public procurement contracts and their same-sector competitors.

	Dependent variable:					
	TFP	TFP	TFP	VA/L	VA/L	VA/L
	ols	ols	ols	ols	ols	ols
	(1)	(2)	(3)	(4)	(5)	(6)
PP dummy	.124**			.448**		
	(8.00)			(12.7)		
GPP dummy		.167**	.186**		.433**	.464**
		(4.42)	(5.47)		(10.8)	(11.5)
CRI mean			.098**			.051**
			(6.70)			(11.1)
GPP dummy *			-.258**			-.655**
CRI>0.5			(-2.86)			(-5.42)
4-digit sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Size, Age, SOE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.740	0.739	0.740	0.370	0.369	0.370
Adjustd R2	0.740	0.739	0.739	0.369	0.368	0.368
Obs total	780,653	780,653	780,653	1,439,689	1,439,689	1,439,689

Source: Firm census panel data from 2010-2018 matched with public procurement transaction data. *Note*:

Second, we restrict the sample only to firms that obtained (any type of) public procurement contracts to estimate if GPP contracts are more often allocated to more productive firms than non-GPP contracts. Again, we test if that relation depends on the corruption risk involved in awarded GPP and other contracts.

Table 6 shows that firms awarded GPP contracts tend to be more productive than same sector, fully privately-owned firms with a comparable size and age that did not obtain any GPP contract (columns 1 and 5). The positive relation between GPP and firm productivity is stronger and significant at conventional levels for both productivity measures (TFP and labor productivity) when GPP carry a low risk of corruption (columns 2 and 4); that is, firms awarded with low corruption-risk GPP contracts have on average a 5.9 percent higher TFP and a 19 percent higher labor productivity.

The results are similar when we use the share of GPP contract values in firms' total public procurement income as a measure of GPP. Specifically, firms with a higher share of GPP in their total public contract value have a higher labor productivity than fully privately-owned firms awarded with non-GPP contracts that operate in the same sector and have a comparable firm size and age.

Taken together, the findings suggest that GPP enhances the efficiency of resource allocation in the economy by helping to channel public resources to more productive firms relative to same sector competitors. Consistent with H3, at least a significant part of this effect is explained by the positive interaction between GPP and the lower risk of corruption. In other words, the positive impact of GPP on the application of more competitive public procurement practices in Bulgaria helps allocating public resources to more productive firms relative to competing firms offering the same product (i.e., that operate within the same 4-digit sector).

Table 6. The relation between green procurement, corruption risk in procurement, and firm productivity among firms awarded with public procurement contracts.

	Dependent variable:							
	TFP	TFP	TFP	TFP	VA/L	VA/L	VA/L	VA/L
	ols	ols	Ols	ols	ols	ols	ols	ols
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GPP dummy	.048	.059**			.145**	.190**		
	(1.51)	(2.37)			(3.33)	(4.91)		
CRI mean		-.012				.092**		
		(-0.48)				(3.85)		
GPP dummy *		-.119				-.251**		
CRI>0.5		(-1.39)				(-2.34)		
GPP share			.023	.038			.090	.145**
			(0.66)	(1.32)			(1.53)	(2.77)
CRI mean				-.012				.086**
				(-0.96)				(3.65)
GPP share *				-.118				-.284**
CRI>0.5				(-1.36)				(-2.37)
4-digit sec FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size, Age, SOE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.813	0.813	0.812	0.812	0.537	0.538	0.535	0.535
Adjustd R2	0.810	0.810	0.810	0.810	0.530	0.531	0.528	0.528
Obs total	22,137	22,137	20,831	20,831	26,618	26,618	24,991	24,991

Source: Firm census panel data from 2010-2018 matched with public procurement transaction data. *Note*:

5. Conclusions and policy implications

We set out to offer a more comprehensive estimation for the prevalence and structure of green public procurement (GPP) in Bulgaria and to assess its impacts on traditional procurement and economic outcomes such as competition, corruption risks and productivity. Using novel data and methods we find surprising results in a country context where GPP is less expected to be widespread and have beneficial wider economic impacts.

The results show, surprisingly, that GPP amounts to about 10%-20% of total public procurement spending in Bulgaria in 2011-2019. GPP can be identified through keyword searches in titles, technical requirements and product descriptions. Green criteria in award criteria texts, which is the main criteria in the literature, lead to a considerable under-estimation of GPP. Our second surprise has been that GPP is found to have a small, but overwhelmingly beneficial impact on primary procurement and economic objectives. GPP improves competition, through encouraging new firm entry, especially those not hailing from the buyer's locality. However, new firms entering through GPP do not become monopolists as their market share will remain low and the number of competitors likely goes up. Furthermore, GPP contracts are linked to lower corruption risks, such as lower single bidding probability and more open procedure types. Finally, GPP leads to the selection of more productive firms, especially when GPP contracts were awarded through lower corruption risk tenders.

Our analysis, while comprehensive and using advanced methods, faced limitations. GPP is rarely introduced in isolation, making it difficult to assess its individual effects on procurement and economic outcomes. GPP can interact with other sustainable policies, such as environmental regulations or social criteria used in the bidding process. The simultaneous implementation of these measures makes it challenging to identify its effects in public procurement, but especially in the wider economy.

Nevertheless, our findings point at clear policy lessons. GPP should be more vigorously pursued, even in the least welcoming contexts. GPP has positive spillover effects, hence pursuing GPP will improve traditional public procurement and economic outcomes. More GPP should help improve competition, lower corruption risks, and improve productivity in the economy. In the longer term, sustained and predictable investments in GPP could also contribute to market building and bring about even larger benefits.

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Annex 1: Public procurement data

Main data processing steps

First, all publications describing a tendering process were scraped (Annex 2 details the list of the publication types for the two national data sources downloaded and processed). Second, the relevant fields of each publication were cleaned and parsed into a standardized, structured dataset.[4]

One tender is described by multiple publications, for example, it usually has a call for tenders (or contract notice) and a contract award document, but sometimes also a modification, cancellation, or contract implementation notice. All the relevant publications are grouped together by their tender IDs (nnnnn-yyyy-xxxx).

Once all publications of a tender are grouped together, a 'mastered' record for each tender is created with the aim of storing the values of each tender detail that can be regarded as the best estimation of the actual tender implementation. For example, CPV codes or the buyer names are published usually in more than one publication, hence only one of the values is kept so that there is one clean buyer name, one clean set of CPV codes, and so on, related to each tender.

As tenders can award one or more contracts, each contract needs to be stored as a separate observation. This can be a complex problem as multi-lot tenders—that set out to conclude multiple contracts by design—announce multiple lots in the call for tenders documents which eventually do not necessarily overlap with the number of concluded contracts, that is, the details of the competition that are in the call cannot be clearly linked to each contract as one contract covers multiple lots. Framework agreements are another exception, as they are first 'pre-awarded' to companies and then the follow-up award (or contract implementation) publications set out the details of the actual contracts.

Once the dataset is compiled, it goes through several stages of filtering, that is, selecting the observations relevant for the analysis. There are two main selection criteria: (a) contracts that are awarded and most likely lead to actual spending of public funds and (b) records with high-enough quality of information for analysis. The observations are filtered by removing records with missing bidder name, missing buyer name, cancelled lots, and non-awarded parts of framework agreements. As a result of filtering, the final, **contract-level** dataset has 220,000 (with 144,000 between 2011 and 2019) observations. This number was reduced from the initial 538,000 observations, most of which had missing bidder names due to contract cancellation, non-awarded part of framework agreement, and so on. For 2011–2019, the dataset has 20,438 unique bidders and 4,982 unique buyers, based on BvD ID.

A current key issue is related to the observations of 2020. First of all, the first half of 2020 is not scraped. Additionally, some publication types in 2020–2021 are not adequately processed. Therefore, current figures show distribution in the time frame of 2011–2019.

To visualize and track annual and quarterly distributions of outcome variables, 'year' and 'month' variables were also created. The main date variable based on which year and month were identified is the award

[4] We use the DIGIWHIST data standard that was specifically developed for storing information on public procurement contracts from Europe: https://docs.google.com/spreadsheets/d/13pGIpt47sMBnZ68E-N-hMLiErpDB1CQwZzd2MXIlq5U/edit.

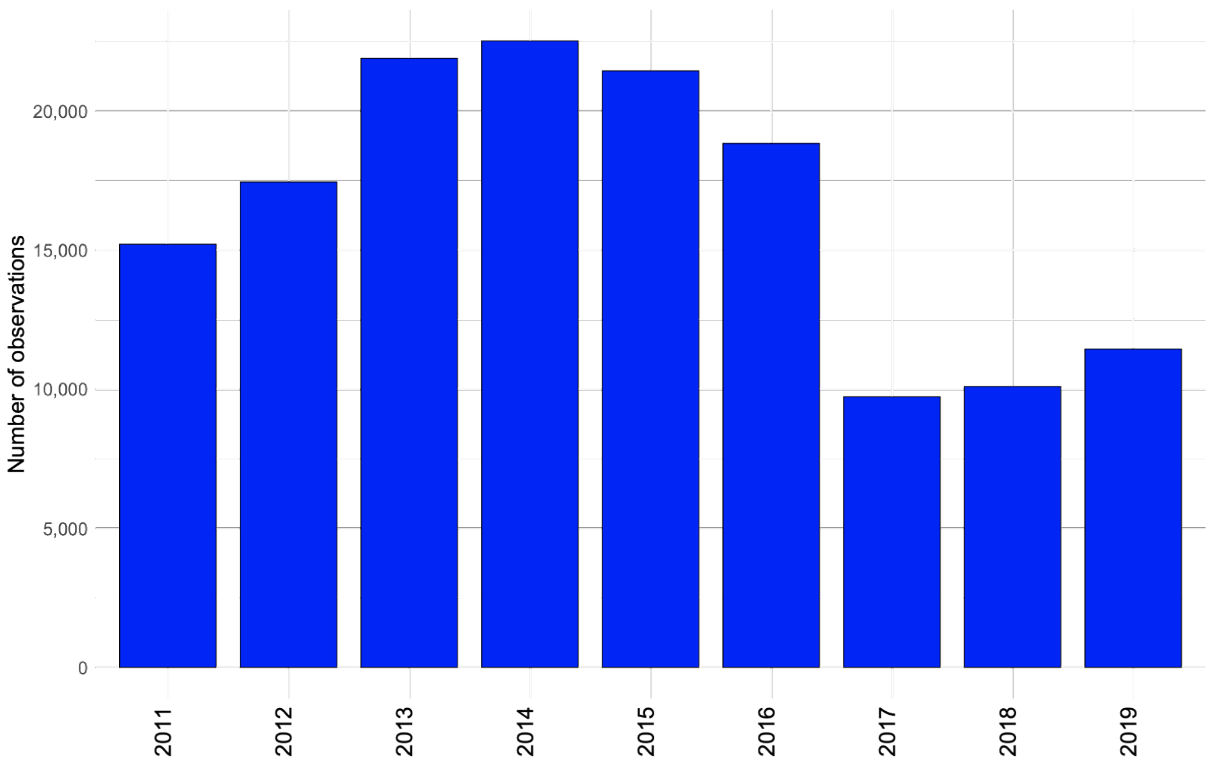
decision date. Yet, due to the number of missing values, in cases where there is no observation for award decision date, year and month were taken from the bidding deadline, call for tender date, or contract date, depending on the availability of data.

As a result of these data processing steps, we create a final data table for analysis in which each row corresponds to either an awarded contract or a lot.[5] The final list of variables is presented in Annex 2.

Overview of the final dataset used for the analysis

After filtering and narrowing down the dataset, the final number of contracts is 148,637, described by 129 variables (for 2011–2019). As we can see in Figure 1.1, the biggest number of observations is from 2012–2016, with a decline after 2017.

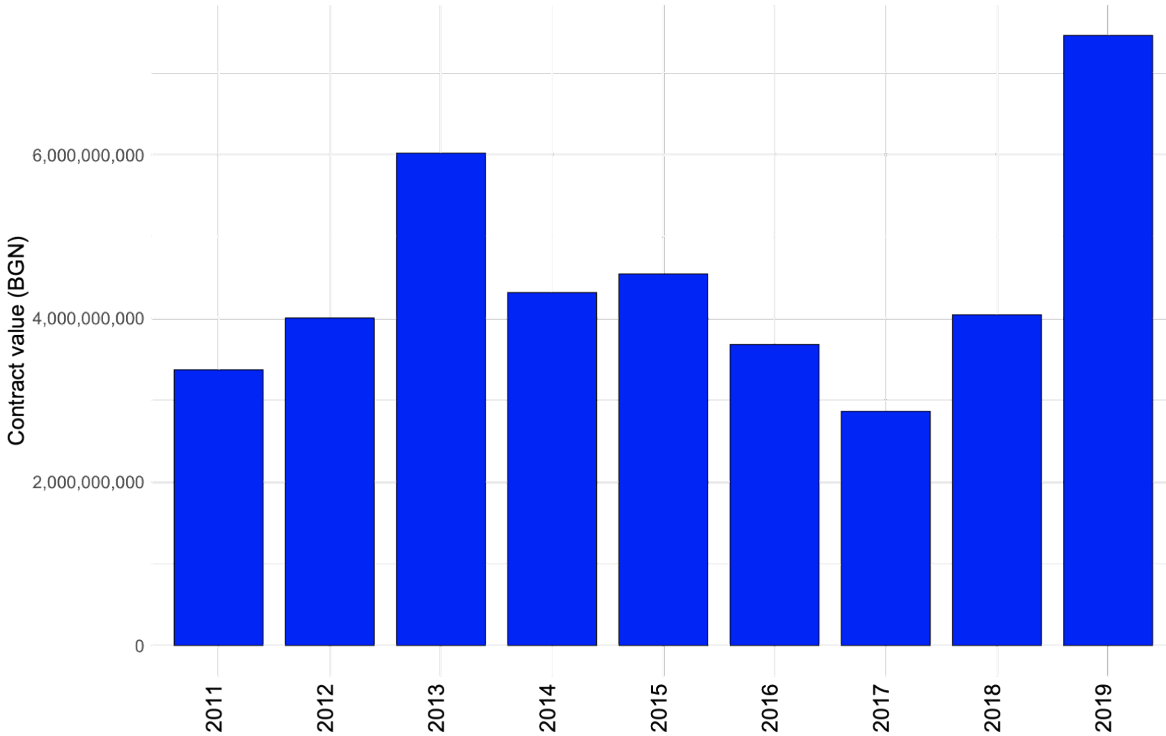
Figure 1.1: Annual number of observations, Bulgaria, 2011–2019



The total value of contracts awarded per year reveals a contrasting picture (Figure 1.2). The biggest total contract value was awarded in 2013–2015 and then in 2019, with the value being largely disconnected from the number of contracts (please note that the EU's budget cycle ended in 2013 with the 2014–2015 period available for spending hitherto unspent funds).

[5] Note that rows that do not have information on a concluded contract but only on lots can be either unawarded (cancelled or not yet awarded) or one awarded together with other lots, hence it stays as a freestanding lot, while another row represents the concluded contract covering it.

Figure 1.2: Total contract value per year, Bulgaria, 2011–2019



Annex 2: Processed publication types

List of publication types downloaded and processed - AOP

Обявление за възложена поръчка
ОБЯВЛЕНИЕ ЗА ВЪЗЛОЖЕНА ПОРЪЧКА
ОБЯВЛЕНИЕ ЗА ВЪЗЛОЖЕНА ПОРЪЧКА
ОБЯВЛЕНИЕ ЗА ВЪЗЛОЖЕНА ПОРЪЧКА В ОБЛАСТТА НА ОТБРАНАТА И СИГУРНОСТТА
Обявление за възложена поръчка - комунални услуги
ОБЯВЛЕНИЕ ЗА ВЪЗЛОЖЕНА ПОРЪЧКА - СПЕЦИАЛНИ СЕКТОРИ
ОБЯВЛЕНИЕ ЗА МАЛКА ОБЩЕСТВЕНА ПОРЪЧКА
РЕШЕНИЕ
ОБЯВЛЕНИЕ ЗА КОНКУРС ЗА ПРОЕКТ
ОБЯВЛЕНИЕ ЗА ОБЩЕСТВЕНА ПОРЪЧКА
ОБЯВЛЕНИЕ ЗА ОБЩЕСТВЕНА ПОРЪЧКА ОТ ВЪЗЛОЖИТЕЛ ПО ЧЛ. 7, Т. 5 ИЛИ 6 ОТ ЗОП
Обявление за поръчка
ОБЯВЛЕНИЕ ЗА ПОРЪЧКА
ОБЯВЛЕНИЕ ЗА ПОРЪЧКА
ОБЯВЛЕНИЕ ЗА ПОРЪЧКА В ОБЛАСТТА НА ОТБРАНАТА И СИГУРНОСТТА
Обявление за поръчка - комунални услуги
ОБЯВЛЕНИЕ ЗА ПОРЪЧКА - СПЕЦИАЛНИ СЕКТОРИ
ОБЯВЛЕНИЕ ЗА ПОРЪЧКА — СПЕЦИАЛНИ СЕКТОРИ
Обявление за приключване на договор за обществена поръчка
ИНФОРМАЦИЯ ЗА ИЗПЪЛНЕНИЕТО НА ДОГОВОР ЗА ОБЩЕСТВЕНА
ПОРЪЧКА
ИНФОРМАЦИЯ ЗА ПРОВЕДЕН КОНКУРС ЗА ПРОЕКТ
ИНФОРМАЦИЯ ЗА СКЛЮЧЕН ДОГОВОР
ИНФОРМАЦИЯ ЗА СКЛЮЧЕН ДОГОВОР ЗА МАЛКА ОБЩЕСТВЕНА ПОРЪЧКА
ИНФОРМАЦИЯ ЗА СКЛЮЧЕН ДОГОВОР ОТ ВЪЗЛОЖИТЕЛ ПО ЧЛ. 7, Т. 5 ИЛИ 6 ОТ ЗОП
Решение за откриване на процедура
ИНФОРМАЦИЯ ЗА ХОДА НА ПРОЦЕДУРАТА ПРИ ПРОИЗВОДСТВО ПО ОБЖАЛВАНЕ
Информация при производство по обжалване
КВАЛИФИКАЦИОННА СИСТЕМА — СПЕЦИАЛНИ СЕКТОРИ
КВАЛИФИКАЦИОННА СИСТЕМА — СПЕЦИАЛНИ СЕКТОРИ
ОБЯВЛЕНИЕ ЗА ДОБРОВОЛНА ПРОЗРАЧНОСТ EX ANTE
ОБЯВЛЕНИЕ ЗА СИСТЕМА ЗА ПРЕДВАРИТЕЛЕН ПОДБОР ОТ ВЪЗЛОЖИТЕЛ ПО ЧЛ. 7, Т. 5 ИЛИ 6 ОТ ЗОП
РЕЗУЛТАТИ ОТ КОНКУРС ЗА ПРОЕКТ

Социални и други специфични услуги - обществени поръчки

List of publication types downloaded and processed - EOP

Decision for starting a tendering procedure
Bid announcement for collecting of offers
F01 - Prior information notice
[str_Enum_publicationformtype_bgf02contractnotice]
F02 - Contract notice
[str_Enum_publicationformtype_bgf05contractnoticeutilities]
F05 - Contract notice – utilities
F17 - Contract notice for contracts in the field of defence and security
Contract award notice for a public procurement with value under art. 20, paragraph 3 or paragraph 7 of the public procurement law.
F03 - Contract award notice
[str_Enum_publicationformtype_bgf03contractawardnotice]
[str_Enum_publicationformtype_bgf06contractawardnoticeutilities]
F06 - Contract award notice – utilities
F18 - Contract award notice for contracts in the field of defence and security
F14 - Notice for changes or additional information
Notice for changes
Corrigendum (ZOP)
[str_Enum_publicationformtype_bg03noticeonfinishedexpiredawardcontract]
[str_Enum_publicationformtype_bg07invitationtocertainpersons]
[str_Enum_publicationformtype_bg09contractawardnoticeinvitation]
F21 - Social and other specific services – public contracts
F15 - Voluntary ex ante transparency notice
F04 - Periodic indicative notice – utilities
F12 - Design contest notice
F07 - Qualification system – utilities
F13 - Results of design contest
F16 - Prior information notice for contracts in the field of defence and security
F19 - Subcontract notice
F20 - Modification notice
F22 - Social and other specific services - utilities

Bulgaria F02 - Contract notice
Bulgaria F03 - Contract award notice
Bulgaria F05 - Contract award notice (utilities)
Bulgaria F06 - Contract notice (utilities)

Annex 3: Descriptive statistics of all variables used in the public procurement data analysis

	Unique (#)	Missing (%)	Mean	SD	Min	Median	Max
year	17	0	2013.4	3.8	2006.0	2013.0	2022.0
bid_digiwhist_price	84071	10	228419.0	3173335.0	99.0	26757.0	1101918138.0
bid_price	92115	11	446418.0	6239070.5	194.0	51750.0	2155722123.0
lot_bidscount	98	2	5.3	20.0	0.0	2.0	996.0
lot_electronicbidscount	11	84	0.1	0.7	0.0	0.0	9.0
lot_estimatedprice	20837	78	660808.9	11467812.4	200.0	79161.0	2155722123.0
lot_row_nr	1142	56	28.9	189.3	0.0	3.0	21105.0
lot_smebidscount	51	78	2.5	7.2	0.0	1.0	996.0
tender_digiwhist_price	67122	6	521983.3	4184994.7	100.0	70247.0	1101918138.0
tender_estimatedprice	24962	53	1541779.9	8623756.8	200.0	210000.0	1024330000.0
tender_finalprice	65706	9	1000515.9	8212798.9	195.0	133390.0	2155722123.0
tender_lotscount	398	0	34.9	117.3	1.0	3.0	1343.0
tender_recordedbidscount	20	0	1.1	0.9	1.0	1.0	35.0
framework_filter	1	0	1.0	0.0	1.0	1.0	1.0
bid_priceUsd	138535	11	653095.3	8999528.8	278.9	75951.6	3086001969.6
lot_estimatedpriceUsd	25610	78	947956.2	16556686.4	284.6	114523.2	3086001969.6
tender_estimatedpriceUsd	33580	54	2212616.0	12446626.0	284.6	307833.5	1466369140.9
tender_finalpriceUsd	83719	9	1461955.3	11892622.5	283.2	196541.5	3086001969.6
singleb	3	2	0.4	0.5	0.0	0.0	1.0
corr_proc	3	0	0.5	0.7	0.0	0.0	2.0
submission_period	109	33	33.6	11.2	0.0	32.0	277.0

	Unique (#)	Missing (%)	Mean	SD	Min	Median	Max
decision_period	367	51	74.1	54.8	0.0	61.0	365.0
corr_decp	3	0	1.5	0.8	0.0	2.0	2.0
filter_ok	1	0	1.0	0.0	1.0	1.0	1.0
market_id	46	0	45.4	23.5	3.0	42.0	99.0
ppp	16	0	0.7	0.0	0.6	0.7	0.7
ca_contract_value	138963	11	304486.0	4291432.2	128.3	35244.0	1489343245.8
ca_contract_value10	11	11	5.5	2.9	1.0	5.5	10.0
submp	108	33	33.7	11.2	1.0	32.0	277.0
submp10	11	0	36.3	44.0	1.0	8.0	99.0
corr_submp	3	0	3.1	4.1	0.0	0.0	9.0
decp	366	37	72.1	52.6	1.0	59.0	365.0
decp10	11	37	5.5	2.9	1.0	5.0	10.0
nocft	2	0	0.3	0.5	0.0	0.0	1.0
sec_score	19	100	65.0	14.4	44.2	59.1	88.6
fsuppl	3	69	0.0	0.1	0.0	0.0	1.0
taxhav	3	0	9.0	0.6	0.0	9.0	9.0
taxhav2	3	0	0.0	0.1	0.0	0.0	2.0
w_yam	95453	0	2288338.3	11574006.6	0.0	96393.3	1489343245.8
proa_w_yam	118489	0	697077.4	5767128.9	0.0	49829.9	1489343245.8
w_ycsh	42525	8	0.8	0.4	0.0	1.0	1.0
w_mycsh	10504	8	0.8	0.3	0.0	1.0	1.0

w_ynrc	120	0	13.0	40.3	1.0	2.0	495.0	
proa_ynrc	191	0	58.6	140.7	1.0	12.0	1146.0	
filter_wy	2	0	0.6	0.5	0.0	1.0	1.0	
n	1879	0	90.8	208.8	1.0	11.0	1879.0	
filter_w	2	0	0.5	0.5	0.0	1.0	1.0	
filter_wproa	2	0	0.7	0.4	0.0	1.0	1.0	
filter_wproay	2	0	0.8	0.4	0.0	1.0	1.0	
w_ycsh4	26161	71	0.4	0.4	0.0	0.2	1.0	
proa_yam	42256	0	14898275.3	68570355.7	0.0	740990.2	1735521845.5	
proa_ycsh	116109	5	0.3	0.4	0.0	0.1	1.0	
proa_mycsh	18726	5	0.5	0.3	0.0	0.5	1.0	
filter_proay	2	0	0.2	0.4	0.0	0.0	1.0	
filter_proa	2	0	0.2	0.4	0.0	0.0	1.0	
proa_nrc	264	0	180.6	350.2	1.0	27.0	1879.0	
proa_ycsh4	90519	32	0.1	0.2	0.0	0.0	1.0	
proa_ycsh9	65621	47	0.1	0.2	0.0	0.0	1.0	
MAD	236	69	0.0	0.0	0.0	0.0	0.1	
corr_ben	4	0	6.6	3.6	0.0	9.0	9.0	
ben	11	0	69.7	43.4	1.0	99.0	99.0	
submp25	26	0	41.3	40.8	1.0	19.0	99.0	
corr_proc2	3	0	0.2	0.4	0.0	0.0	1.0	
corr_decp2	3	0	0.7	0.4	0.0	1.0	1.0	

proa_yam	42256	0	14898275.3	68570355.7	0.0	740990.2	1735521845.5
proa_ycsh	116109	5	0.3	0.4	0.0	0.1	1.0
proa_mycsh	18726	5	0.5	0.3	0.0	0.5	1.0
filter_proay	2	0	0.2	0.4	0.0	0.0	1.0
filter_proa	2	0	0.2	0.4	0.0	0.0	1.0
proa_nrc	264	0	180.6	350.2	1.0	27.0	1879.0
proa_ycsh4	90519	32	0.1	0.2	0.0	0.0	1.0
proa_ycsh9	65621	47	0.1	0.2	0.0	0.0	1.0
MAD	236	69	0.0	0.0	0.0	0.0	0.1
corr_ben	4	0	6.6	3.6	0.0	9.0	9.0
ben	11	0	69.7	43.4	1.0	99.0	99.0
submp25	26	0	41.3	40.8	1.0	19.0	99.0
corr_proc2	3	0	0.2	0.4	0.0	0.0	1.0
corr_decp2	3	0	0.7	0.4	0.0	1.0	1.0
corr_submp2	3	33	0.2	0.4	0.0	0.0	1.0
cri	96005	0	0.4	0.3	0.0	0.3	1.0
covid_ted_product	2	0	0.0	0.0	0.0	0.0	1.0
covid_decree_products	2	0	0.0	0.1	0.0	0.0	1.0
hh_market	2	0	0.2	0.4	0.0	0.0	1.0
hh_contract	2	0	0.0	0.1	0.0	0.0	1.0
product_groups	3	0	1.2	0.4	1.0	1.0	3.0

Annex 4: Green procurement keywords & CPV codes

Sustainability	устойчивост
Sustainable	устойчив
Recycling	рециклиране
Recycled	рециклиран
energy efficiency	енергийна ефективност
water efficiency	водна ефективност
local content	местно съдържание
local source	местен източник
reduced plastic	намаляване употребата на пластмаса; намалена вложена пластмаса
recyclable packaging(s)	рециклируеми опаковки; рециклируема опаковка
low emission	ниски нива на емисии; ниски емисии
low fumes	ниски нива на изпарения
greenhouse gases	парникови газове, парников газ

GHG	емисии на парникови газове
substances of concern	рискови вещества, вещества; пораждащи безпокойство, вещества; будещи безпокойство
recyclability	рециклируемост
takeback programs	програми за връщане; програми за връщане (на стари уреди)
efficient installation	ефективна инсталация
low power mode	енергоспестяващ режим (на работа)
ecoperformance	екорезултати
extended warranty	удължена гаранция
extended service and repair agreement	договор за удължено обслужване и ремонт
repairability	ремонтопригодност
low emission vehicles	превозни средства с ниски емисии
reduced packaging	ограничаване на теглото и обема на опаковките; намалено опаковане
environmental management systems	системи за управление на околната среда

green design	екодизайн; екологосъобразен дизайн
green construction	екологосъобразно строителство, екологично строителство
environmental impact	влияние върху околната среда; въздействие върху околната среда
environmental preservation	опазване на околната среда
green space	зелено пространство
stormwater control	контрол на дъждовните води
waste management	управление на отпадъците
waste reuse	повторно използване на отпадъците
renewable energy/electricity	възобновяема енергия; електроенергия от възобновяеми източници
renewable energy/electricity	енергия от възобновяеми източници
solar energy	слънчева енергия
solar electricity	слънчева електроенергия
wind energy	вятърна енергия

wind electricity	вятърна електроенергия
solar, wind energy/electricity	слънчева, вятърна енергия/електроенергия от слънце/вятър
efficient lighting	ефикасно осветление; ефективно осветление
thermal energy	термална енергия; топлинна енергия
thermal electricity	термална електроенергия; топлинна електроенергия
thermal energy/electricity	термална/топлинна енергия/електроенергия
ISO 14024	ISO 14024
ISO 14021	ISO 14021
ISO 14025	ISO 14025
EU Ecolabel	екомаркировка на ЕС
EU Energy label	енергийно етикиране на ЕС; енергийно етикиране (на ЕС), енергиен етикет
energy labeling	енергиен етикет
Blue Angel	Blue Angel; Син ангел
Nordic Swan	Nordic Swan; Северен лебед

Energy Star	Energy Star; Енергийна звезда

CPV codes (everything under category)	CPV labels
907	Environmental services
45321	Thermal insulation work
71313	Environmental engineering consultancy services
9073	Pollution tracking and monitoring and rehabilitation
90514	Refuse recycling services
933	Solar energy
713143	Energy-efficiency consultancy services
311213	Wind-energy generators
4526264	Environmental improvement works
8054	Environmental training services
42914	Recycling equipment
4526141	Roof insulation work
90715	Pollution investigation services

45261215	Solar panel roof-covering work
606513	Anti-pollution ship services
9071527	Recycling plant site investigation
4521327	Construction works for recycling station
45251141	Geothermal power station construction work

Annex 5: Validated CRIs ('red flags') and their definitions for Bulgarian public procurement data

Indicator name	Indicator definition
Single bidder contract	0 = more than one bid received 1 = one bid received
Call for tenders publication	0 = call for tenders advertised 1 = call for tenders not advertised
Procedure type	0 = open procedure 0.5 = negotiated/accelerated procedures 1 = non-open procedure type (for example, direct contracting) (for detailed definition see Annex 3)
Length of submission period	Number of days between publication of call for tenders and submission deadline 0 = from 12 to 183 days 0.5 = from 7 to 11 days 1 = from 1 to 6 days
Length of decision period	Number of calendar days between submission deadline and announcing of contract award 0 = from 9 to 365 days 0.5 = from 5 to 8 days 1 = from 1 to 4 days
Buyer's dependence	Shows the contracting authorities' contract share rewarded to the same supplier in a given year