Policy Research Working Paper 11007

Measuring the Risk of Corruption and Its Price Impact in North Macedonia 2011–2022

Mihaly Fazekas
Aly Abdou
Klea Ibrahimi
Bence Tóth
Zdravko Veljanov

WORLD BANK GROUP
Economic Policy Global Department—Trade
December 2024

Policy Research Working Paper 11007

Abstract

Public procurement in North Macedonia amounted to 16 percent of total government expenditure in 2018, or 5 percent of gross domestic product. The country's public procurement is also vulnerable to corruption risks, which typically push prices up, leading to overspending. To support better budget policies, this paper maps corruption and state capture risks using administrative data on public procurement and examines their impact on prices. The analysis finds that overall corruption risk decreased slightly in 2011–22, with, for example, the single bidding rate remaining around 30 percent. Estimated overpricing at the contracting stage due to corruption risks ranged between 5 and 6 percent of spending throughout the period. The highest savings potentials are presented by lowering single bidding, increasing the use of a simplified open procedure, and advertising tendering opportunities longer. Network analysis of contracting relationships reveals that the 2017 change in government weakened the centrality of high corruption risk groups of organizations, leading to an overall higher integrity core.

This paper is a product of the Economic Policy Global Department—Trade. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at FazekasM@ceu.edu.

Measuring the Risk of Corruption and Its Price Impact in North Macedonia 2011-2022

Mihaly Fazekas[1,3], Aly Abdou[3], Klea Ibrahimi[1], Bence Tóth[2,3], Zdravko Veljanov[1,3]

1-Central European University
2-University College London
3-Government Transparency Institute

This paper is a product of the Macroeconomics, Trade and Investment Global Practice, conducted in the context of the World Bank North Macedonia Public Finance Review (P179795), led by Sanja Madzarevic-Sujster, Senior Economist. The authors thank the World Bank for funding this research project. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http:// www.worldbank.org/prwp. The authors may be contacted at FazekasM@ceu.edu.

Keywords: public procurement, competition, corruption, network analysis, North Macedonia

JEL classification: H57; D73; L14

Contents

Introduction

North Macedonia is coping with the aftermath of its deepest recession since 2001. The 3.9 percent growth of 2019 was reversed to -6.1 percent by the end of 2020 as the COVID-19 pandemic unfolded. The fiscal deficit increased to 8.8 percent of GDP in 2020 as a result of plummeting revenues and the unprecedented transfers to firms and households (of around 10 percent of GDP). This pushed up public debt by 11 percentage points in just one year to a new historical peak of 60.8 percent of the GDP.

Now that the recovery is starting to take hold, public finances need to be brought back onto a sustainable path. Given a gradual deficit-reduction trajectory, as announced in the government's Fiscal Strategy 2021-26, public debt will remain above 60 percent of GDP by 2026. With current policies and new support packages discussed, the primary fiscal deficit (Public Enterprise for State Roads included) will not close even by 2026. The projected deficit reduction will come mainly from lower subsidies and higher revenues as the economy recovers. This is a lower adjustment effort than the average for the Western Balkans and is also based on optimistic growth expectations of above 5 percent on average by 2026.

Public procurement in North Macedonia amounted to 16% of the total government expenditures or 5% of GDP in 2018 (OECD 2020, chapter 7). According to the same report, countries from the Western Balkans face challenges in ensuring efficient spending. They maximize the value of their purchases. Combining this with the critical role played by public procurement in the provision of works, goods, and services, it is a category within the state budget that is closely scrutinized for spending reforms by organizations such as OECD (OECD 2020) as well as the EU (European Commission 2022).

Hence, one possible way to control state expenditures is to improve public procurement practices and enhance value for money, that is procuring the same goods and services but for better prices. North Macedonia continues to lag EU countries on governance indicators. The gap to the EU is most pronounced along institutions critical for economic growth such as the rule of law, control of corruption, and government effectiveness. One critical institutional area where governance weaknesses and state capture by private interests are evident is public procurement. Thanks to the digitalization of public procurement data and the introduction of national e-procurement systems, audits, and judicial institutions, analysts and civil society whistleblowers now have access to electronic public procurement transaction data, including the details of individual government contracts. Such administrative datasets allow us to analyze the cost of non-competitive public procurement practices and corruption risks. Moreover, they also allow for a comprehensive analysis of economic relations, that is contracts, among public and private organizations revealing hidden partners of state capture risks.

This paper presents an in-depth analysis of public procurement in North Macedonia based on contract level data between 2011 and 2022. First, it gives a descriptive overview of the country's public procurement market. Second, it calculates and validates a set of corruption risk indicators following the risk measurement approach introduced in Fazekas & Kocsis (2020) and applied in

the region to Bulgaria (Fazekas et al, 2023). Third, it maps the distribution of risks by various tendering dimensions. Fourth, it shows the relationship between corruption risk indicators and price savings. This allows us to see the estimated total savings achievable by reducing risky tendering practices and to identify the practices most closely linked to inflated contract values. Fifth, it analyzes tendering risks from a network perspective, that is looking into recurring high risk contracting patterns between public buyers and specific suppliers.

Regulatory Framework

The overarching legislation on public procurement was adopted in 2007 (Official Gazette of the Republic of North Macedonia 136/2007) and subsequently amended to better reflect changing market realities. In 2019, for the purpose of better and closer harmonization with the EU guidelines and standards, the Public Procurement Law (PPL) underwent a major revision (Official Gazette No. 24/2019).

One of the most substantial changes in 2019 was the creation of a simplified open procedure that replaced the ‘competitive negotiated procedure’. This simplified open procedure can be applied following increased thresholds: 70,000 EUR (in Macedonian denars counter-value) for goods and services and 500,000 EUR (in Macedonian denars counter-value) for works, thus effectively replacing the ‘competitive negotiated procedure’ (whose thresholds stood at 20,000 EUR and 50,000 EUR). The introduction of the simplified procedure allows purchasing authorities to draw up a shortlist of potential suppliers and invite them to submit bids, much like the competitive negotiated procedure, and effectively cut short the period of advertisement. At least three bidders have to submit bids, hence this procedure type maintains some safeguards for competition. However, in practice the competition is limited as bidding is restricted to a select few, potentially leading to lower quality and higher prices. Furthermore, the PPL incorporates relevant provisions from the EU Directives, including the introduction of the Most Economically Advantageous Tender (MEAT, in Article 99) as the leading award criteria.

The legal framework is overseen by the Public Procurement Bureau (PPB), which is an independent body. The PPB is the central body responsible for coordinating and monitoring public procurement and also for providing training and guidance to public procurement officers and contractors. At the same time, it can conduct audits and investigations in cases of potential irregularities. However, certain limitations of the current legal framework remain as the country has repeatedly delayed the implementation of the Public-Private Partnership (PPP) Law and Law on Concessions (European Commission 2022).

Data

Our main data source is the official public procurement data portal of North Macedonia https://e-nabavki.gov.mk/. We follow the data collection, standardization and quality assurance procedures outlined in Fazekas et al (2024) and further refined on https://opentender.eu/. We first annotate the source website and identify all the relevant fields required for the analysis as well as create enumerations for data fields which are published in Macedonian. For example, enumerating national procedure types to commonly used procurement procedure types such as open procedure or supply types such as goods, works or services. We then built a dedicated web crawler to scrape the HTML pages of all the available procurement publications such as call for tenders, contract awards, contract amendments and cancellations. We then use the publications' identification numbers to correctly match the publications with each other to create a single record in our dataset that accurately represents the complete tendering process from publishing the call for tenders to the contract award (including any amendments). We also flag tenders that were canceled at any point during the tendering process to be excluded from the analysis. The collected raw data of the matched publications is then parsed into a standard data structure[1] allowing for consistent analysis over time within the same country, but also comparisons across countries.

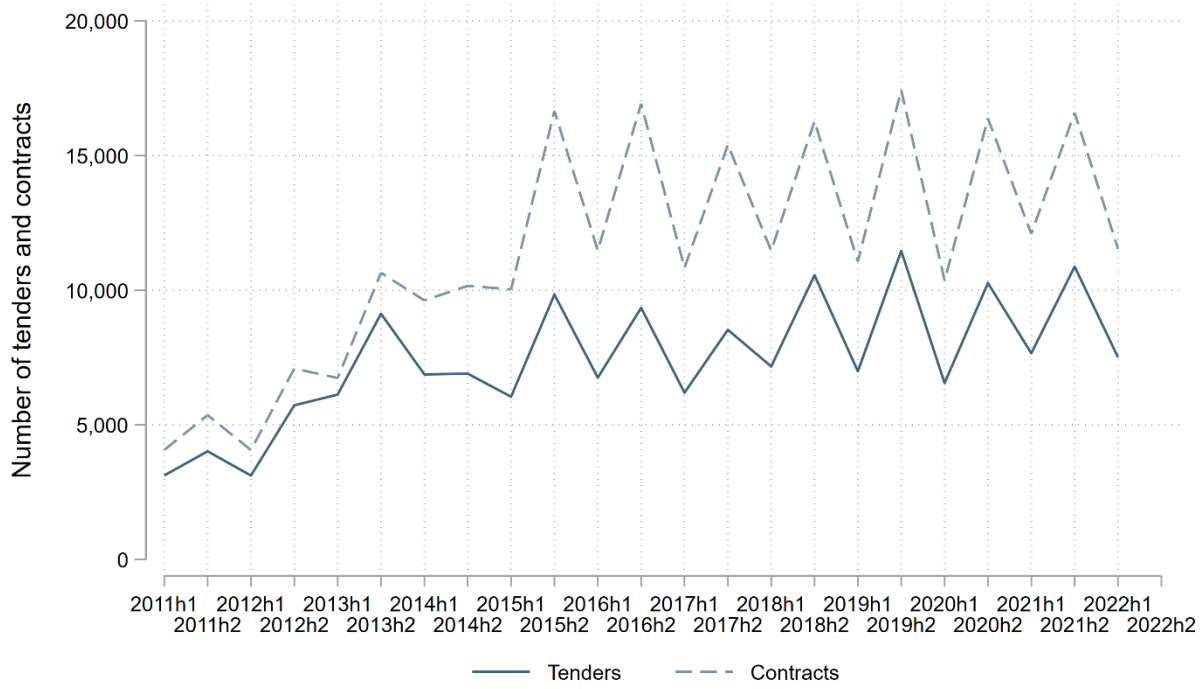
We manually validate the collected data fields against the source publications to confirm that the data accurately matches the official information. The data goes through several rounds of data validation to ensure data collection accuracy. After a successful validation stage, we perform further cleaning to the dataset to reduce any errors, inconsistencies and missing values in the official data. For example, we geolocate the organization's unstructured addresses using the HERE REST APIs[2] to standardize 1,429 unstructured address values to 764 unique values. This improves the dataset by removing spelling errors and having locations in different languages. Since the source lacks consistent organization IDs, we also generate a unique organization identification number. For procurement authorities, we use the lowest available geolocation (district when available) along with a cleaned name to generate the identification number. For suppliers, we use the structured supplier city, cleaned name and a supplier's legal form to tag organizations.

In the following analysis, we use 169,830 tenders which resulted in 267,427 contracts awarded between 2011 and 2022. Figure 1 shows the seasonality of public procurement purchases both in terms of the number of tenders and contracts (Panel A) and total spending (Panel B). Public procurement data became steadily available in 2011 and the publication rate increased in the following years, whereas total spending covered by the dataset fluctuates around 2.5 billion to 5 MKD per month with a slight increase in spending during the second half of 2021.

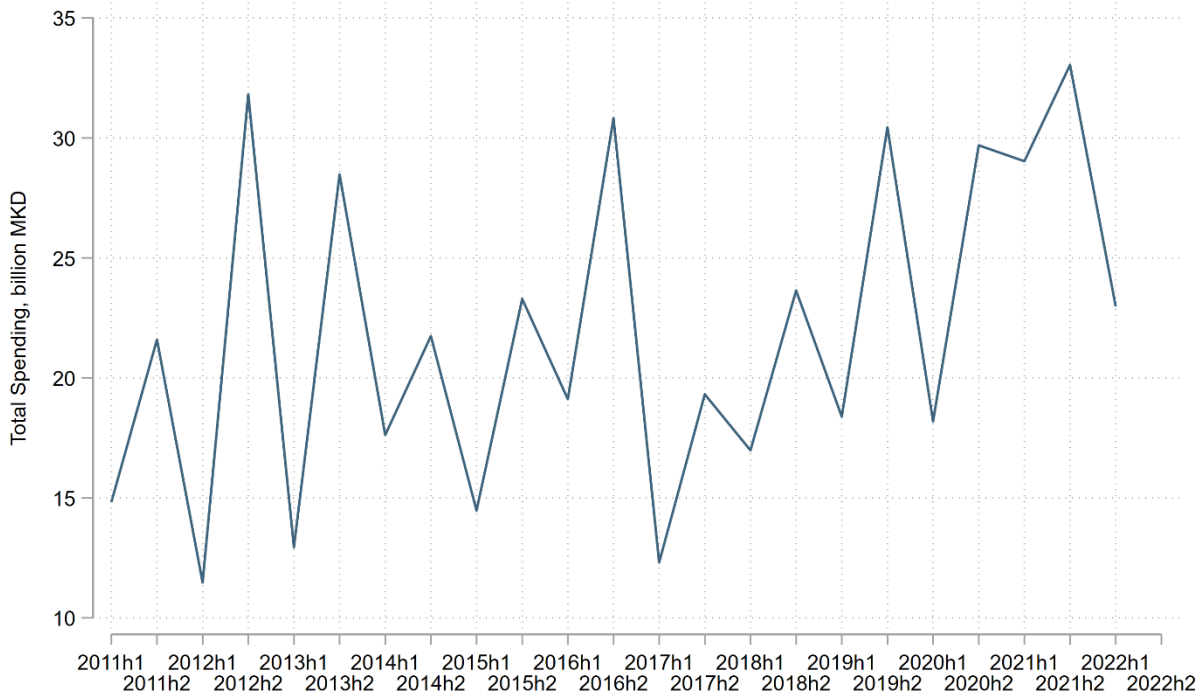
[1] For a full description of the data standard see: https://opentender.eu/mk/about/how-opentender-works
[2] https://developer.here.com/develop/rest-apis

Figure 1: Distribution of public contracts over time

Panel A: Number of tenders and awarded contracts in North Macedonia, 2011-2022



Panel B: Total monthly spending in North Macedonia, 2011-2022

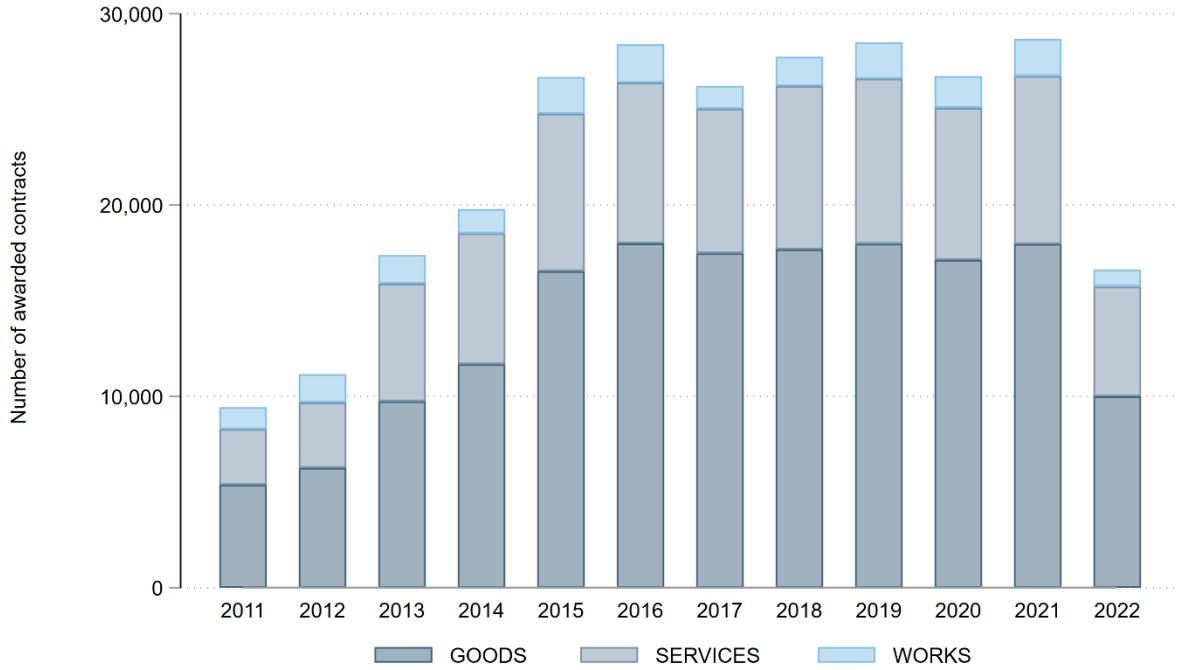


The public procurement dataset covers a total spending of 512 billion MKD over the 10-year period. The majority of spending is concentrated on supply contracts (247 billion MKD) followed

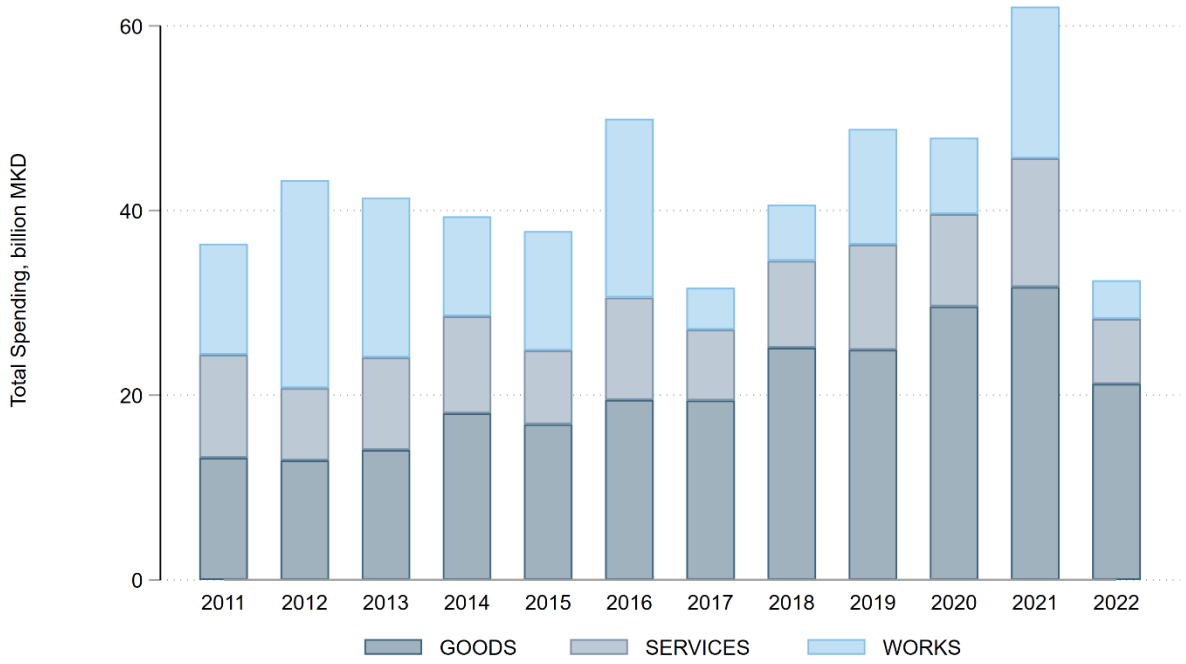
by works contracts (147 billion MKD) and services contracts (118 billion MKD). In terms of the number of contracts, supply contracts are the most frequent as well (62% of the awarded contracts) followed by services (31%) and works (7%). Figure 2 shows the yearly distributions of the awarded contracts (Panel A) and the total spending by the contract type (Panel B).

Figure 2 Distributions of awarded contracts by contract type

Panel A: Yearly distribution of public contracts in North Macedonia, 2011-2022



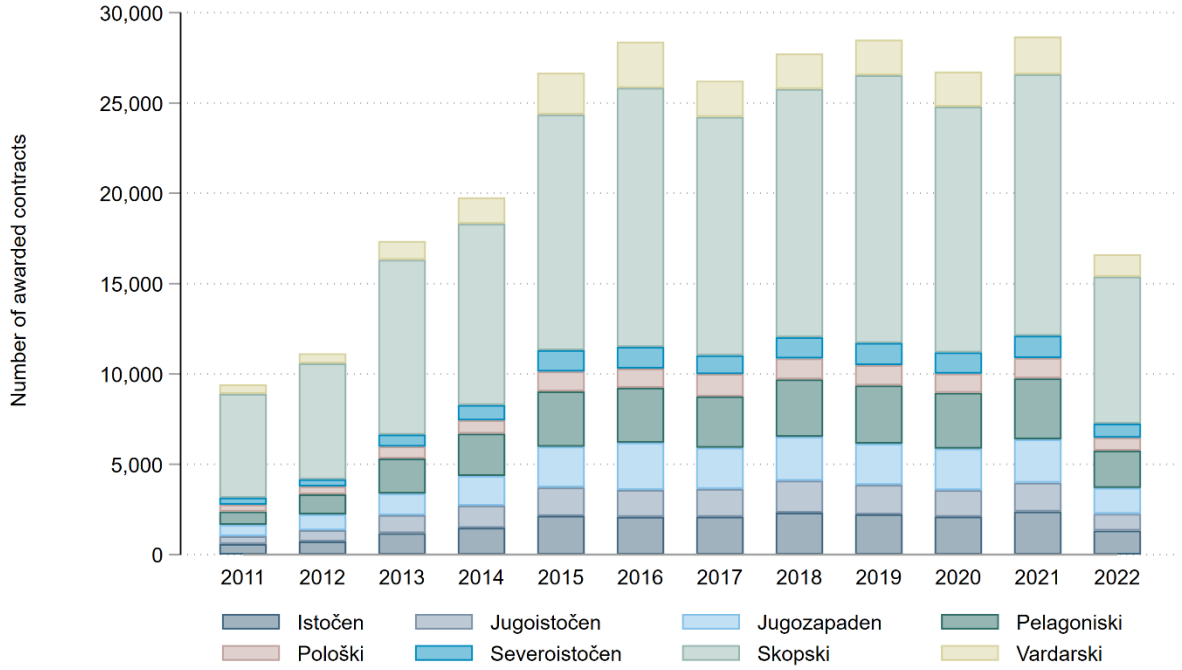
Panel B: Yearly spending by contract type in North Macedonia, 2011-2022



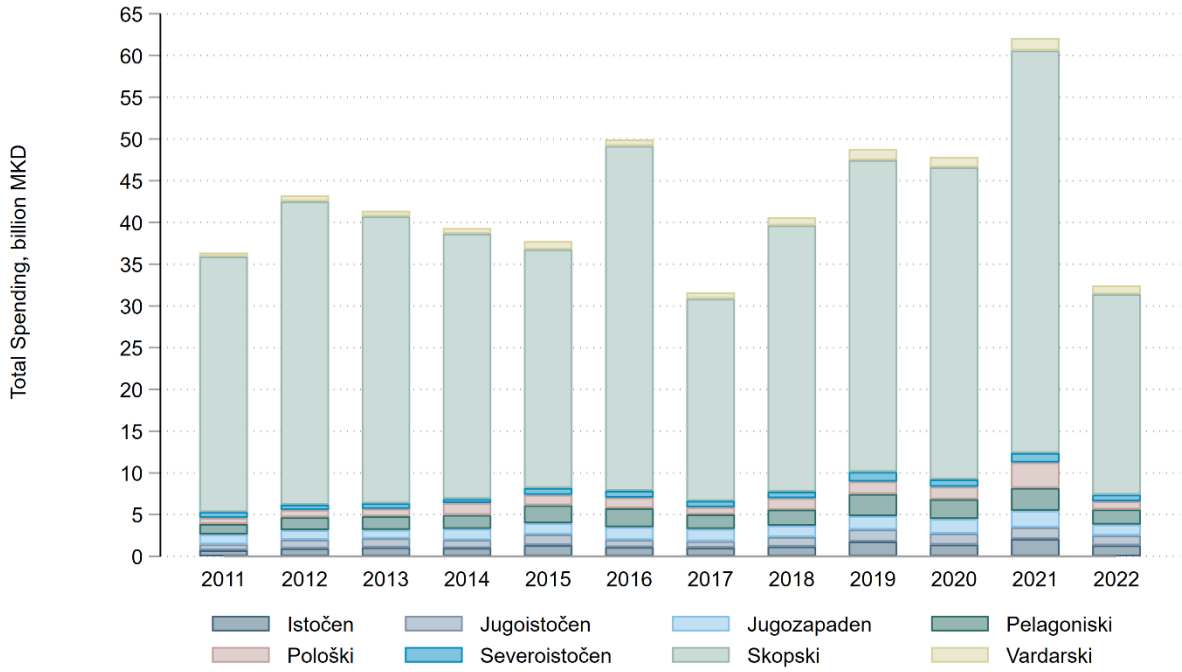
The dataset includes procurement contracts from various regions throughout North Macedonia. More than 75% of the total spending and 50% of the awarded contracts are concentrated within the Skopski region. The remaining 20% of spending is distributed between the other seven regions. Figure 3 shows the yearly distribution of awarded contracts (Panel A) and spending over time (Panel B) across all geographical regions.

Figure 3 Distributions of awarded contracts across geographical regions

Panel A: Yearly distribution of contracts across geographical regions in North Macedonia, 2011-2022



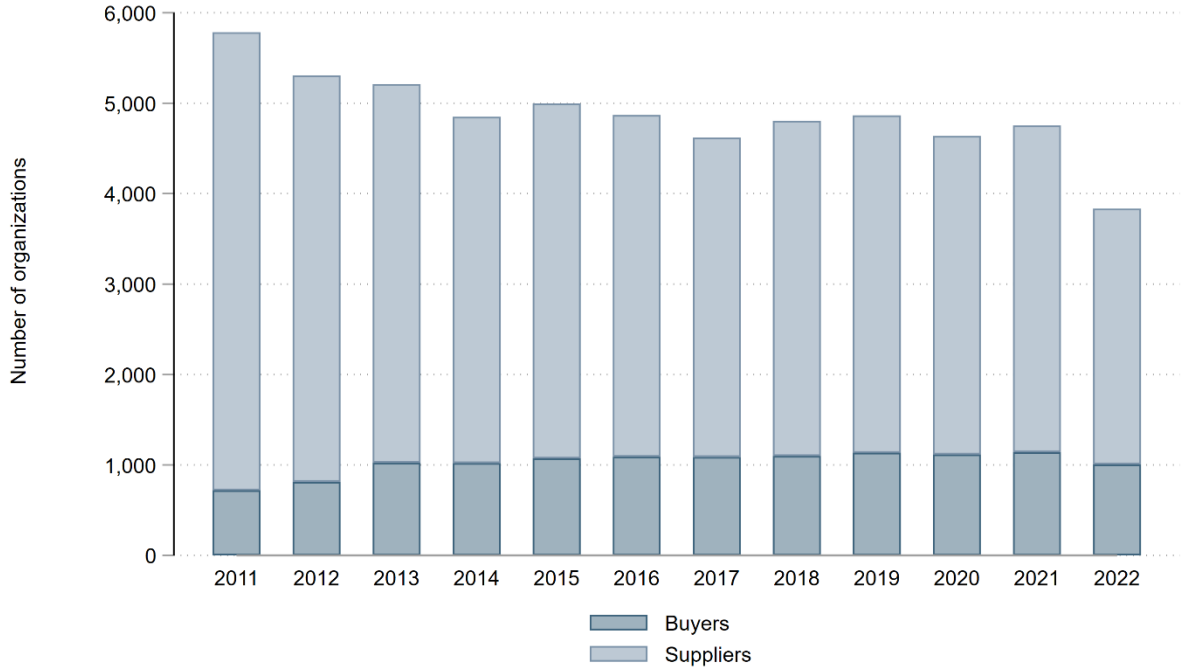
Panel B: Yearly total spending across geographical regions in North Macedonia, 2011-2022



Based on the assigned unique buyer and supplier IDs (for the process, see above), there are 1,542 procurement authorities and 16,742 suppliers in the dataset. Figure 4 shows that the yearly

distribution of organizations appearing in North Macedonia's public procurement records is stable over time.

Figure 4: Yearly distribution of procurement organizations in North Macedonia, 2011-2022



Measuring corruption risks in public procurement

This section outlines the Corruption Risk Index (CRI) methodology and the exact process for identifying the thresholds used to flag contracts as risky. We define corruption in public procurement as a set of practices that violate the principles of open competition by deliberately favoring one or a few bidders to the detriment of others. These practices would ensure that procurement authorities do not end up with the best value for money. Often both prices and the quality of the procured products suffer due to corrupt practices thus harming the public budget.

Based on the wide literature on public procurement practices, single bidding is one of the direct outcomes of corrupt practices and is frequently used as a signal of wrongdoing in the tendering process. Further evidence can be found in Fazekas & Kocsis (2020). Therefore, we use single bidding as our main corruption proxy in order to validate other practices of favoritism. In a regression framework, we identify those procurement practices which are associated with single bidding in otherwise competitive markets, as these indicate likely competition restriction supporting favoritism. For example, tenders with open procedures are usually the norm in many countries leading to multiple bidders submitting bids. We compare the relationship of restricted and open procedures regarding single bidding. A positive significant relationship would mean that the use of restricted procedures can be considered a risky practice as it has a positive (and significant) relationship with single bidding - i.e. single bidding is a more likely outcome (Coviello and Spagnolo 2018). We consider such statistical relationships as evidence for validity of our corruption risk indicators. It is important to note that using this methodology, we only identify corruption risk and not cases of actual corruption. Such risk indicators are useful as they point policymakers and other stakeholders at a wider set of contracts in the economy such as sectors, regions or periods, suffering from high corruption risks.

We can calculate and validity test seven public procurement corruption risk indicators[3]:

- **Single bidding** indicates that a given tender only had one bidder during the procurement process, hence there was no competition for the contract. The lack of competition is one of the main signs of corruption risks in the tendering process. Single bidding can be easily extracted from the data and has the key qualities necessary for an adequate indicator.
- **The length of the advertisement period** is the time difference between the first publication date of the contract notice and the deadline until which suppliers can submit their bids (bidding deadline). An extremely short advertisement period could indicate corruption, and we find a strong connection between the length of the period and the likelihood of single bidding.
- **Procedure type** indicates the type of procedure by which the tender will be contracted. Non-open procedures, which are less transparent and competitive, create more opportunities to limit the range of bids received and to exclude bids. Additionally, they

[3] Another common indicator is whether or not the CFT document was published. We did not find cases where the contract notice was published but not the CFT document in the scraped dataset.

create more opportunities for issuers to repeatedly award contracts to the same company.

- **The length of the decision period** is a time difference between the submission deadline and the announcement of the contract award. An overly lengthy decision period gives the opportunity for multiple legal challenges against the tender, suggesting that the issuer attempted to limit competition. Additionally, it suggests that the issuer wants to award the contract to a specific company.
- **Supplier' dependence** indicates the share of the contracts' value received from the same procurement authority by the same supplier. A high share can indicate personal ties between the suppliers and the contracting authority, preventing the tenders to be contracted under fair competition.
- **Suppliers registered in a tax haven** flags all contracts by suppliers with their headquarters registered in a tax haven. Tax haven registration makes it harder to track the beneficial owners of a company and thus opens the doors to many corruption issues.
- **The Benford's law** indicator flags all contracts by buyers whose contract prices do not follow the Benford's distribution. The Benford distribution has been used in many applications to detect fraud as naturally occurring numbers typically follow the Benford distribution. Violating this natural distribution may signal deliberate manipulation.

We use a regression framework to test the association of these corrupt practices with single bidding. In all of the regression models we control for contract prices using price deciles, contract types, buyer's type and location, product markets identified by CPV divisions and year. By adding these control variables, we attempt to isolate the structural effects of each of the control variables from the tested relationship. Although we do not claim a causal relationship, a positive correlation indicates that the practice goes together with a higher likelihood of single bidding on average. In models 1-6 in Table 1, we show the association of each indicator with single bidding separately while we also demonstrate the combined effect of the indicators on single bidding as corrupt practices usually occur in parallel with each other (Model 7 in Table 1). All indicators are positively correlated with single bidding indicating that corruption risks increase with the risky behaviors as precisely defined in Table 2.

Table 1: Validation of corruption risk indicators using Single bidding as the main corruption risk proxy in an binary logistic regression framework- North Macedonia 2011-2022

		Single bidding is the main dependent variable						
Independent variables	**Corruption risk level**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Procedure type	Medium Risk	0.309***						0.130***
		(0.012)						(0.017)
	High Risk	2.271***						2.039***
		(0.031)						(0.034)
Advertisement period	High Risk		0.460***					0.165***
			(0.011)					(0.015)
Decision period	Medium Risk			0.427***				0.185***
				(0.012)				(0.013)
	High Risk			0.371***				0.337***
				(0.011)				(0.012)
Tax Haven	Foreign Supplier				0.828***			0.564***
					(0.038)			(0.042)
	Supplier registered in a tax haven				1.627***			0.953**
					(0.315)			(0.344)
Supplier Dependence						0.490***		0.509***
						(0.023)		(0.024)
Benford's Law	High Risk						0.073****	0.080***
							(0.010)	(0.011)
N		265,920	265,920	265,920	267,920	267,920	265,920	265,920
pseudo R^2		0.067	0.050	0.050	0.047	0.047	0.046	0.073

All validity regressions controls for contract values, buyer types and locations, contract's supply type and markets identified by CPV divisions, and contracting year. Robust standard errors shown in brackets below the coefficients. The stars represent the significance levels *** p<0.01, ** p<0.05, * p<0.1

Table 2 presents the exact definitions used to create the corruption risk indicators. All indicators are formulated to fall between 0 and 1. For some indicators, we also identify a medium risk category which takes the value of 0.5 (example procedure type risk). Each awarded contract receives a score for each indicator depending on the availability of the variable required to calculate the indicator. All risk indicators are simply averaged to calculate the composite risk score (CRI) for each contract (missing indicator values are not considered in the average score, hence the weight of individual risk factors might vary based on how many other factors are non-missing).

Table 2: Corruption risk indicators thresholds used in North Macedonia's composite risk score (CRI)

Indicator name	Indicator definition
Single bidder contract (corr_singleb)	Low risk: more than one bid received High risk: one bid received
Procedure type (corr_proc)	Low risk: Negotiated with publication, Open, QualificationSystem Medium Risk: Low estimated value procedure, Request For Proposal, Simplified Open Procedure*. High risk: Negotiated without publication, Other.
Length of advertisement period (corr_subm)	Number of days between publication of call for tenders and submission deadline Low risk: from 15 to 365 days High risk: from 1 to 14 days & missing values
Length of decision period (corr_decp)	Number of calendar days between submission deadline and announcing of contract award Low risk: from 59 to 111 days Medium risk: from 27 to 58 days & missing values High risk: from 1 to 26 days & 112 to 730 days
Supplier's dependence (w_ycsh4)	Shows the supplier's contract share received from the same procurement authority in a given year based on contract values.
Benford's law (corr_ben)	Flags contracts by buyers whose contract prices do not conform with the Benford's distribution Low risk: Acceptable conformity, Close conformity High risk: Marginally acceptable conformity, Nonconformity
Tax haven (taxhav2)	Supplier registered in a country flagged as a tax haven based on the Financial Secrecy Index by the Tax justice network

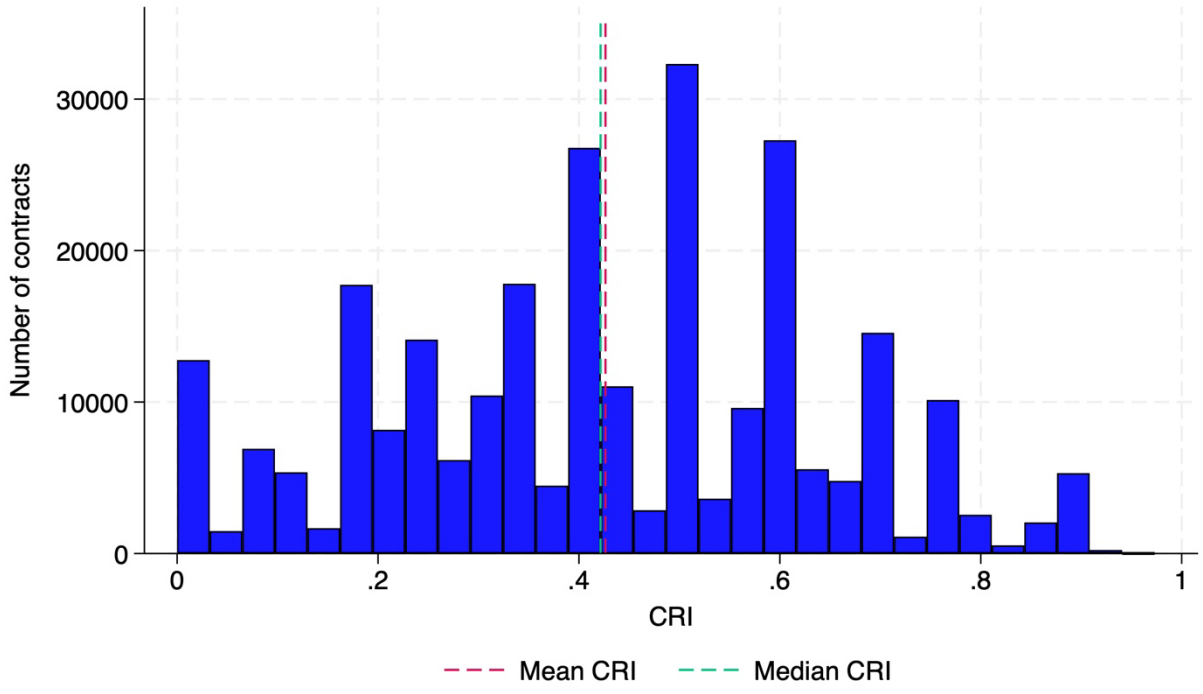
* Simplified open procedures started to be used from 2019 after a law amendment that entered into force in February 2019. THe amendment increased the thresholds allowed for the use of this simplified procedure type which led to the heavy dependence on this new type compared to the previously used Open procedures (Palguta and Pertold 2017). We found that these newly introduced Simplified procedures are correlated with higher single bidding risk compared to the previously used Open procedures and thus were included as risky procedure types.

Mapping corruption risk distributions and trends

This section analyzes the distribution of public procurement corruption risks across North Macedonia from 2011 to 2022. The advantage of this indicator is that it is calculated at the contract level, allowing us to assess corruption risk starting from a granular level. This enables comparisons of bidders and suppliers, trend analysis over time, and examination of regional and industry-level differences. Additionally, we focus on the Covid-19 period to determine if any irregularities in public procurement corruption occurred during that time.

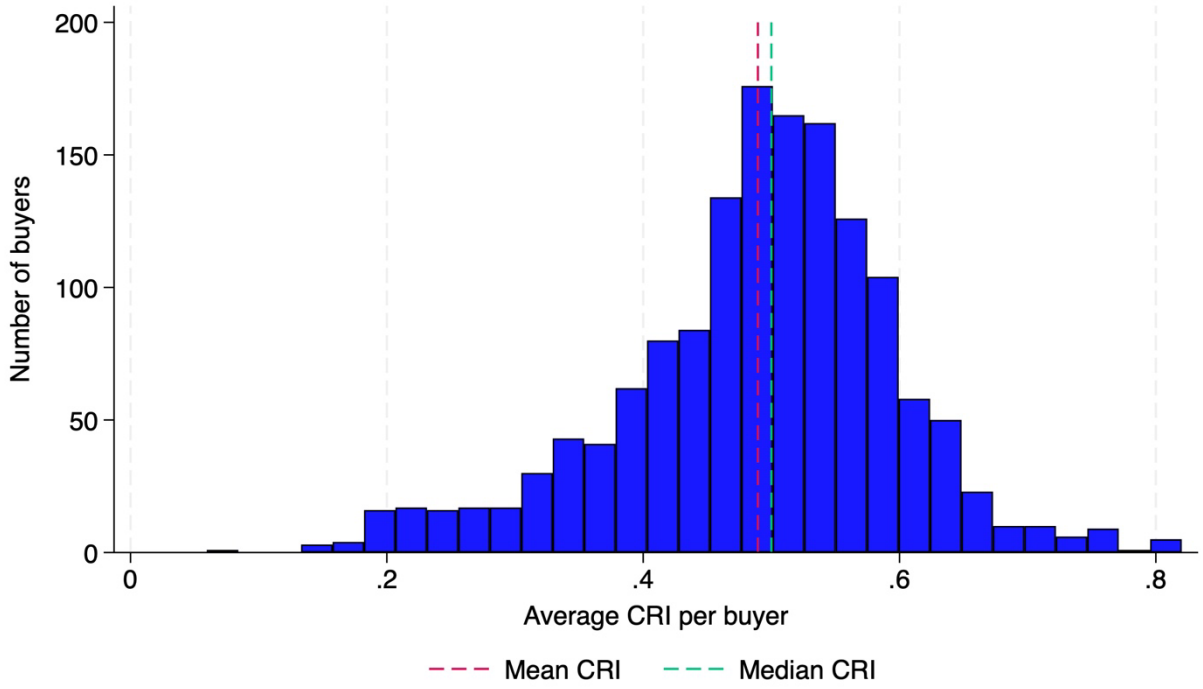
Figure 5 shows the distribution of the awarded contracts by CRI for North Macedonia from 2011 to 2022. In North Macedonia, the CRI of the average contract is 0.43, that is three out of the seven red flags are present in the tender. Overall, the distribution is right skewed with contracts being concentrated at average CRI values as denoted by the red line. More than 40,000 contracts have a corruption score indicator between 0.4 and 0.5, close to the average score. While almost 19,000 public procurement contracts have CRI above 0.75, that is five or more out of the seven individual indicators signal a high risk of corruption. However, a significant proportion of contracts also have low CRI values between 0 and 0.25. It is notable that the distribution is uneven at the contract level, with certain CRI scores appearing significantly more frequently. These spikes in the distribution can be interpreted as typical combinations of risk factors or risk profiles; for instance, many contracts score 1 for having a single bidder.

Figure 5: Distribution of awarded contracts by their average CRI , North Macedonia, 2011-2022



One may argue that corruption risk indicators at the individual contract level may be quite noisy; that is, some contracts may require exceptional procedures given product or market specificities which can explain the presence of some red flags. However, when aggregating risk information at the organizational level, it is possible to identify more robust patterns. For example, a municipality that occasionally awards high-risk tenders might still maintain high integrity, but if it awards nearly all contracts using high-risk practices, it indicates weak institutional control of corruption. Thus, we examine average organizational CRI scores for both buyers and suppliers.

Figure 6: Distribution of procurement authorities by their average CRI , North Macedonia, 2011-2022.

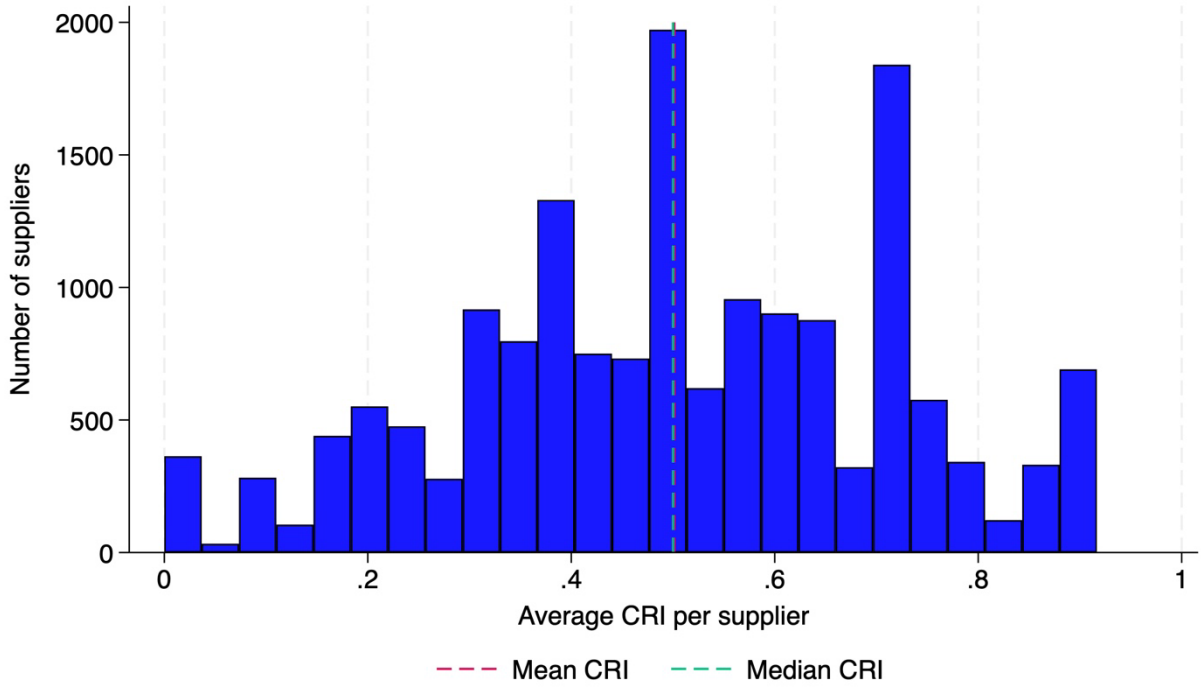


Examining the distribution of procurement authorities by their average CRI scores in North Macedonia in the period 2011-2022, the mean is 0.48. The distribution of the procurement authority-level CRI is skewed to the right with the majority of contracts centered around 0.45-0.55 and fewer contracts with high values (Figure 6). The maximum in these CRI scores means that there is a high number of government agencies that predominantly use procurement practices of moderate risk of corruption. Interestingly, almost none of the public bodies are located in the low levels of CRI (CRI equal to zero or very close to it), meaning that there is at least some degree of risks in the procurement process. On the other end of the scale, there are 12 government agencies, out of the 1,470 in total, that score higher than 0.75 on average, that is systematically contracting with very high risks across their contracts.

We observe an uneven distribution of CRI for suppliers (see Figure 7) where similar to buyers, the distribution is skewed to the right. However, there is more variety in the observations on the right side of the distribution, with a higher number of organizations scoring higher CRI values. In

contrast to the buyers which are more concentrated, the supplier-level histogram is more scattered and diverse. While most of the awarded firms participating in public procurement face some competition and bid on somewhat open tenders, there is a considerable number of firms prone to high corruption risks with an average CRI of 0.5.

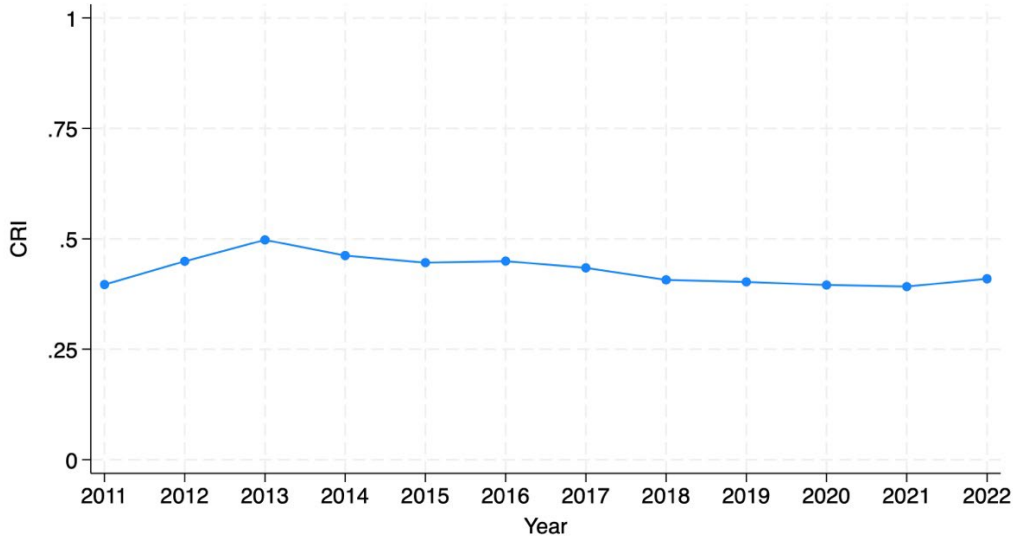
Figure 7: Distribution of awarded firms by their average CRI, North Macedonia, 2011-2022.



Focusing on the overall trend of CRI from 2011 until 2022 corruption risks in public procurement have slightly decreased (Figure 8). From 2011 to 2013 corruption risks experienced a small increase of 0.1 percentage points. From 2013 to 2021 they slightly decreased. During this period a new law in public procurement in North Macedonia was introduced which could have contributed to this modest decrease. The law mandated that the award decision should be made based on economic advantage rather than choosing the lowest bid. In addition, it enforced equal treatment of local and foreign entities. For 2022 compared to 2021 there has been a slight increase of 0.017 percentage points so far. Moreover, there is a marked seasonality of corruption risks, largely following annual budgeting cycles: the first quarters are often characterized by lower corruption risks, whereas the fourth quarters typically see a jump in CRI.[4]

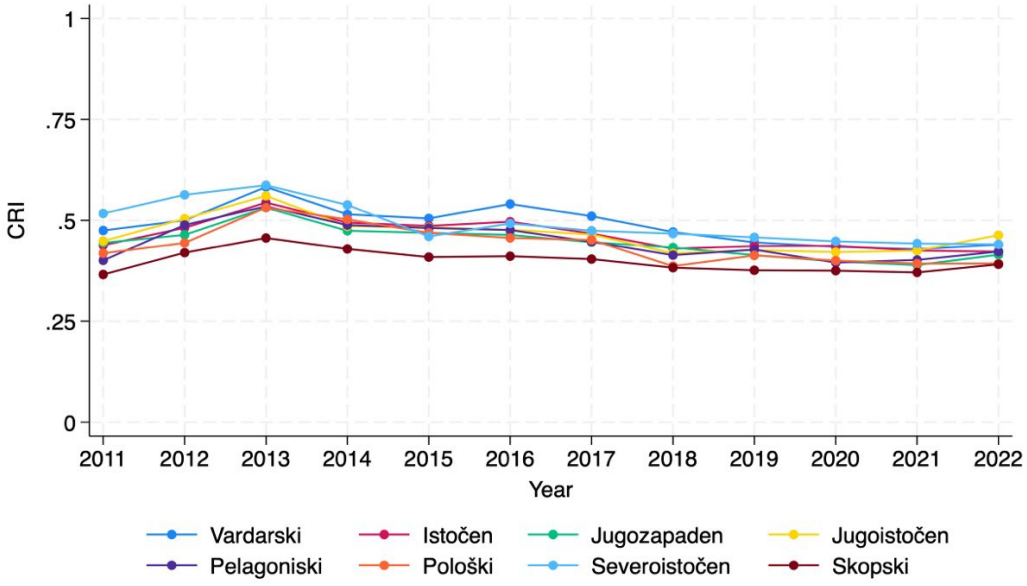
[4] This is consistent with results from the U.S. where spending in the last week of the year is 4.9 times higher than the rest-of-the-year weekly average, and year-end information technology projects have substantially lower quality ratings (Liebman and Neale Mahoney, 2017).

Figure 8: Annual average CRI, North Macedonia, 2011-2022



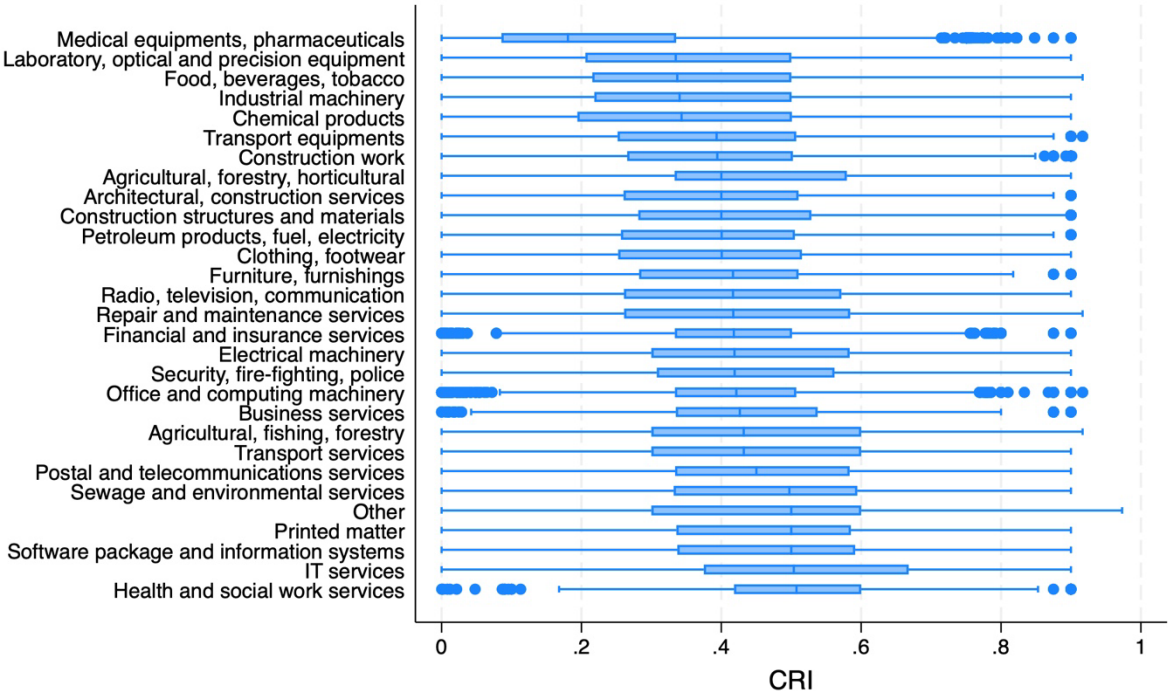
So far, we have analyzed the overall distribution of the CRI, now we focus on the regional level to see whether there are important differences. Figure 9 displays the average CRI by region and year in North Macedonia. Quite interestingly, there is a small variation across NUTS-3 regions and they have followed the same trends during the past decade. In addition, the values seem to be converging. Skopje has the lowest CRI on average however, some of the contracts still reach values close to one, a value that signals high risks of corruption.

Figure 9: Average CRI per contract trends across regions, North Macedonia, 2011-2022



Vardarski and Severoistočen are the two regions that have the highest CRI on average (0.485 and 0.479). While Skopje which is the most developed region has the lowest risk level (0.39). It should be noted that Skopje is the region where 52% of procurement contracts are awarded which account for around 80% of the overall contract value.

Figure 10: CRI by industry, (number of contracts>1000)



Next, we look at CRI differences across sectors in Figure 10. In 2011-2022, the sectors where procurement contracts have the highest CRI levels are IT services such as software development, internet and support services; and health and social work services. While the sectors with the lowest CRI levels are the medical, pharmaceuticals and laboratory equipment. Furthermore, in each sector there are contracts with CRI values of 0.8 and higher indicating that each sector harbors some sub-sectors and contracts prone to high corruption risks. However, looking at trends over time by sector could be more informative and that is why we plot the values for each sector by quarter. For example, the construction sector is one of the sectors with lower CRI values on average, contrary to popular perceptions, at least up until 2019 (Figure 11). However, from 2019 this sector has experienced a big jump in CRI and has converged to the other sectors' average value.

Interestingly, there has been a rise in CRI values in many sectors in 2019 while from 2020 the start of the pandemic, CRI values have experienced only small changes. This holds also for the health sector (Figure 12). Especially for the health and social work services CRI values jumped in 2019 and have stayed high.

Figure 11: CRI trends for the construction sector compared to the other sectors, 2011-2022.

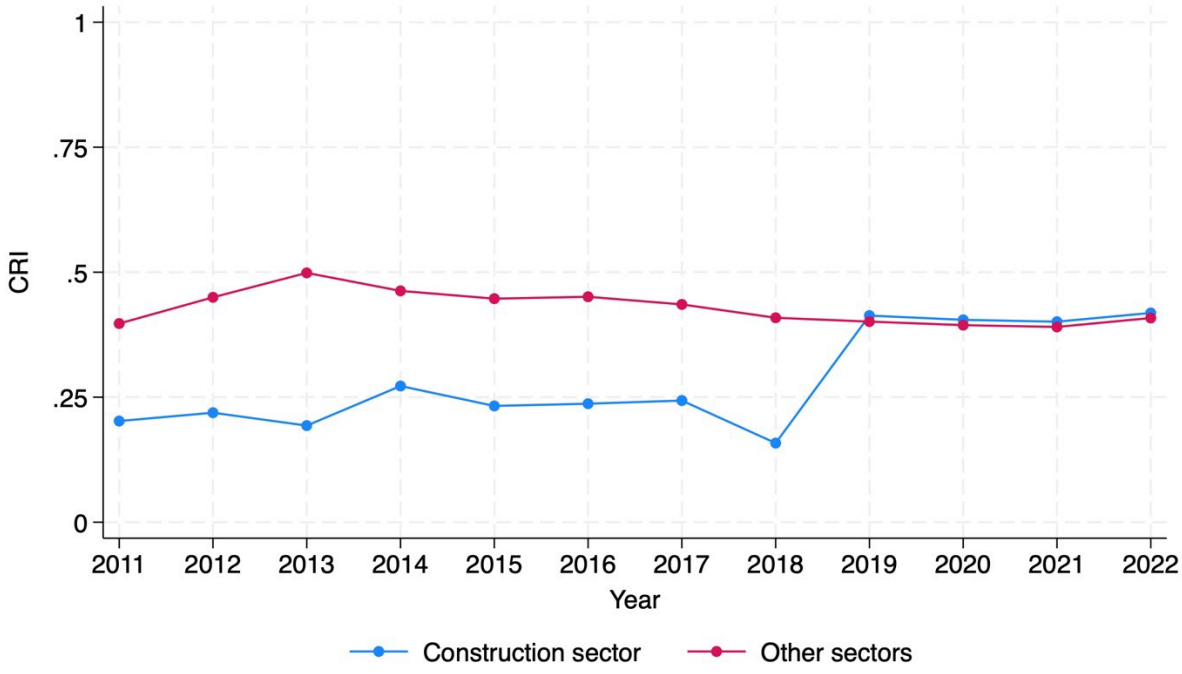
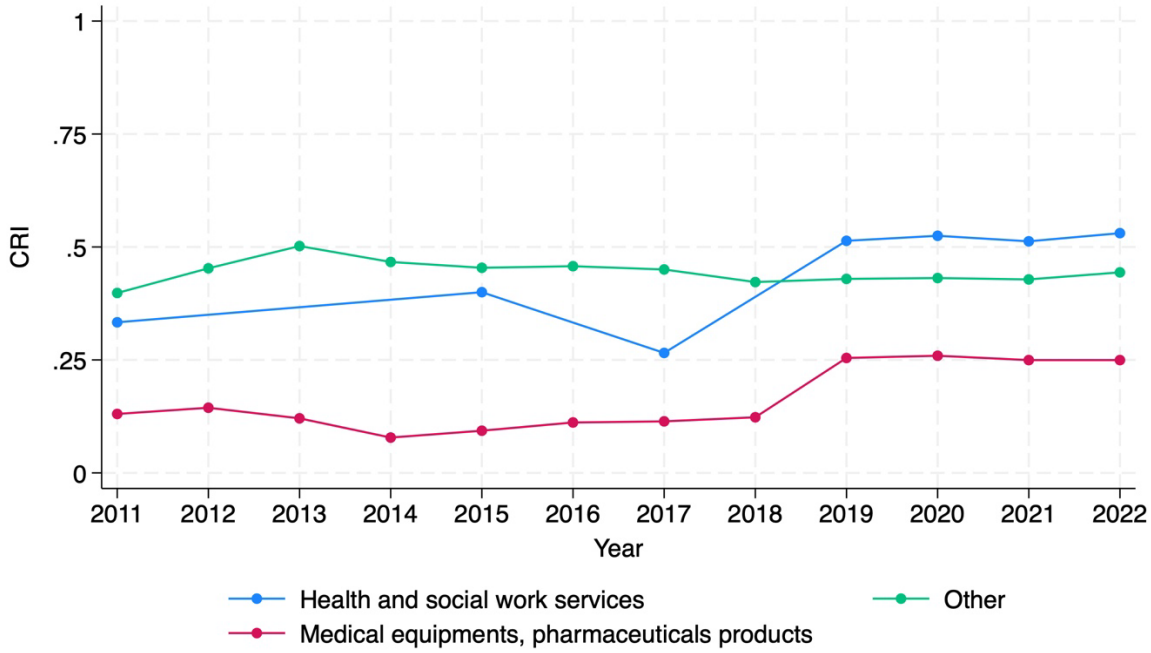
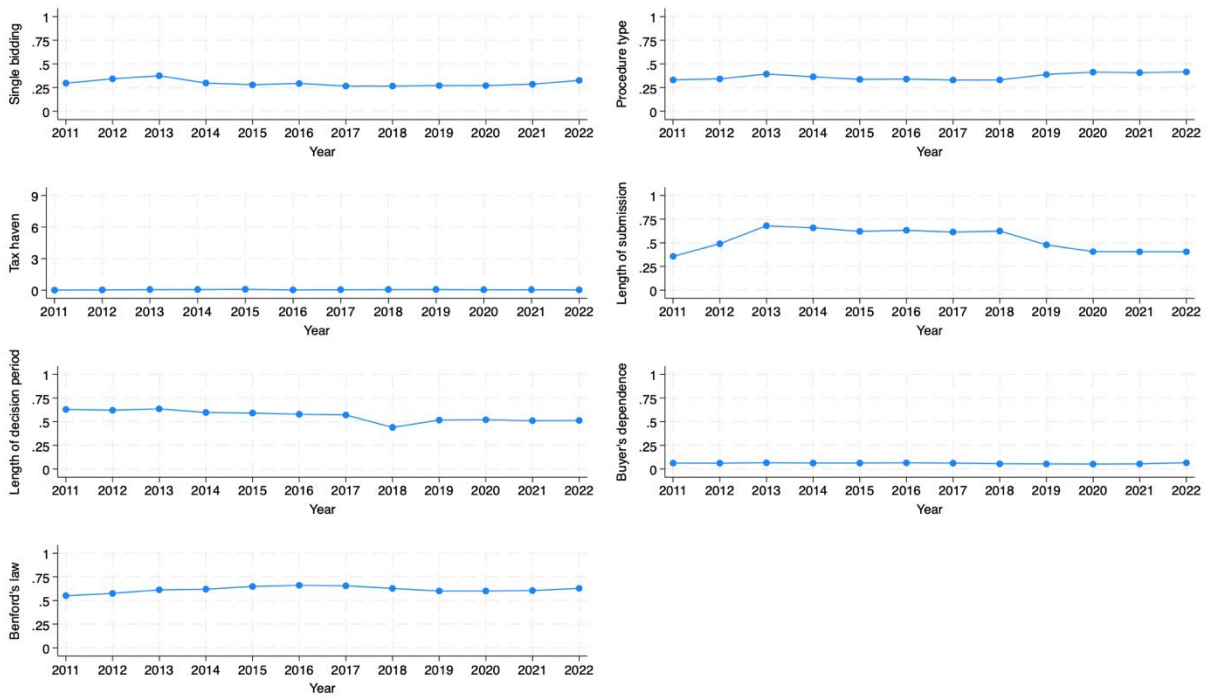


Figure 12: CRI trends for the health sector compared to the other sectors, 2011-2022



We proceed by looking at the seven sub-indicators from which the CRI is composed in Figure 13. One of the key CRI components is the single bidding indicator which shows if a tender had only one bidder during the procurement process and therefore signals a lack of competition. In North Macedonia, for 2011-2022 the indicator on average has a value of 0.29 which means that one in every three contracts has a single bidder. In total for this period, 78,474 contracts are single bidders. The number seems to have slightly increased from 2020 where in 2022 thirty-three percent of the contracts have a single bidder. Furthermore, there seems to be a connection between single bidding and the length of the advertisement period. Around 60% of contracts that have a single bidder also have a short advertisement period which can signal corruption practices. Even so, the indicator of the advertisement period during Covid-19 has remained constant.

Figure 13: Annual trends for individual red flags

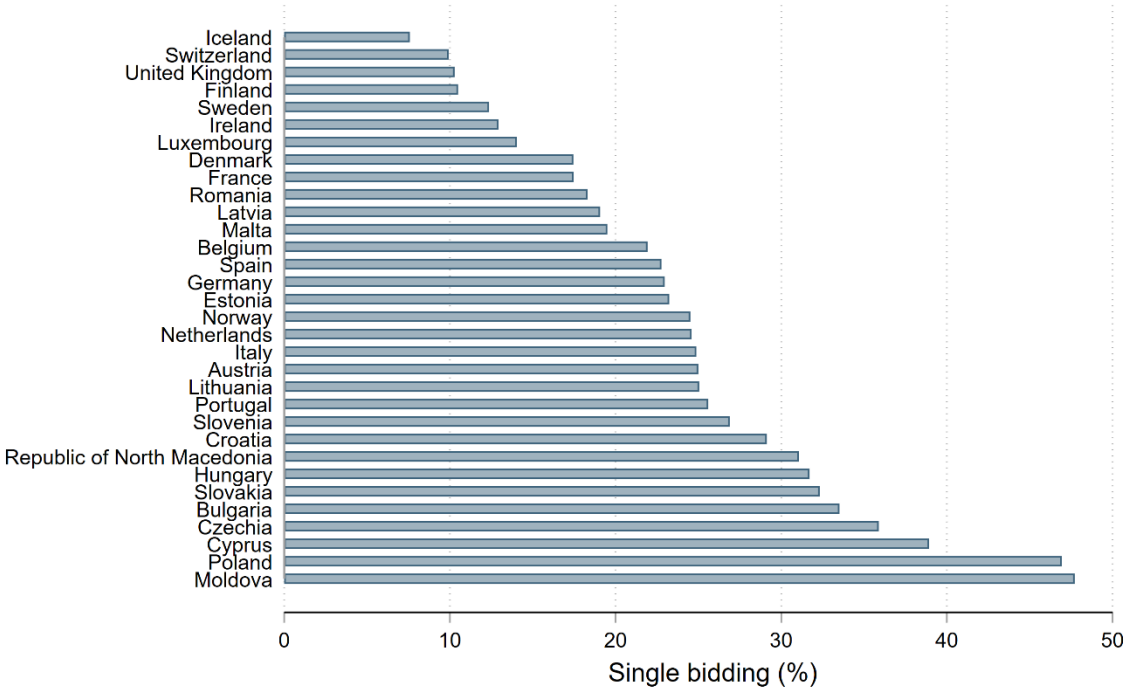


The sub-indicator that shows the length of the decision period has slightly increased during the pandemic. This sub-indicator shows the time difference between the submission deadline and the announcement of the contract award. If for example, a decision period takes a very short time it can indicate that the consideration of competitors was marginal and one specific company was preferred. Buyer's dependence, which measures the share of the contracts' value received from the same procurement authority to the same company, scores low values. So at least at an aggregate level, we do not find such widespread risks. Another sub-indicator that has slightly increased over the analyzed period is the non-open procedure type. This indicates the type of procedure by which the tender will be contacted. On average, 67% or 180,560 of the awarded contracts indicate a medium-risk, 30% low-risk, and only 3% high-risk procedure type. Two important sub-indicators which have had considerable high values for North Macedonia during 2011-2022 are the tax haven and Benford's law. A critical number of contracts are awarded to

suppliers that have headquarters registered in a tax haven. Since 2011 this indicator has increased and had consistently high values, at least in international comparative perspective. Many corruption issues can prevail due to this issue as being registered in a tax haven increases the difficulty of finding the beneficial owner of the company. Additionally, contract pricing distribution, as determined by Benford's law, appears to have problems. Even though this indicator has slightly decreased since 2011 it has remained consistently high over the analyzed period.

Compared to other EU countries' public procurement contracts published on TED, North Macedonia is among the highest risk countries in Europe. Its single bidding rate of 0.32 on average is among the highest, close to the Slovak Republic, Hungary and Bulgaria (Figure 14). Slovenia and Croatia's rates are slightly better than North Macedonia's, ranking it slightly below the 0.3 threshold. The next section will further explore the issue of contract pricing and how much can be saved in the case of correct pricing.

Figure 14: Average single bidding rate in North Macedonia and the EU (TED data)



Relationship between corruption risks and prices

This section analyzes the price impact of corruption risks in public procurement in North Macedonia. We attempt to quantify the potential savings that can be achieved if corruption risks were eliminated. To measure how pricey a contract is, we use the relative price which is a ratio between the final contracted price and the estimated contract value (i.e. auction reference price). The relative price captures the discount achieved by procurement authorities. We expect that tenders with high corruption risks suffer from higher relative prices. In other words, the ratio between the contracted price and the estimated contract value would be higher or, in more extreme cases, the final contracted prices would be higher than the estimated prices.

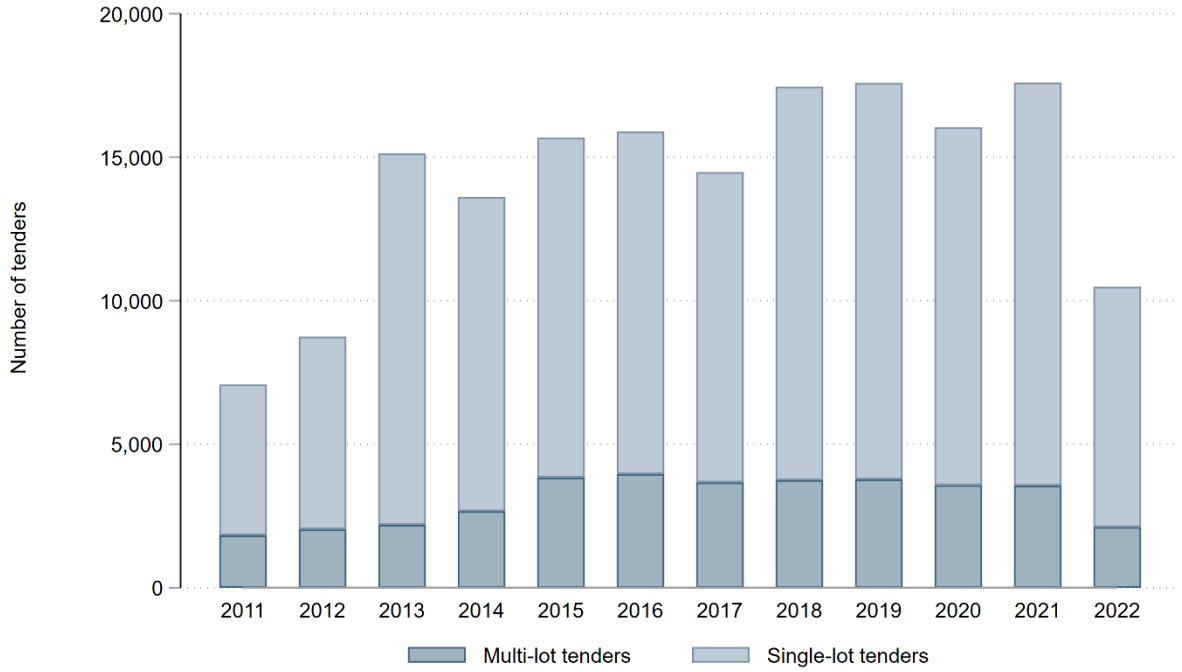
The method can be briefly summed up as follows: We run a linear regression model using CRI as the main predictor of the logarithm of relative prices (we use logarithm of prices to account for the uneven price distribution). The model controls for differences in contract value deciles, procuring authority type and location, supply type, product market (2-digit CPV divisions), year and month. We also test the corruption risk-price relationship with the individual corruption risk indicators and calculate the expected savings achieved if policy makers were to focus their efforts on reducing the risk scores of a specific corruption risk indicator. Based on the best fit estimation model (i.e. highest explanatory power), we predict the relative prices for each contract in the case of zero CRI (lowest possible corruption risk score). These no-risk contract value estimations enable us to estimate the savings to be made in each sector, time period, or geographical location. This method is further discussed in Abdou, Basdevant, David-Barrett & Fazekas (2022).

We need accurate contract/lot level estimated contract values to calculate relative prices achieved by procuring authorities in the contracting process. However, the North Macedonia's data portal only publishes estimated contract values at the tender level with no way to accurately break it down to the contract or lot level. Therefore, the analyzed sample had to be restricted to single-lot tenders where tender and lot values are necessarily the same. Furthermore, we also restrict relative prices to fall between 0.5 and 1.3 – as ratios outside this range might be due to data reporting errors. In Figure 15, panels A and B, we display the distribution of tenders in the dataset split over single-lot and multi-lot tenders.[5] Single-lot tenders represent 78.3% of all tenders (132,902 tenders) and 65.6% (335.5 billion MKD) of the total contract value available in the dataset.

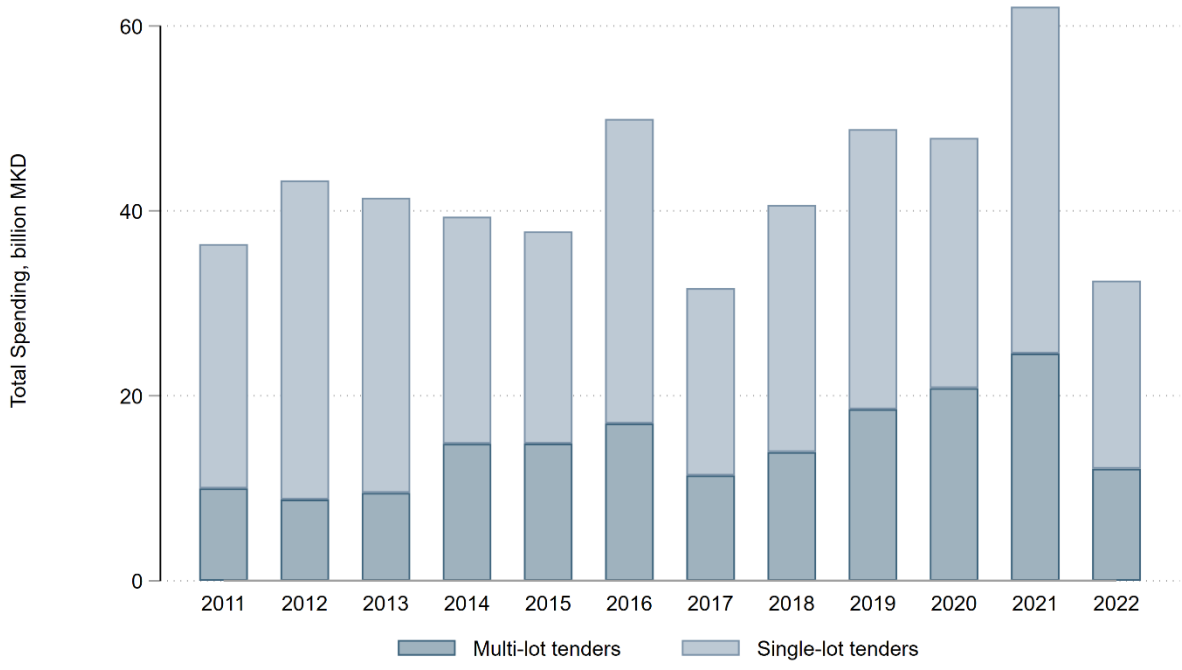
[5] We count the single-lot tenders based on the CFT notice url appearing only once in our lot level dataset.

Figure 15 Distribution and spending of multi-lot and single-lot tenders

Panel A: Annual distribution of tenders across multi-lot and single-lot tenders in North Macedonia, 2011-2022



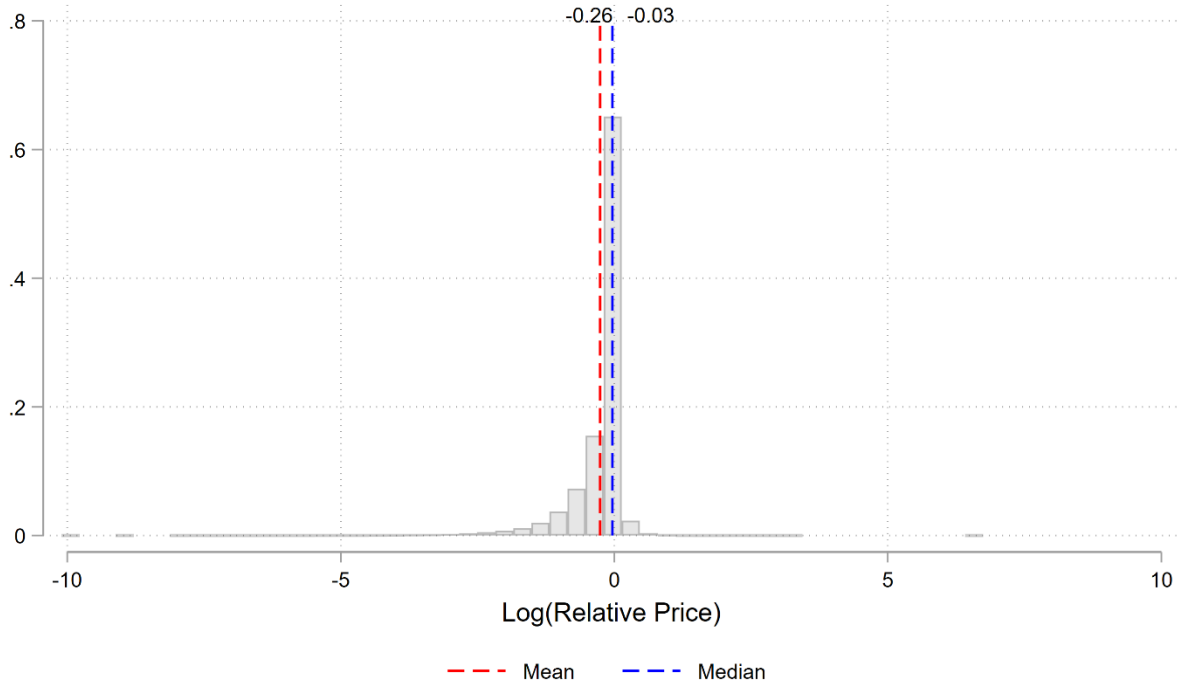
Panel B: Annual total spending in multi-lot and single-lot tenders in North Macedonia, 2011-2022



The distribution of relative prices is by design highly skewed distributions as most contract values are very close or equal to the reference prices, indicating limited competition and bidders

matching their bids to the auction information. We transform the relative prices to their logarithmic values to normalize the distribution to fit the model's assumption in Figure 16. We model the contract's composite risk scores (CRI) as the main independent variable in different estimations by gradually adding our control variables. Table 3 shows the improvement of fit in each subsequent model and the strengthening of the relationship between CRI and the logarithm of relative prices. We consider model 4 as best because it includes the full set of control variables.

Figure 16: The distribution of the logarithm of relative contract value in single-lot tenders



The final model shows a significant positive association between CRI and (log)relative prices. Model (4) shows that a one unit increase in CRI is associated with a 17.9% increase in the relative price when all risk factors were eliminated (i.e. CRI scores changed from 0 to 1). In other words, the model estimates that eliminating all risk factors in a high risk contract (CRI = 1) is associated with a 17.9% lower relative price on average.

Table 3: Regression results quantifying the correlation between CRI and the logarithm of relative price North Macedonia 2011-2022

Independent variables	Log(Relative price) is the main dependent variable (1)	(2)	(3)	(4)
CRI	0.069*** (0.008)	0.173*** (0.009)	0.175*** (0.009)	0.179*** (0.013)
Contract value deciles		Yes	Yes	Yes
Contract supply type		Yes	Yes	Yes
Contract market (CPV division)		Yes	Yes	Yes
Buyer Locations (NUTS codes)			Yes	Yes
Buyer types			Yes	Yes
Year				Yes
Month				Yes
N	113,747	113,747	113,747	113,747
R^2	0.006	0.107	0.109	0.114

Standard errors clustered on CPV divisions shown in brackets below the coefficients. The stars represent the significance levels *** p<0.01, ** p<0.05, * p<0.1

We also perform a similar analysis as above using each individual corruption risk indicator. For models 1 to 7 in Table 4, we use each corruption risk indicator as the main dependent variable and estimate its impact on relative prices. All individual risk indicators have a positive relationship with relative prices.[6] Eliminating single bidding from public tenders is associated with a 7.2% decrease in relative prices whereas relying on open procedures instead of high risk, non-open procedure types is associated with a 5.7% decrease in relative prices.[7] Similarly, avoiding higher risk, that is shorter, advertisement and decision periods is associated with a 6.2% and 1.3% decrease in relative prices, respectively. While full, detailed identification of causal impacts is beyond the scope of this paper, the results suggest that corruption risks are likely to have a considerable impact on prices and reducing those risks can help increase the procurement authorities' savings in procurement.

Table 4: Regression results quantifying the correlation between corruption indicators and the logarithm of relative price in North Macedonia 2011-2022

Independent variables		Log(Relative price) is the main dependent variable Coefficient (Cluster Std. errors in bracket)	N	R^2
Model 1 Single bidding	High Risk	0.072*** (0.006)	113,747	0.123
Model 2 Procedure type	High Risk	0.057** (0.020)	113,747	0.094
Model 3 Advertisement period	High Risk	0.062*** (0.005)	113,747	0.097
Model 4 Decision period	High Risk	0.013*** (0.002)	113,747	0.089
Model 5		0.038		

[6] The coefficient in Model 5 using Tax haven registration as the main indicator was not significant as there were only 12 instances within the analyzed sample.

[7] Procedure type risk was switched to binary indicator for the price impact analysis because there was only one instance of the high risk type within the filtered analysis sub-sample.

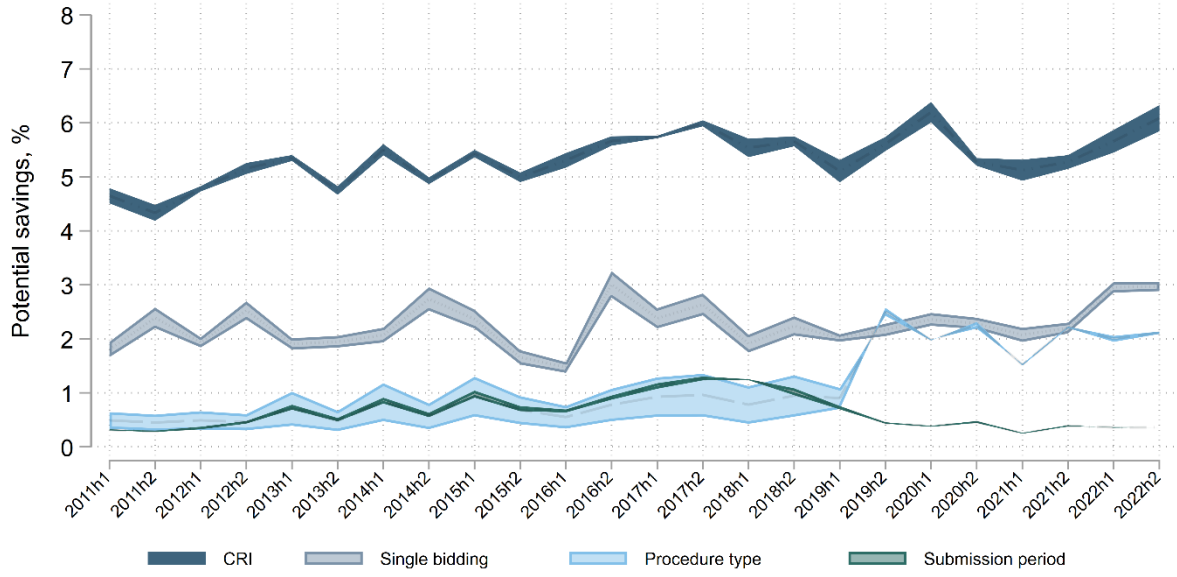
Tax Haven	Supplier registered in a tax haven	(0.036)	113,747	0.088
Model 6		0.007***		
Benford's Law	High Risk	(0.002)	113,747	0.093
Model 7		0.047***	81,334	0.003
Supplier Dependence		(0.006)		

All regressions control for contract values, buyer types and locations, contract's supply type and markets identified by CPV divisions, and contracting year. Coefficients for control variables have been removed for readability. The stars represent the significance levels *** p<0.01, ** p<0.05, * p<0.1

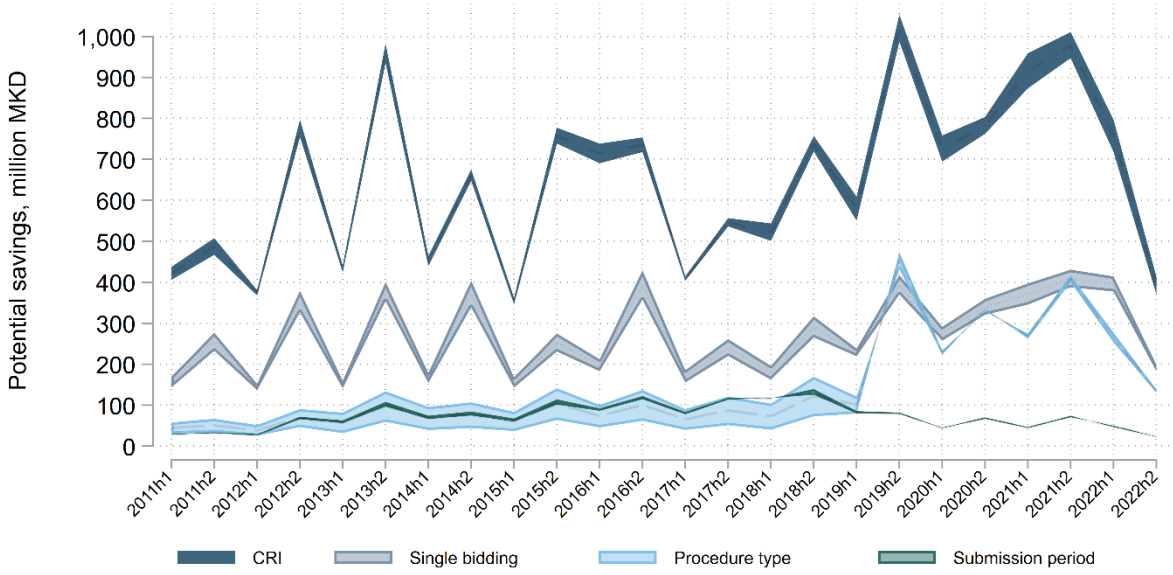
After choosing the model that best fits the data, we are able to predict the relative prices of contracts under counterfactual scenarios such as a no-risk scenario. We compute the counterfactual contract values when CRI and each corruption risk score is reduced to 0. By comparing the counterfactual contract value and the true contract value, we estimate the savings that can be achieved for each contract in the no-risk scenario. It is essential to keep in mind that the calculation of savings is based on the initial CRI scores of each contract. Therefore, if a contract has a low initial CRI score, the savings calculated for that contract will also be low, and these savings will be reflected in the overall savings calculation. Therefore, we estimate a total savings of 5.3% of total spending which amounts to 15.49 billion MKD in North Macedonia between 2011-2022. The savings amount for each contract can be aggregated over different levels in order to gain a better understanding of the distribution of total potential savings over geographical locations, product sectors and time periods. In Figure 17, we show one of those possible aggregations. We plot the trend lines of savings as a percentage of total spending in panel A and the total amount in million MKD in panel B, by budget quarters. We observe an increase in potential savings on the right panel of Figure 16 due to the increasing CRI scores in the later time period.

Figure 17 Potential savings after eliminating procurement corruption risks (CRI), North Macedonia, 20122-2022

Panel A: Half Yearly potential savings rate by eliminating CRI and other selected corruption risk indicators



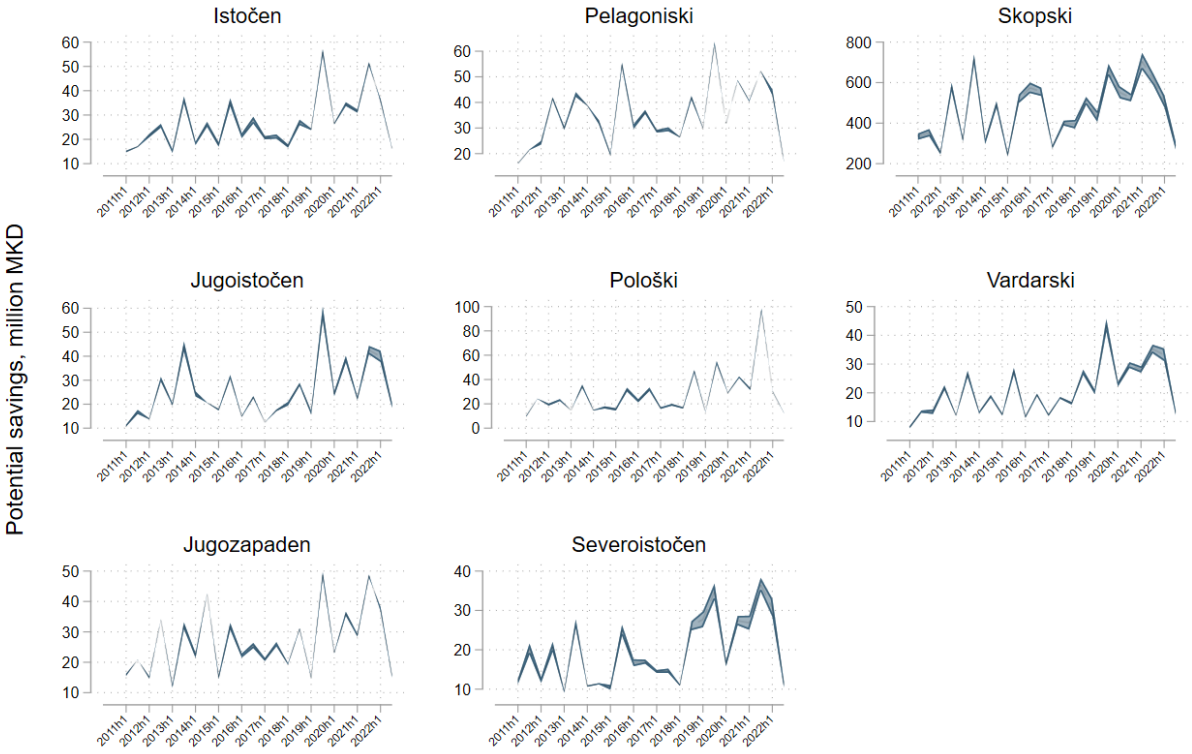
Panel B: Half Yearly potential savings in million MDK by eliminating CRI and other selected corruption risk indicators



The counterfactual contract values are estimated from the models in Tables 3 and 4 by predicting relative prices in the case of no corruption risk (i.e CRI = 0).

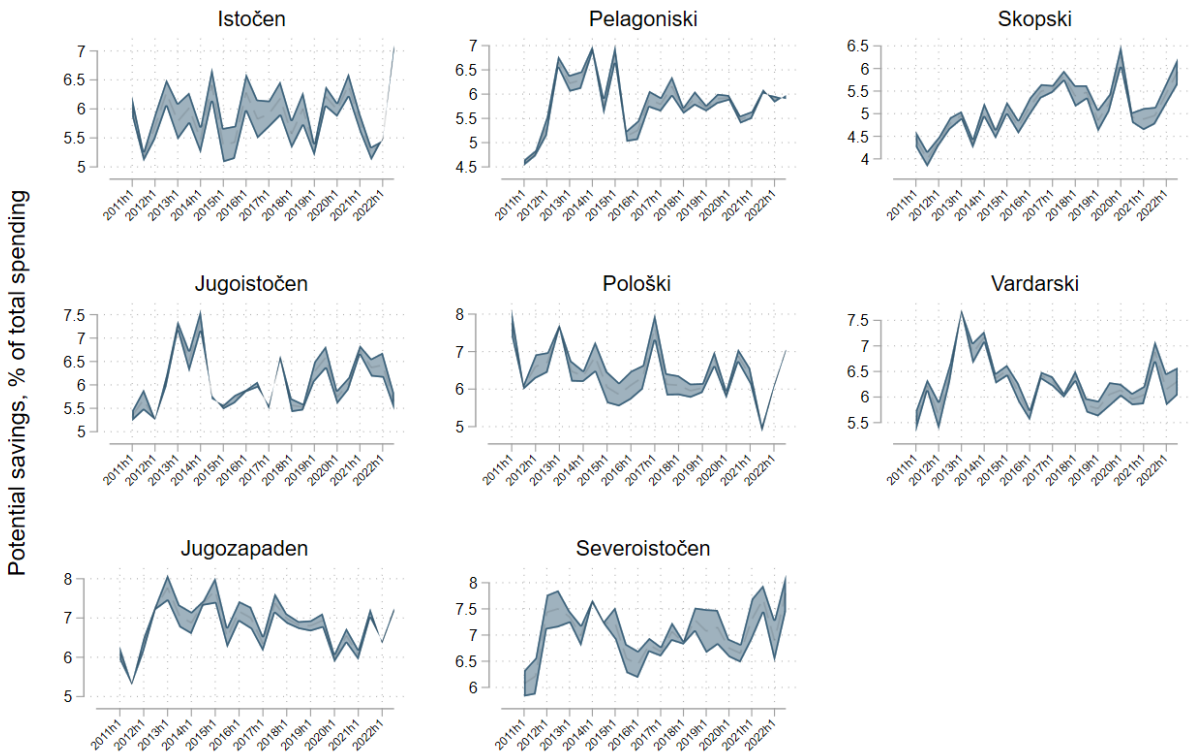
Furthermore, we aggregate the savings over all the regions of North Macedonia. We mainly find that a total of 11.1 billion MKD can be saved due to eliminating all corruption risks (i.e decreasing CRI scores to 0) in Skopski compared to 842.6 million MKD in Pelagoniski and 470.3 million MKD in Severoistočen. In Figure 18, we display the quarterly distribution of the total savings across regions. The upward saving trend observed in most regions like Skopski, Vardarski, and Istocen can be directly linked to the increasing trend of CRI scores in those regions due to the positive correlation of CRI scores and savings explained above.

Figure 18: Distribution of potential savings (million MKD) by eliminating all procurement corruption risks (CRI) across regions in North Macedonia 2011-2022



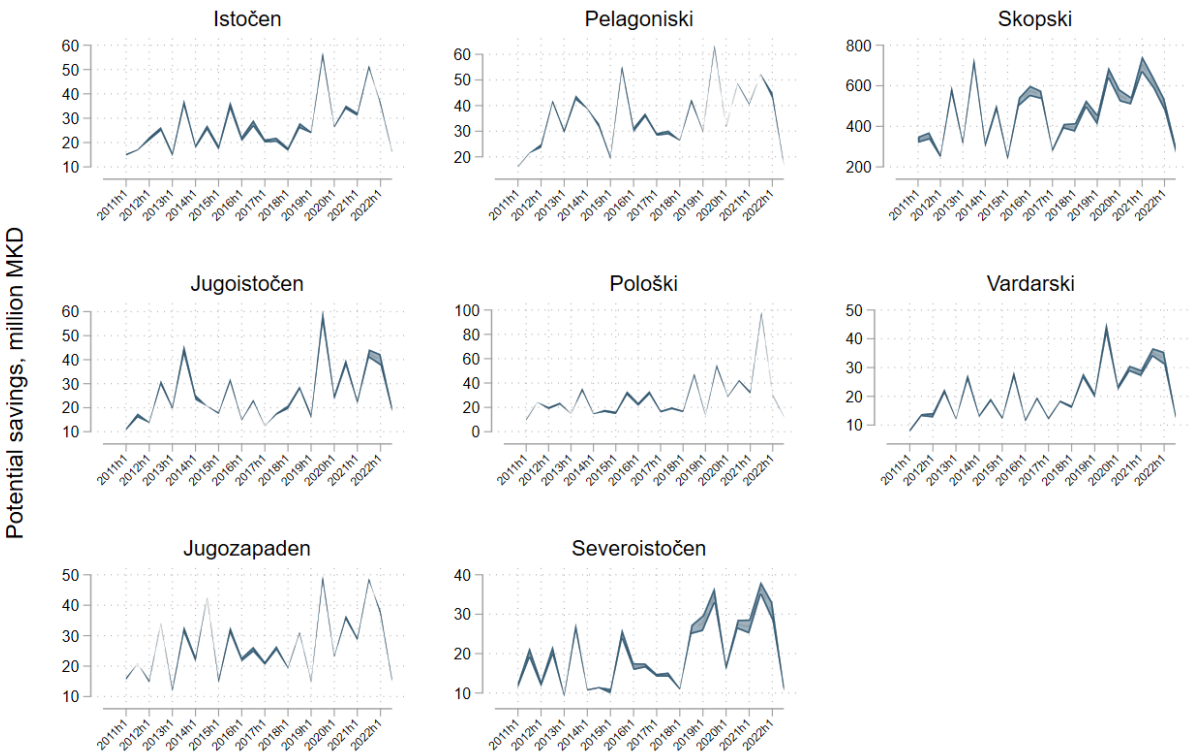
Despite the majority of spending taking place in Skopski, we see a higher potential for cost savings as a percentage of overall spending in nearly all other regions. As seen in Figure 19, our models estimate a potential savings rate of around 5 percentage points of total spending in Skopski whereas the rate fluctuates around 6-8 percentage points in the rest of the regions by eliminating all corruption risks. However, the potential saving rate increases over the years in Skopski as it decreases in Jugozapaden, Položki, Vardarski and remains almost stable in the rest of the regions.

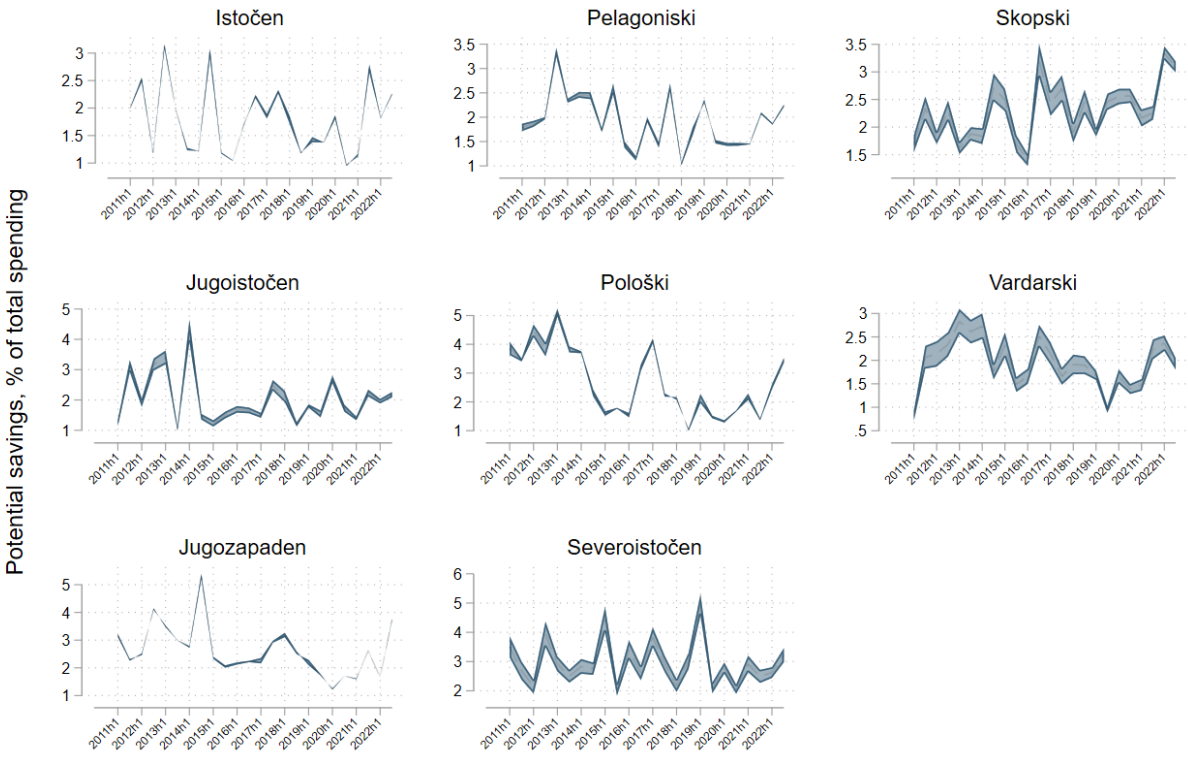
Figure 19: Distribution of potential savings (percentage points) by eliminating all procurement corruption risks (CRI) across regions in North Macedonia 2011-2022



In order to offer a more fine-grained view, Figure 20 displays the savings rate that can be achieved by only eliminating single bidding in each region. We previously found that single bidding is the strongest predictor of relative prices in North Macedonia (Table 4) and we can see in Figure 19 that from the total 5 percentage points of savings in Skopski, around 2-3 percentage points is due to single bidding alone. The trend lines of savings due to single bidding are closely related to the rates of single bidding in those regions.

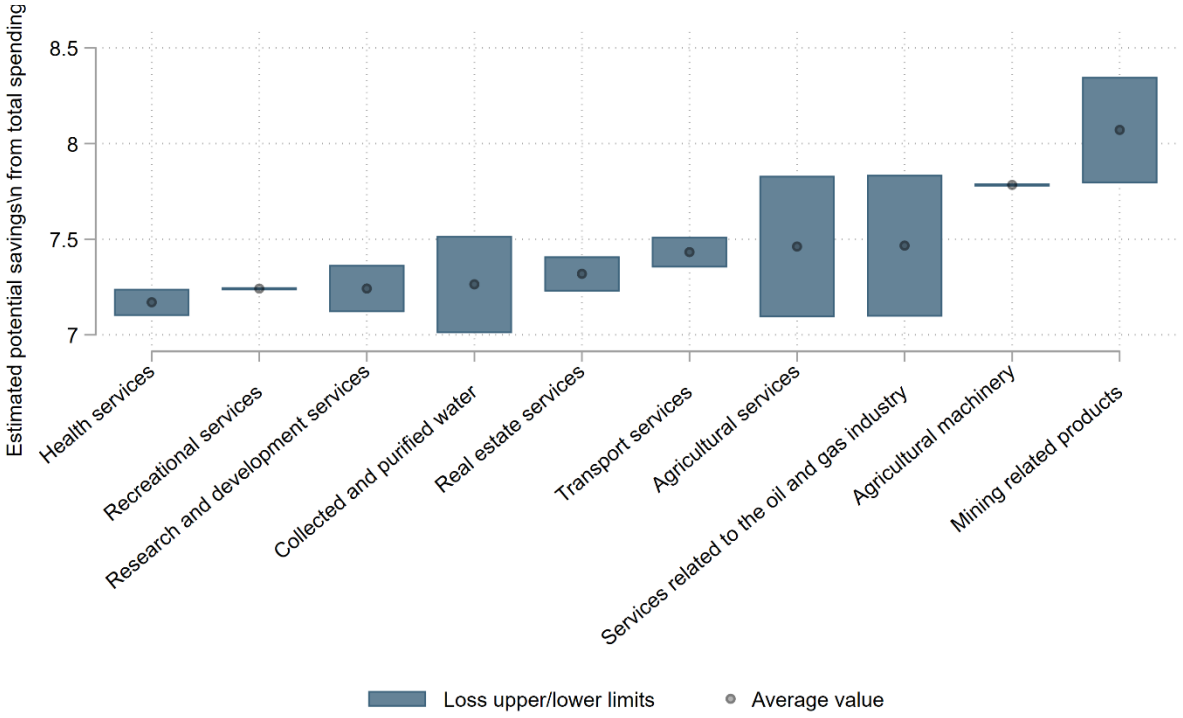
Figure 20: Distribution of potential savings (percentage points) by eliminating single bidding corruption risk across regions in North Macedonia 2011-2022





Finally Figure 21 shows the potential savings rates due to reducing the composite CRI in each CPV division. On the one hand, we find that the CPV divisions 14 Mining related products,16 Agriculture machinery, and 76 Oil and gas services are the sectors that have the greatest potential savings as a percentage of total spending. However, it is common for these critical industries to have higher risk scores compared to other sectors since they operate with a limited number of potential suppliers in most economies. On the other hand, public utilities, construction and mining equipment, and the architectural and construction engineering services sectors have the lowest potential savings as a percentage of total spending. More specifically the public utilities CPV division demonstrated a much lower potential savings rate at 3% compared to the country average. This is due to the public sector division having a low CRI score, and more specifically a much lower single bidding rate compared to the country average.

Figure 21: Distribution of potential savings (% of total spending by eliminating all procurement corruption risks (CRI) across regions in North Macedonia 2011-2022 – Top 10 CPV divisions by highest saving potential



State capture risks in North Macedonia's public procurement

In this section, we outline our methodology for proxying state capture in public procurement using large-scale network analysis. We then apply this approach to analyze patterns of state capture in North Macedonia between 2011 and 2022.

To begin, we provide an overview of the North Macedonia's public procurement contracting network and examine the level of cohesion across all sectors. We then leverage a government change in 2017 to observe the reconfiguration of the network before and after this political event. Next, we conduct an exploratory analysis of the construction sector to demonstrate the changes in the network structure and several network metrics before and after the government change of May 2017. Finally, we briefly review the configurations of ego networks of selected entities to determine the extent of state capture at the procurement organization level.

While this approach is complementary to analyzing political connections of suppliers, it offers a more comprehensive view of state capture across the entire procurement market. Estimating state capture through direct political connections is a robust approach, it may underestimate the true extent of state capture, as not all connections are easily discernible from publicly available information such as asset declarations. Therefore, the two approaches should complement each other for the most accurate estimation of state capture.

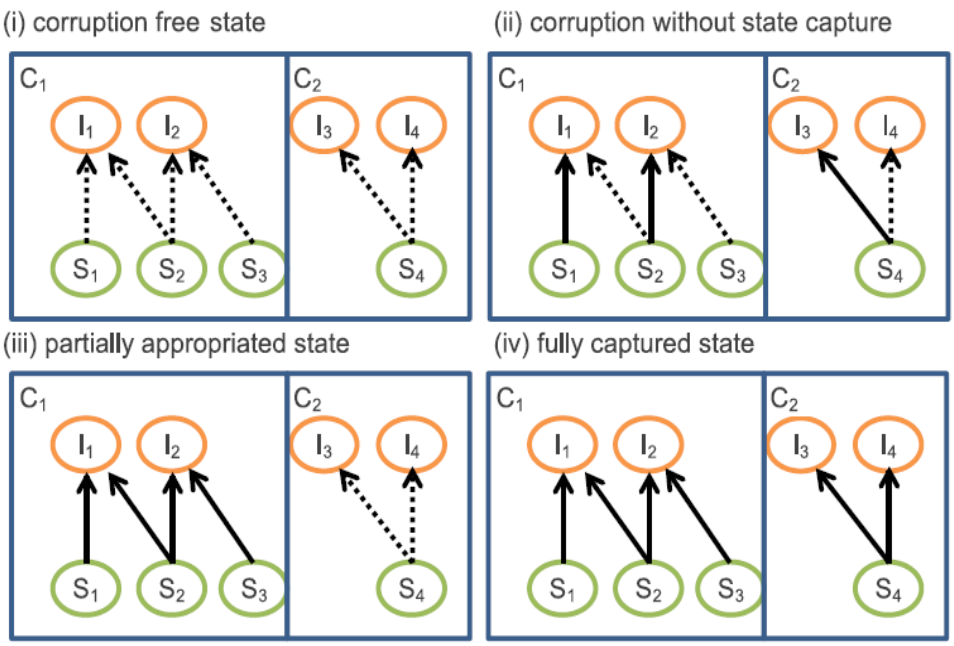
How we estimate state capture

The concept of state capture is defined as a group-level phenomenon in which private sector companies and public procurement authorities collude to dominate government contracting and extract private benefits from public resources. This can occur in either direction, with the state dominating a network of suppliers or the other way around. State capture results in a failure to achieve public goals and obtain high value for public money.

Our method for assessing state capture involves differentiating the extent and distribution of corrupt practices in public procurement among suppliers and procurement authorities. This analysis is conducted through the lens of networks, with the aim of identifying patterns of corruption risk incidence and clustering of such risks. By utilizing this approach, it is possible to pinpoint state capture networks that are separate from both clean and randomly corrupt contracting networks. The framework is designed to not only identify high corruption risk connections, but also to take into account the consistency and interconnectedness of these patterns in order to point at captured contracting networks.

To demonstrate the essence of our network approach, four ideal types of contracting networks are described based on the degree and distribution of corruption risks: clean networks, corrupt but not captured networks, partially captured networks, and fully captured networks. A simplified version of these network structures is depicted in Figure 22.

Figure 22: Theoretical network configurations of corruption and state capture



Source: Fazekas and Tóth (2016), p.323

In this diagram, procurement authorities and suppliers are represented as I and S respectively. The solid lines represent contracts with high corruption risk, while the dashed lines indicate low corruption risk contracts. The first panel illustrates a clean network, with no high corruption risk ties in either of the two clusters (C1 and C2). The second panel depicts corruption without state capture, where high corruption risk ties are randomly distributed among different procurement authority-supplier clusters. Although the integrity of the procurement system may be weakened, there are no systematic abuses by participating firms and public entities. The third and fourth panels showcase two examples of state capture, namely partial and full. In the third panel, the high corruption ties are concentrated in one procurement authority-supplier cluster, making public organizations I1 and I2 vulnerable to capture, but not I3 and I4. In the fourth panel, high corruption ties dominate both clusters, resulting in full capture of public organizations and suppliers.

In practice, contracting networks are typically characterized by dense ties within clusters and sparse ties across clusters, and the corruption risk index (CRI) is a continuous indicator enabling a careful assessment of risks. Hence, the identified clusters may only differ in the degree of corruption risk associated with their contractual relationships. For a more detailed discussion of the state capture concepts and measurement, refer to Fazekas and Tóth (2016).

Mapping state capture risks across North Macedonia

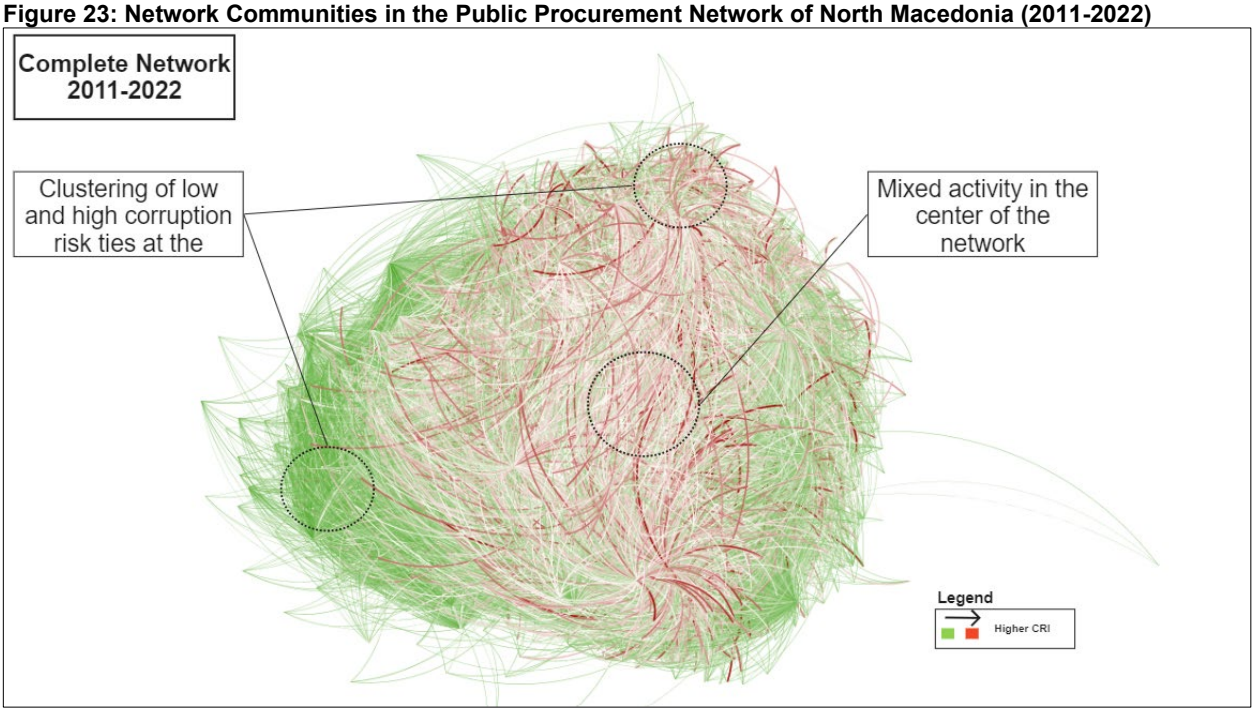
In this subsection, we examine the public procurement network in North Macedonia spanning from 2011 to 2022. Our primary objective is to conduct an empirical evaluation of state capture patterns present in the complete contracting network. By utilizing this approach, we aim to gain a comprehensive understanding of the extent and degree of state capture risks across various grouping variables, including geographical regions, time periods, and economic sectors.

The first step in the process is to condense the contract dataset into bi-modal graph data, which is achieved by calculating the average CRI score for each unique pair of buyers and suppliers. This aggregation process involves analyzing a total of 267,295 contracts which ultimately results in 92,195 distinct relationships represented as ties between nodes in the graph. The contracting network analyzed in this study has a total value of 512 billion MKD, which is distributed across 45 CPV sectors. The median procurement authority has 393 contracts, with a total value of 304 million MKD and a CRI score of 0.48. The median supplier in the network has 50 contracts, with a total value of 40 million MKD and a CRI score of 0.44. On average, a tie between a procuring authority and a supplier in the network represents 2.9 contracts, with a total value of 5.5 million MKD and a CRI score of 0.45. However, it is worth noting that the distribution is heavily skewed towards larger organizations, as the median value of a tie is only 500,000 MKD.

For the network representations that follow, our focus is solely on organizations with more than one tie. This allows us to capture contracting patterns across organizations, as isolated nodes offer limited insights in this regard. Additionally, we focus on the main component of the network to present a comprehensive analysis. As a result of this filtering process, we reduce the number of ties under investigation by 22%. In Figure 23 we present the complete contracting network in North Macedonia between 2011 and 2022.[8] Each link in the figure denotes a relationship between a buyer and supplier, with the color coding representing the average CRI between the two parties. It is clear that the low and high corruption risk ties are clustered together in the peripheral regions of the network. This clustering of high corruption risk ties suggests a higher likelihood of misconduct in those areas. In contrast, the center of the network features contracting activity with mixed corruption risk scores, depicted by the presence of white ties.

[8] To improve the clarity of the figure, we have chosen to display only the ties between the nodes, omitting the nodes.

Figure 23: Network Communities in the Public Procurement Network of North Macedonia (2011-2022)



Blondel et al. (2008) proposed a modularity method for detecting communities in large networks, which has been implemented in tools such as Gephi[9]. The algorithm iteratively partitions the network into communities by maximizing a modularity score. Communities are defined as groups of nodes with more connections within the group than expected by chance. The algorithm merges nodes into communities until no further increase in modularity is possible.

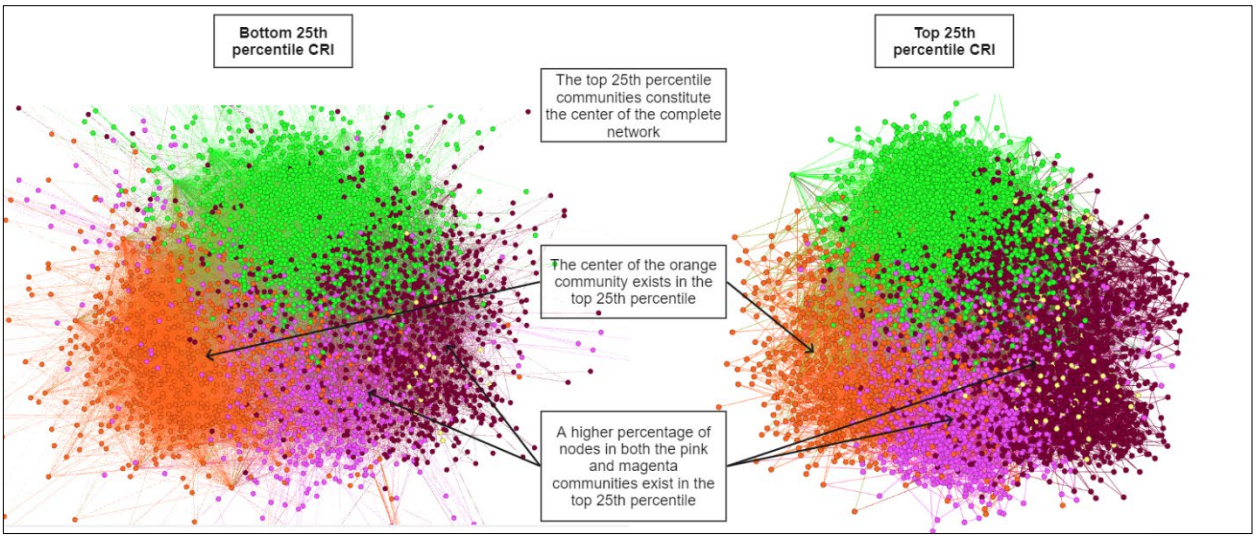
In our analysis, we applied this algorithm to partition the network into five communities. The largest community, shown in magenta in Figure 24, contains 65.43% of the nodes, followed by the bright green community (13.98%), the pink community (9.82%), the orange community (7.02%), and the smallest community is the yellow (0.75%). We observe a high degree of mixing across communities in the complete procurement network, with certain nodes acting as bridges between communities. This finding is consistent with what is typically observed in procurement networks, where communities are not isolated, and specific nodes play a crucial role in maintaining the interconnectedness of the network.

Figure 24 provides the initial evidence of state capture in the contracting network. The network is split into two groups based on the top and bottom 25th edge CRI percentiles. Two key observations can be made from this figure. First, the high corruption risk ties are located at the center of all communities rather than the periphery. This is expected since the tie weights are represented by the tie CRI scores, which means that organizations with high tie CRI scores are more likely to attract each other in the network representation than organizations with lower tie CRI scores.

[9] https://gephi.org/

Second and more importantly, a higher percentage of nodes in the magenta and pink communities are found in the top 25th percentile compared to the lower percentiles, indicating that a high proportion of those communities' ties suffer from high corruption risk. This suggests that repeated contractual relationships between organizations in these communities are more susceptible to high corruption risk than other communities in the procurement network. If we assume a scenario with no state capture, we would expect to see an equal number of nodes in both the top and bottom 25th percentiles. This pattern can be observed in the green community where the nodes are evenly split between the two percentiles. However, the magenta community shows a higher level of state capture with 14% of its nodes falling in the top 25th percentile compared to only 7% in the bottom percentile. The yellow community shows the highest level of capture with 73% of its nodes in the top 25th percentile, while only 18% are in the bottom 25th percentile.

Figure 24: Community Split Based on Edge CRI Percentile in North Macedonia's Procurement Network (2011-2022)



We explore the changes in the network structure due to a change of government that took place in May 2017 in North Macedonia. The incumbent government, led by the VMRO-DPMNE party, lost power after a 10-year tenure, and a new government led by the SDSM party took over. A change in government can often result in changes in policies, priorities, and regulations, which can potentially affect the structure of the procurement network. For instance, a new government may prioritize different industries or projects, and they may introduce new rules and regulations concerning procurement processes. As a result, these changes may impact the suppliers and contractors involved in procurement networks, as well as how procurement decisions are made.

Before and after the government change, the networks had similar total contract values of 221 million and 253 million MKD, respectively, as shown in panel A of Table 5. The number of distinct procurement authorities increased from 1,215 to 1,356 while the number of distinct suppliers decreased from 9,527 to 6,940. The median procurement authority had 179 contracts before the change, which increased to 193 contracts after the change. The median supplier had 34 contracts before the change, which increased to 68 contracts after the change. The median procurement

authority's total contract value decreased slightly from 148 million MKD to 142 million MKD, while the median supplier's total contract value increased considerably from around 21 million MKD to 45 million MKD. This is also accompanied with an observed decrease in the average CRI score from 0.48 to 0.43. These changes suggest a shift in procurement patterns and possibly a change in the types of suppliers being awarded contracts due to redistribution of resources after the government change.

Table 5: Summary of Procurement and Network Statistics before and after the government change in North Macedonia

	Jan 2011-May 2017	Jun 2017-Dec 2022
A) Procurement Statistics		
Total contract value	~ 221 billion MKD	~ 254 billion MKD
Number of procurement authorities	1,215	1,356
Number of suppliers	9,527	6,940
Median # contracts (PA)	179	193
Median # contracts (Supplier)	34	68
Median Total contract value (PA)	~ 148 million MKD	~ 142 million MKD
Median Total contract value (Supplier)	~ 21 million MKD	~ 45 million MKD
Average CRI	0.48	0.43
B) Network Statistics		
Number of ties	39,939	53,173
Average degree	15.12	19.39
Clusters (Louvain algorithm)	225	62
Modularity (stronger clustering of buyer-supplier ties)	0.405	0.350
Closeness Centrality* (higher values given to buyers/suppliers that are closer to other nodes in the network)	0.256	0.272
Betweenness Centrality* (higher values given to buyers/suppliers that create shorter paths between two nodes)	185.186	9.401

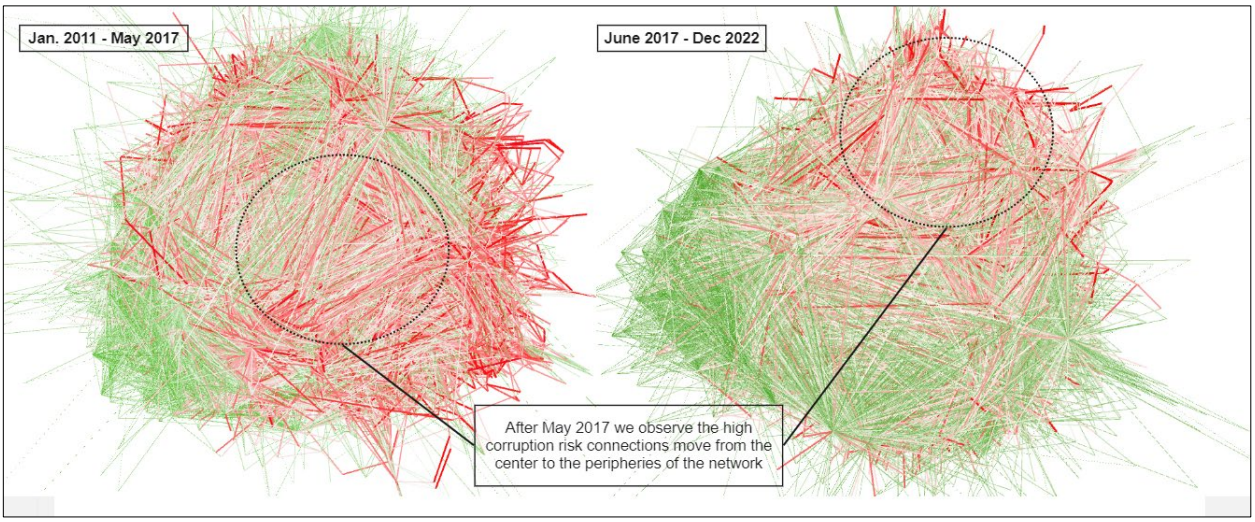
* These aggregated centrality measures are network measures based on the centrality scores of each node in the network, The higher the centrality scores, the more likely for nodes that are further apart to interact together through central agencies/firms

According to Panel B of Table 5, the number of distinct ties in the procurement network increased from 39,939 to 53,173 after the government change. The average degree in the network also rose from 15 to 19 connections, indicating an increase in network connectivity. However, there was no noticeable change in the closeness centrality of the network, although the average betweenness centrality score dropped sharply from 185.19 to 9.4. This suggests that after the government change, fewer nodes acted as brokers between different communities in the network. The Modularity score also decreased from 0.41 to 0.35, indicating a reduction in the number of

communities in the network. Overall, the increase in network connectivity led to a less modular network, reducing the reliance on specific nodes to act as brokers across different communities.

Figure 25 displays the procurement network, highlighting the ties between procurement authorities and suppliers. The ties are colored based on their CRI scores, with green representing low CRI and red representing high CRI. The average CRI value in the network is used as the turning point for the scale. The network structure and tie distribution before and after the May 2017 government change are examined. The decrease in CRI previously mentioned is clearly visible in the network, as it becomes greener after the government change. Additionally, high-risk connections are seen to have migrated from the center of the network towards the periphery, indicating a lower degree of state capture in North Macedonia's complete network following the 2017 government change.

Figure 25: Procurement network representation before and after the government change in North Macedonia



By analyzing the changes in the network structure within sectors, we can gain a more detailed picture of how the 2017 government change could have influenced procurement practices and network dynamics in North Macedonia.[10] We focus on the construction sector given its critical role in shaping development projects. By analyzing the shifts in the network structure within the construction sector, we can better understand how the government change may have affected procurement practices and network dynamics. Such an analysis can help us comprehend how the new government's policies and regulations was reflected in the way procurement authorities and suppliers interacted with each other.

The total contract value of the construction sector during this period was approximately 75 billion MKD. Panel A in Table 6 presents some descriptive statistics about the procurement data, indicating that spending increased by roughly 15 billion MKD after the government change. This increase in spending is accompanied by a rise in the number of organizations participating in the

[10] For a more comprehensive exploration of the changes in the main network metrics across all CPV sectors, please refer to Appendix II B.

sector. However, the number of procurement authorities increased by 46%, compared to only a 10% increase in the number of suppliers, suggesting a potentially more competitive procurement process. Additionally, there was an increase in the number of contracts for the median procurement authority and supplier, reflecting the growth in participating organizations.

Interestingly, we also found that the median procurement authority's total contract value increased by approximately 20 million MKD, and the median supplier's total contract value increased by 17.2 million MKD. We observe these changes along with drops in the average tie CRI from 0.49 to 0.42. These findings suggest that the construction sector may be experiencing growth and increased investment under the new government. Nevertheless, a further analysis is necessary to determine the underlying factors driving these changes and to assess their long-term impacts on the sector and the overall economy.

Table 6: Summary of the Construction Sector Procurement and Network Statistics before and after the government change in North Macedonia.

	Jan 2011-May 2017	Jun 2017-Dec 2022
A) Procurement Statistics		
Total contract value	~ 30 billion MKD	~ 45 billion MKD
Number of procurement authorities	571	835
Number of suppliers	1,235	1,360
Median # contracts (PA)	8	13
Median # contracts (Supplier)	3	10
Median Total contract value (PA)	~ 9 million MKD	~ 29 million MKD
Median Total contract value (Supplier)	~ 1.8 million MKD	~19 million MKD
Average CRI	0.49	0.42
B) Network Statistics		
Number of ties	2,128	3,993
Average node degree	2.357	3.683
Average path length	6.575	5.241
Graph Density	0.001	0.002
Clusters	158	93
Modularity (stronger clustering of buyer-supplier ties)	0.852	0.666
Closeness Centrality* (higher values given to buyers/suppliers that are closer to other nodes in the network)	0.1089	0.1723
Betweenness Centrality* (higher values given to buyers/suppliers that create shorter paths between two nodes)	0.0023	0.0016

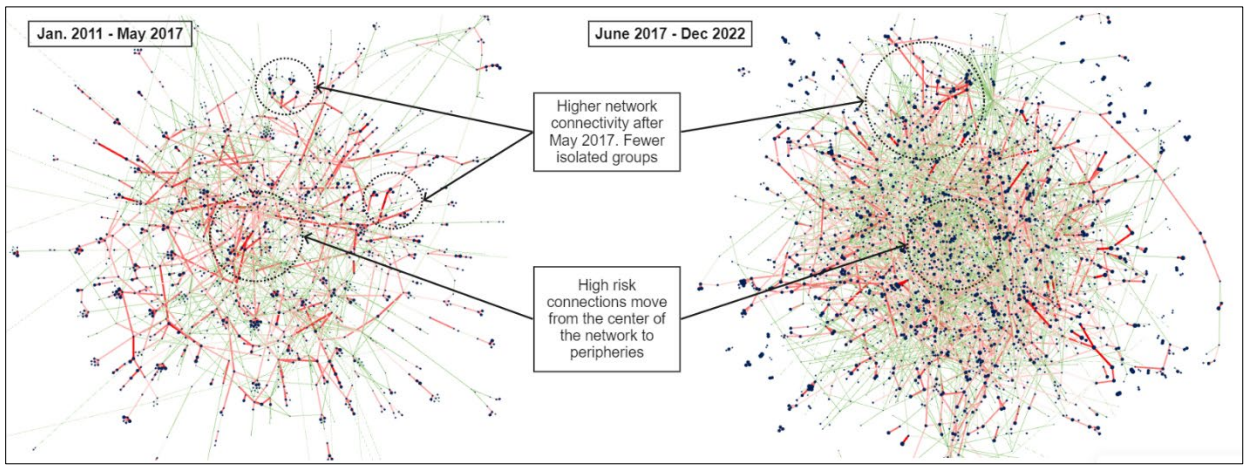
* These aggregated centrality measures are network measures based on the centrality scores of each node in the network, The higher the centrality scores, the more likely for nodes that are further apart to interact together through central agencies/firms

Panel B in Table 6 demonstrates the changes in various network statistics in the construction sector of North Macedonia between 2011-2022. These findings align with our observations in the complete network comparison. We notice that the network becomes more connected after the government change, as indicated by the increase in the number of ties and average node degree and decrease in the shortest path length. The slight increase in graph density signifies that there are more ties available using a completely connected network as a reference point. As a result of increased connectivity, we see fewer distinct communities in the construction network after the government change, which is also supported by the decline in modularity scores. Furthermore, the rise in the average closeness centrality demonstrates that two random organizations are more easily connected, potentially through more direct or shorter paths, after the government change. Lastly, the reduction in the average betweenness centrality score suggests that organizations are less likely to serve as bridges across communities.

Figure 26 provides a visual representation of the changes in the construction sector's network structure that were highlighted in Table 6. By splitting the contracts into the two time periods, we can clearly see how the network becomes more interconnected and has fewer isolated contracting islands after the government change. Moreover, the high corruption risk ties are observed to move from the center of the network towards the peripheries, indicating a decrease in capture.

After the May 2017 government change, the construction network showed significant growth, which is supported by visual evidence. As a result of this growth, the structure of the procurement network underwent significant changes, including an increase in the interconnectedness of the network and a shift away from the dominant role of high corruption risk ties prior to the government change.

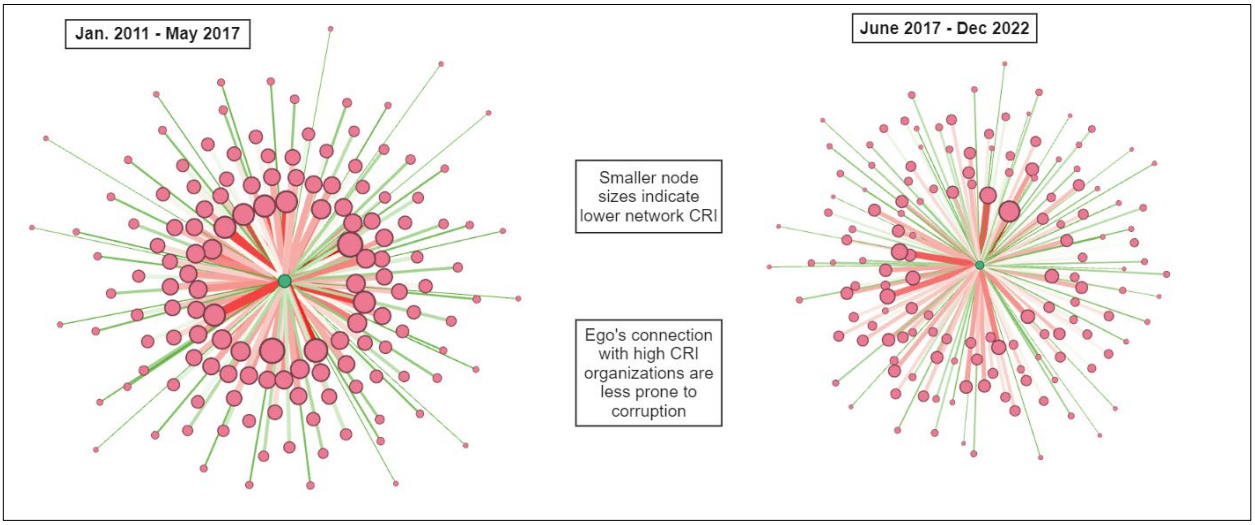
Figure 26: Construction Procurement network representation before and after the government change in North Macedonia, 2011-2022



In Figure 27, we take a closer look at one of the largest procurement authorities in the construction sector by analyzing its ego network (i.e. its direct contracting partners). The procurement authority had a total contract value of approximately 5.4 billion MKD before the government change and 13 billion MKD after. The node sizes represent the CRI score of each organization from all its other

contracts, and the tie colors indicate the tie CRI score, with green representing lower CRI and red representing higher CRI. The average tie CRI falls from 0.28 to 0.18. After the government change, we observe that the ego node forms ties with organizations with lower organizational CRI scores compared to its network before the government change. Additionally, the larger node organizations are now further away from the ego node, indicating that relationships with high CRI scores are now less common after the government change. Overall, these findings suggest that the largest procurement authority becomes less captured after the May 2017 government change.

Figure 27: Ego network of the largest procurement authority in the construction sector before and after the government change in North Macedonia, 2011-2022



Conclusion

This paper uses comprehensive, economy-wide administrative data to assess corruption risks in North Macedonia's public procurement and their implications for overpricing of contracts. It also looked at the networked nature of contracting risks and how some of these networks develop into state capture formations.

The analyzed data points at persistently high risks of corruption in North Macedonia, compared to EU countries. For example, the single bidding rate of North Macedonia is very similar to the Slovak Republic, Hungary and Bulgaria, but considerably higher than core Western European countries such as Germany or France. The overall corruption risk level slightly decreased throughout 2011-2022, with, for example, the single bidding rate remaining around 30%.

This paper finds a strong association between corruption risks and relative prices. The effect of the composite risk indicator, Corruption Risk Index (CRI), on relative prices is estimated to be strong, with the CRI score moving from its maximum (1) to its minimum (0) leading to 17.9% lower prices. Looking at individual risk factors points at actionable, directly influenceable levers for policy makers. Factors estimated to lead to higher prices are the type of procedure, length of advertisement period, and supplier dependence on a buyer. For instance, greater use of more competitive and open procedures or providing more time for suppliers to prepare bids are found to be associated with lower relative prices. Other factors, such as single bidding and supplier dependence on a buyer are only indirectly influenceable, but programs aimed at stimulating competition, reducing the documentation burdens on suppliers or eliminating transaction costs can create a more favorable environment for higher competition, and consequently lower the relative prices. These factors are also likely to influence prices considerably as for example single bidding is associated with a 7.2% increase in relative prices compared to multiple bidding (i.e. a tender receiving two or more bids).

Data analysis also reveals indications of state capture patterns. There are groups of suppliers and buyers with high corruption risk contracting relationships among them. This suggests that purchasing authorities with high CRI scores are more likely to attract suppliers with similarly high risks. The repeated contractual relationships between buyers and suppliers within these groups are likely to be more susceptible to state capture risks compared to other communities in the contracting network. However, the change in government in 2017 has led to the weakening of state capture patterns with the previously central capture groups moving outwards, to the periphery. Parallel to this, the center of the contracting network is now more populated by low-risk communities, suggesting a lower degree of network capture.

Our analysis is not without limitations. Due to data limitations, we had to focus the price analysis on single lot tenders, which significantly reduces our sample. Notwithstanding the importance of relative price analysis in identifying actionable policies that can generate savings, there are further measures of value for money that can be used such as unit prices paid for standardized goods. In addition, the analysis could be further improved by more reliably identifying unique organizations by their legal identifiers. Further work could imply using advanced data science

techniques with available datasets for constant monitoring and analysis of prices and their determinants. Therefore, it is essential to ensure that public sector users have access to easily analyzable data, supporting their policy reforms and helping them communicate these reforms through continuous monitoring of risks and using policy insights driven by data in daily policymaking.

References

Abdou, A., Basdevant, O., David-Barrett, E., & Fazekas, M. (2022). Assessing Vulnerabilities to Corruption in Public Procurement and Their Price Impact. IMF Working Papers, 2022(094).

Blondel, V. D., Guillaume, J. L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. Journal of statistical mechanics: theory and experiment, 2008(10), P10008.

Bosio, E., Djankov, S., Glaeser, E., and A., Shleifer, 2020, “Public Procurement in Law and Practice,” NBER Working Paper #27188. https://www.nber.org/papers/w27188.

Coviello, D., Guglielmo, A., and G., Spagnolo, 2018, “The Effect of Discretion on Procurement Performance.,” Management Science, vol. 64(2): pp. 715–738. https://doi.org/10.1287/mnsc.2016.2628.

European Commission. 2022. Commission Staff Working Document: North Macedonia 2022 Report -. Available https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0337&from=EN. Last accessed 12 March 2023. Brussels: EC. Section 2.4.

Fazekas, Mihály, and István János Tóth. "From corruption to state capture: A new analytical framework with empirical applications from Hungary." (2016) *Political Research Quarterly* 69, no. 2: 320-334

Fazekas, M., & Kocsis, G. (2020). Uncovering high-level corruption: cross-national objective corruption risk indicators using public procurement data. British Journal of Political Science, 50(1), 155-164.

Fazekas, Mihály; Poltoratskaia, Viktoriia; and Tóth, Bence (2023) Corruption Risks and State Capture in Bulgarian Public Procurement. Policy Research Working Paper: WPS 10444 Washington, D.C.: The World Bank.

Fazekas, Mihály; Bence, Tóth; Abdou, Aly & Ahmed Al-Shaibani (2024) Global Contract-level Public Procurement Dataset. Data in Brief, 54.

Hagberg, A.A., Schult, D.A., and Swart, P.J., "Exploring Network Structure, Dynamics, and Function using NetworkX", in Varoquaux, G., Vaught, T., and Millman, J. (Eds.), Proceedings of the 7th Python in Science Conference (SciPy2018), 2018.

OECD. 2020. Government at a Glance: Western Balkans. Chapter 7. Available at: https://www.oecd-ilibrary.org/governance/government-at-a-glance-western-balkans_a8c72f1b-en. Last accessed 11 March 2023.

Official Gazette of the Republic of North Macedonia 136/2007. Text available at: https://www.crm.com.mk/CRMPublicPortalApi/api/files/adc5d8e0-fe49-41bc-a3e0-a244a752b290?ln=1.

Palguta, J., and F., Pertold, 2017, "Manipulation of Procurement Contracts: Evidence from the Introduction of Discretionary Thresholds," American Economic Journal: Economic Policy, vol. 9(2), pp. 293-315. https://doi.org/10.1257/pol.20150511.

Vincent D Blondel, Jean-Loup Guillaume, Renaud Lambiotte, Etienne Lefebvre, Fast unfolding of communities in large networks, in Journal of Statistical Mechanics: Theory and Experiment 2008 (10), P1000

Appendix I: Additional tables and figures

Table A1.a: List of CPV sectors

03	Agricultural, farming, fishing, forestry and related products
09	Petroleum products, fuel, electricity and other sources of energy
14	Mining, basic metals and related products
15	Food, beverages, tobacco and related products
16	Agricultural machinery
18	Clothing, footwear, luggage articles and accessories
19	Leather and textile fabrics, plastic and rubber materials
22	Printed matter and related products
24	Chemical products
30	Office and computing machinery, equipment and supplies except furniture and software packages
31	Electrical machinery, apparatus, equipment and consumables; lighting
32	Radio, television, communication, telecommunication and related equipment
33	Medical equipments, pharmaceuticals and personal care products
34	Transport equipment and auxiliary products to transportation
35	Security, fire-fighting, police and defence equipment
37	Musical instruments, sport goods, games, toys, handicraft, art materials and accessories
38	Laboratory, optical and precision equipments (excl. glasses)
39	Furniture (incl. office furniture), furnishings, domestic appliances (excl. lighting) and cleaning products
41	Collected and purified water
42	Industrial machinery
43	Machinery for mining, quarrying, construction equipment
44	Construction structures and materials; auxiliary products to construction (except electric apparatus)
45	Construction work
48	Software package and information systems
50	Repair and maintenance services
51	Installation services (except software)
55	Hotel, restaurant and retail trade services
60	Transport services (excl. Waste transport)
63	Supporting and auxiliary transport services; travel agencies services
64	Postal and telecommunications services
65	Public utilities
66	Financial and insurance services
70	Real estate services
71	Architectural, construction, engineering and inspection services
72	IT services: consulting, software development, Internet and support
73	Research and development services and related consultancy services
75	Administration, defence and social security services
76	Services related to the oil and gas industry
77	Agricultural, forestry, horticultural, aquacultural and apicultural services
79	Business services: law, marketing, consulting, recruitment, printing and security
80	Education and training services
85	Health and social work services
90	Sewage, refuse, cleaning and environmental services
92	Recreational, cultural and sporting services
98	Other community, social and personal services

Figure A1.b: Total awarded contract value as a percentage for Skopje and other regions, 2011-2022, North Macedonia.

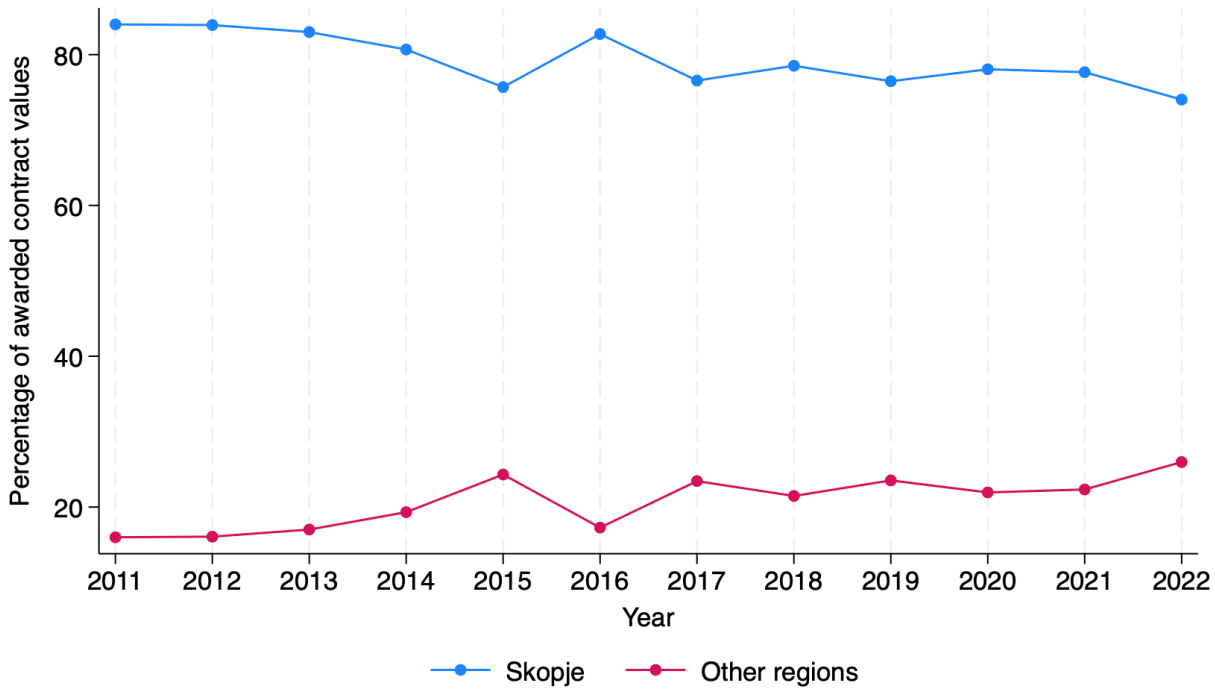


Figure A1.c: Total awarded contract value for Skopje and other regions, 2011-2022, North Macedonia.

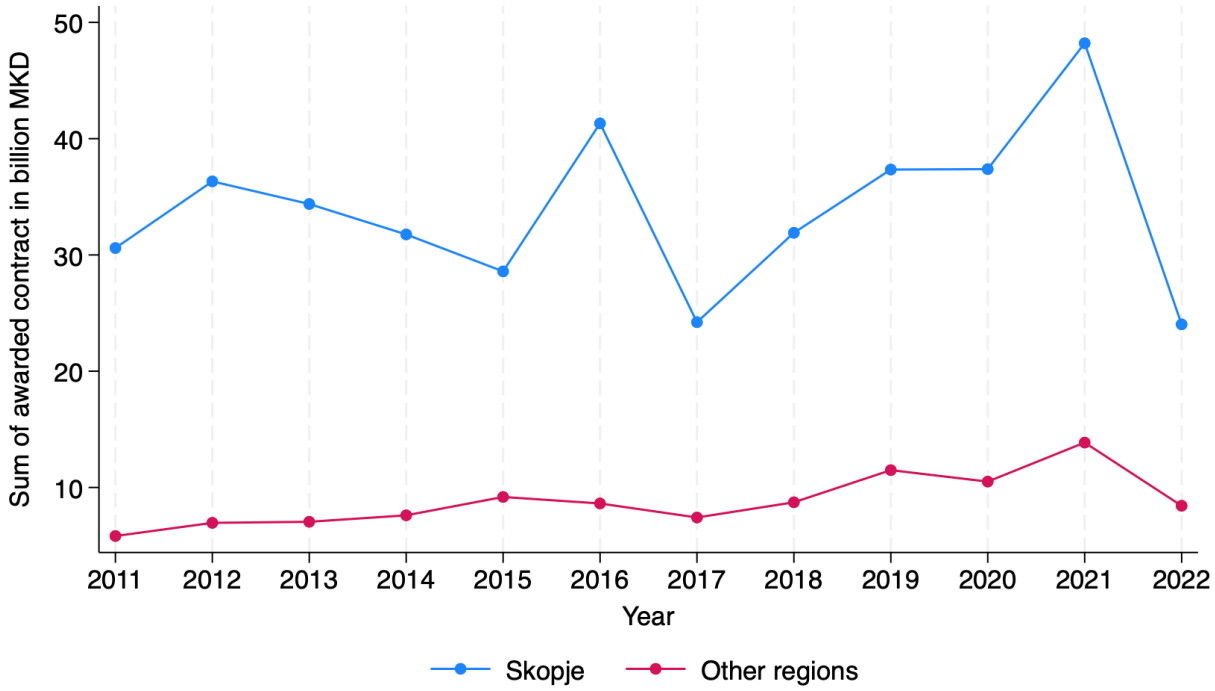


Figure A1.d: Average CRI across regions in North Macedonia for 2011-2022.

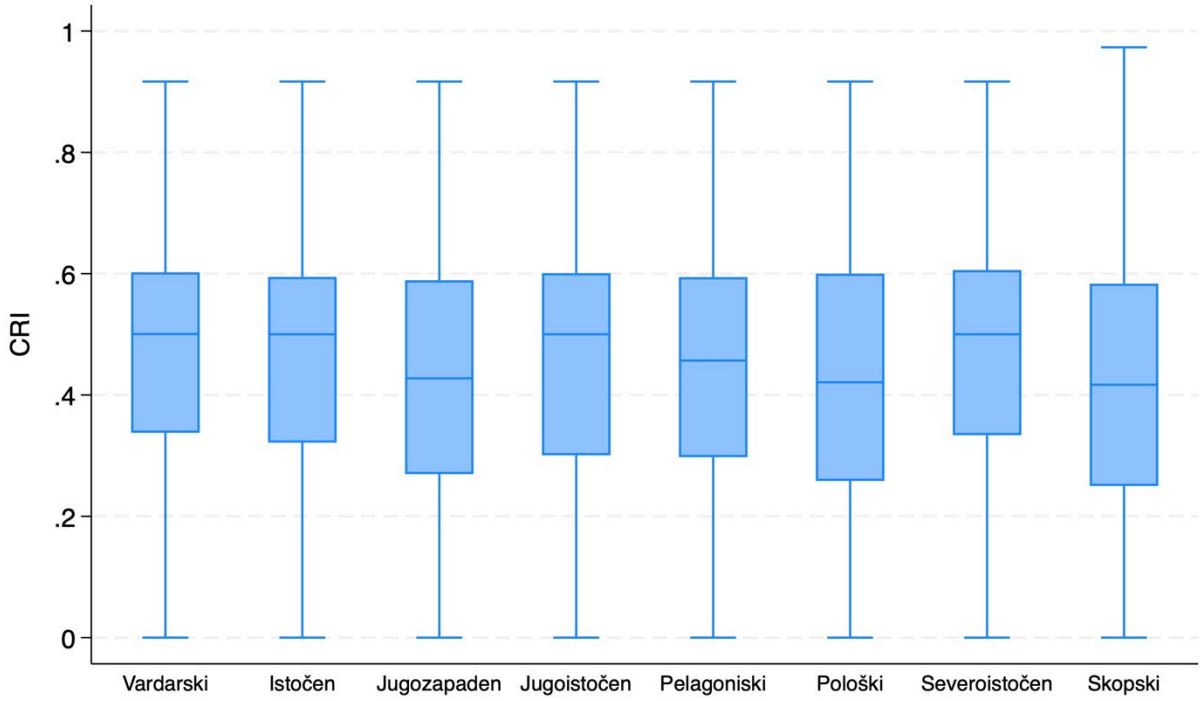
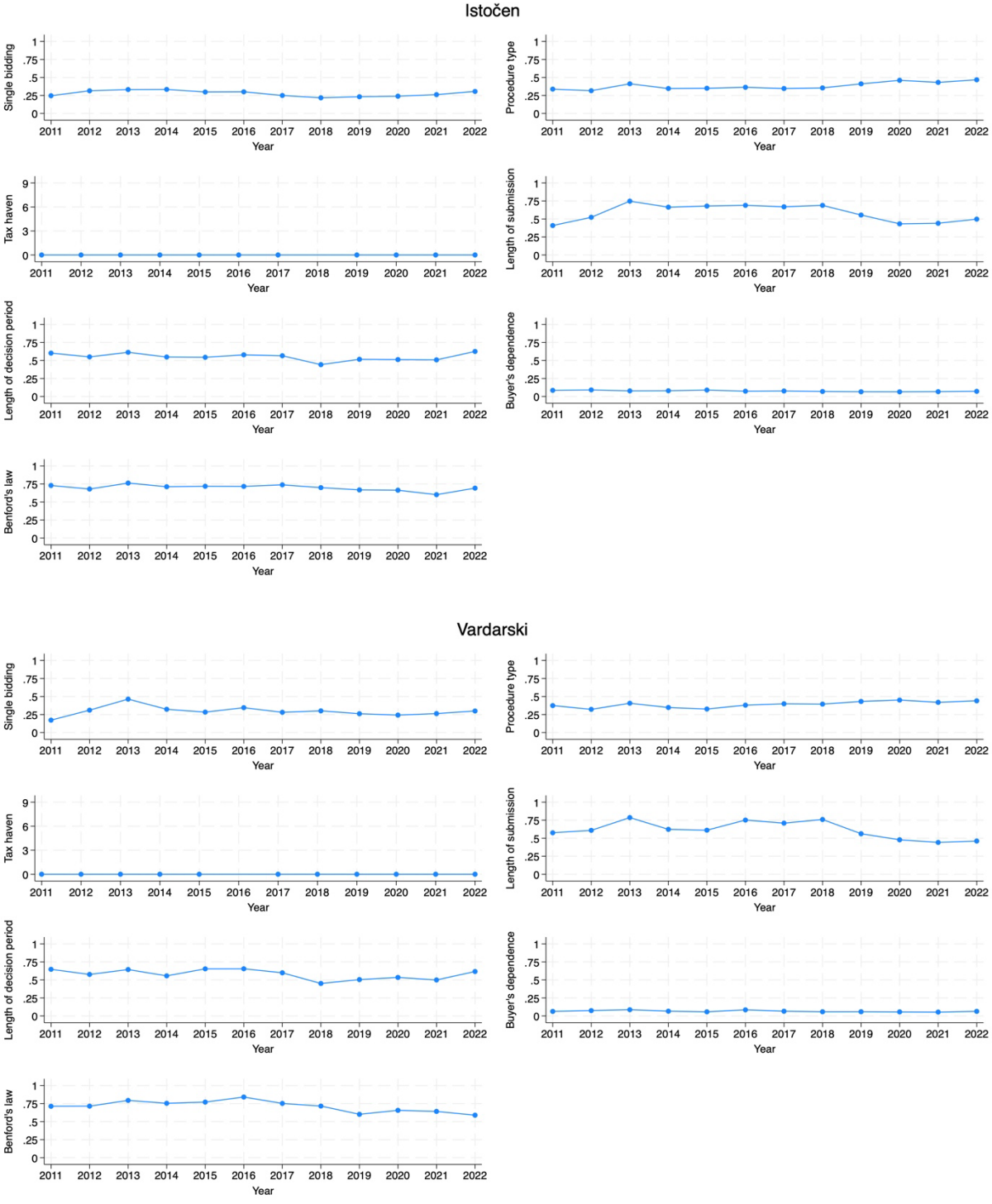
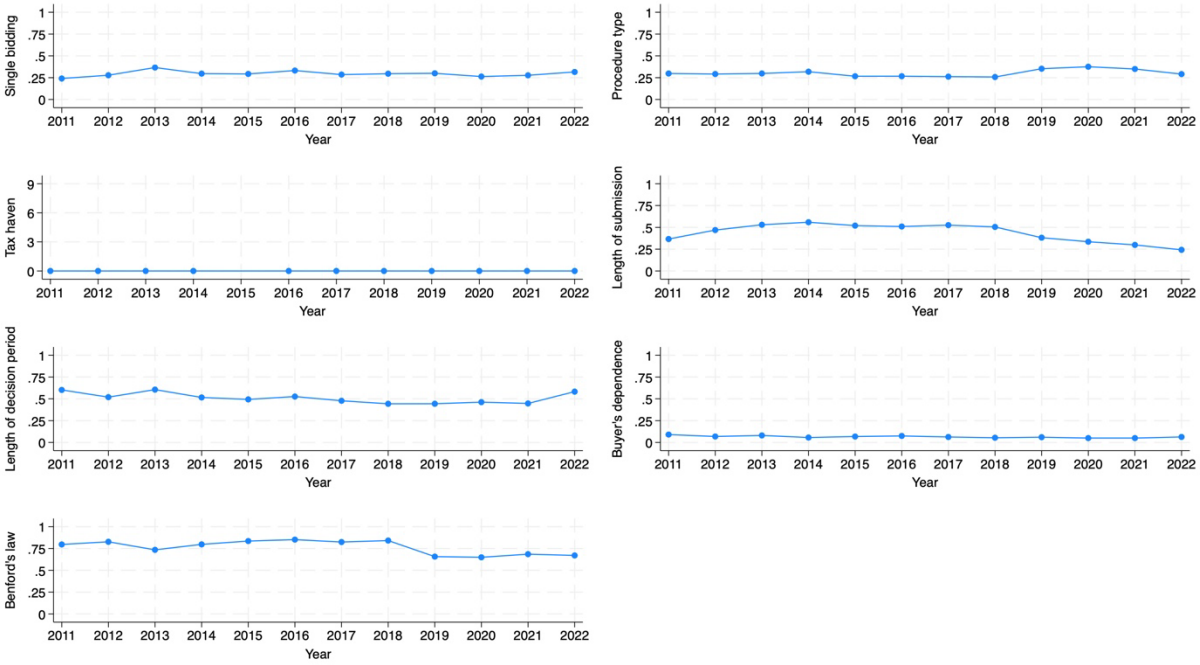


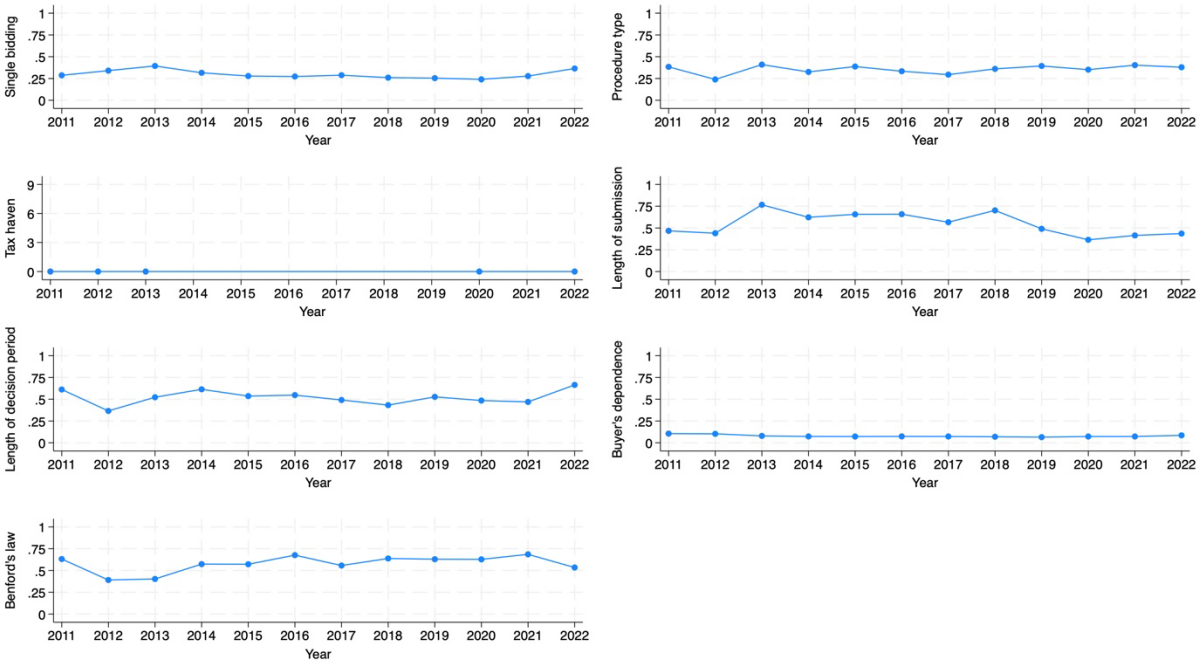
Figure A1.e: Annual trends for individual red flags by each region, 2011-2022.



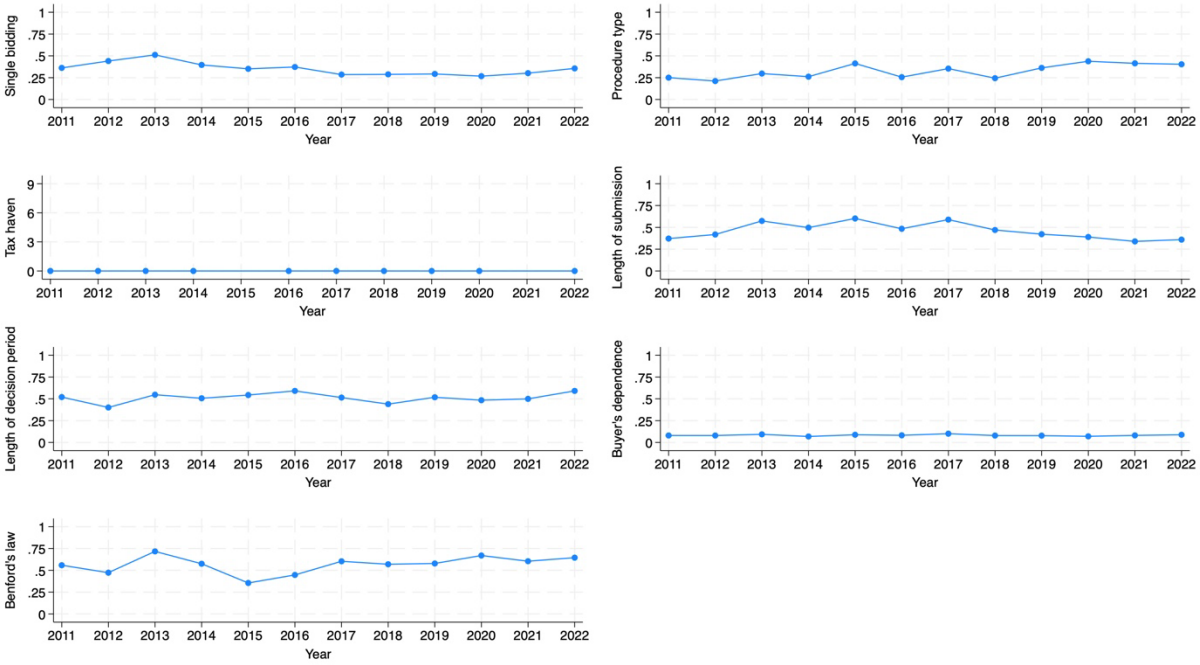
Jugozapaden



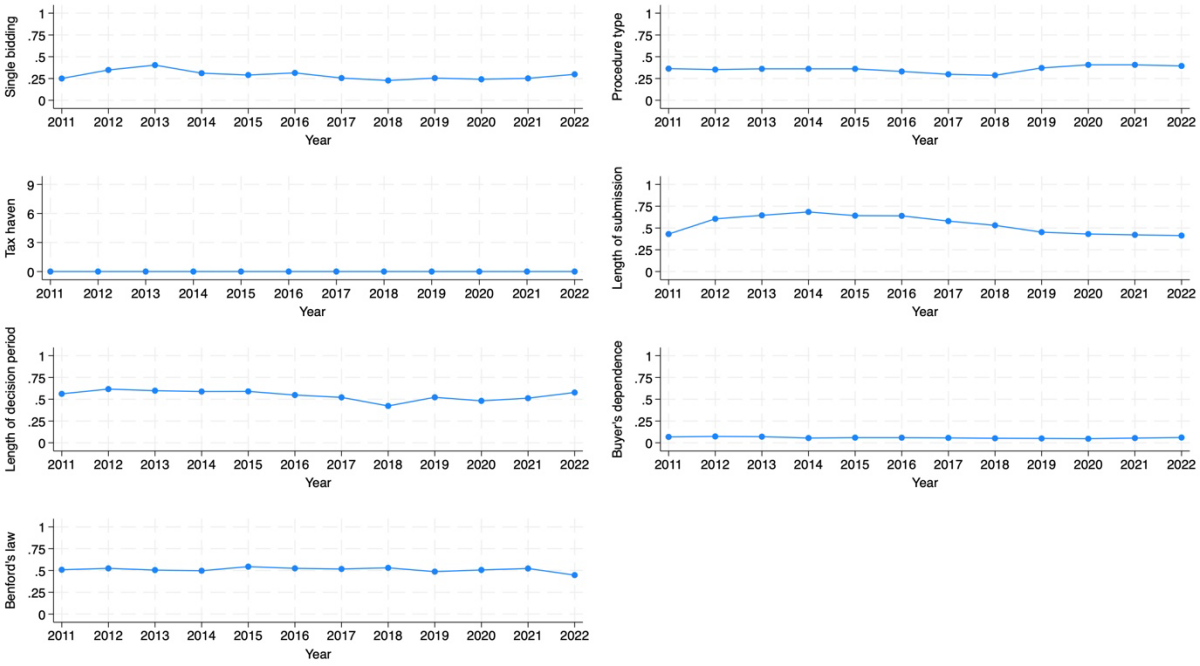
Jugoistočen



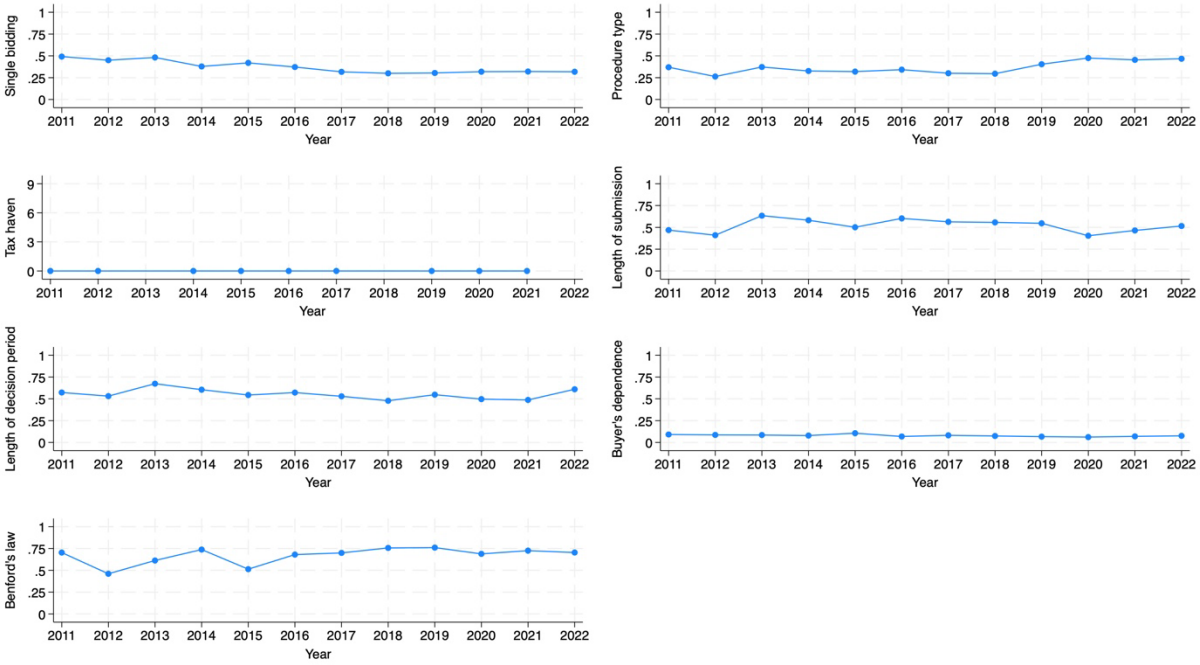
Pološki



Pelagoniski



Severoistočen



Skopski

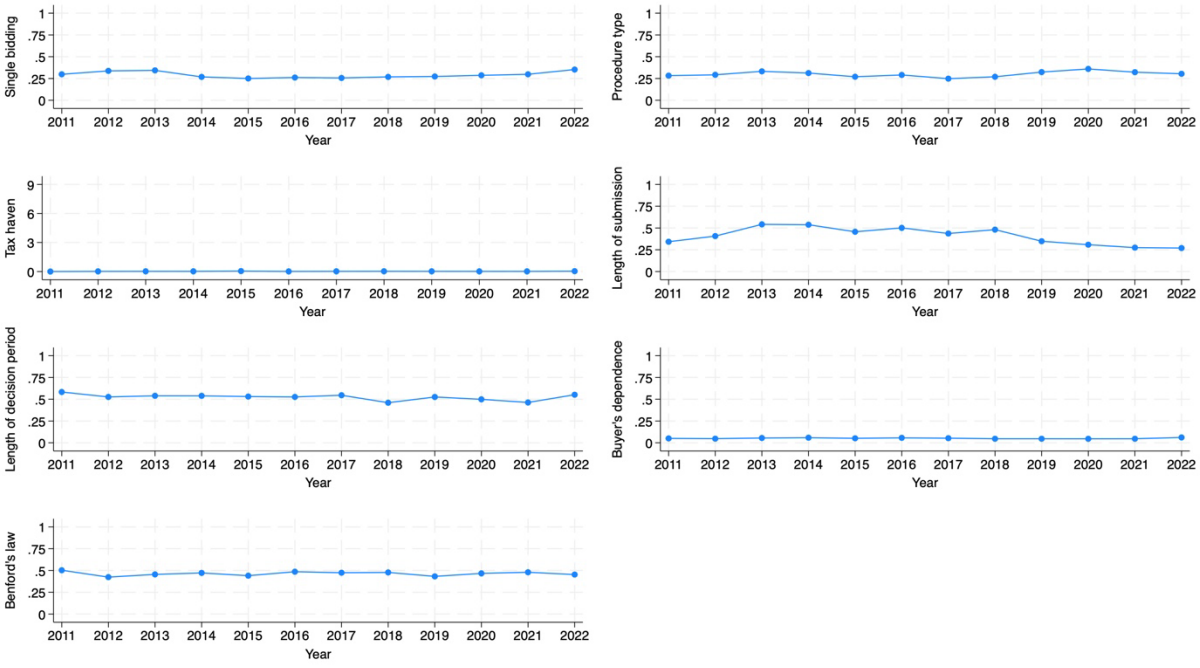
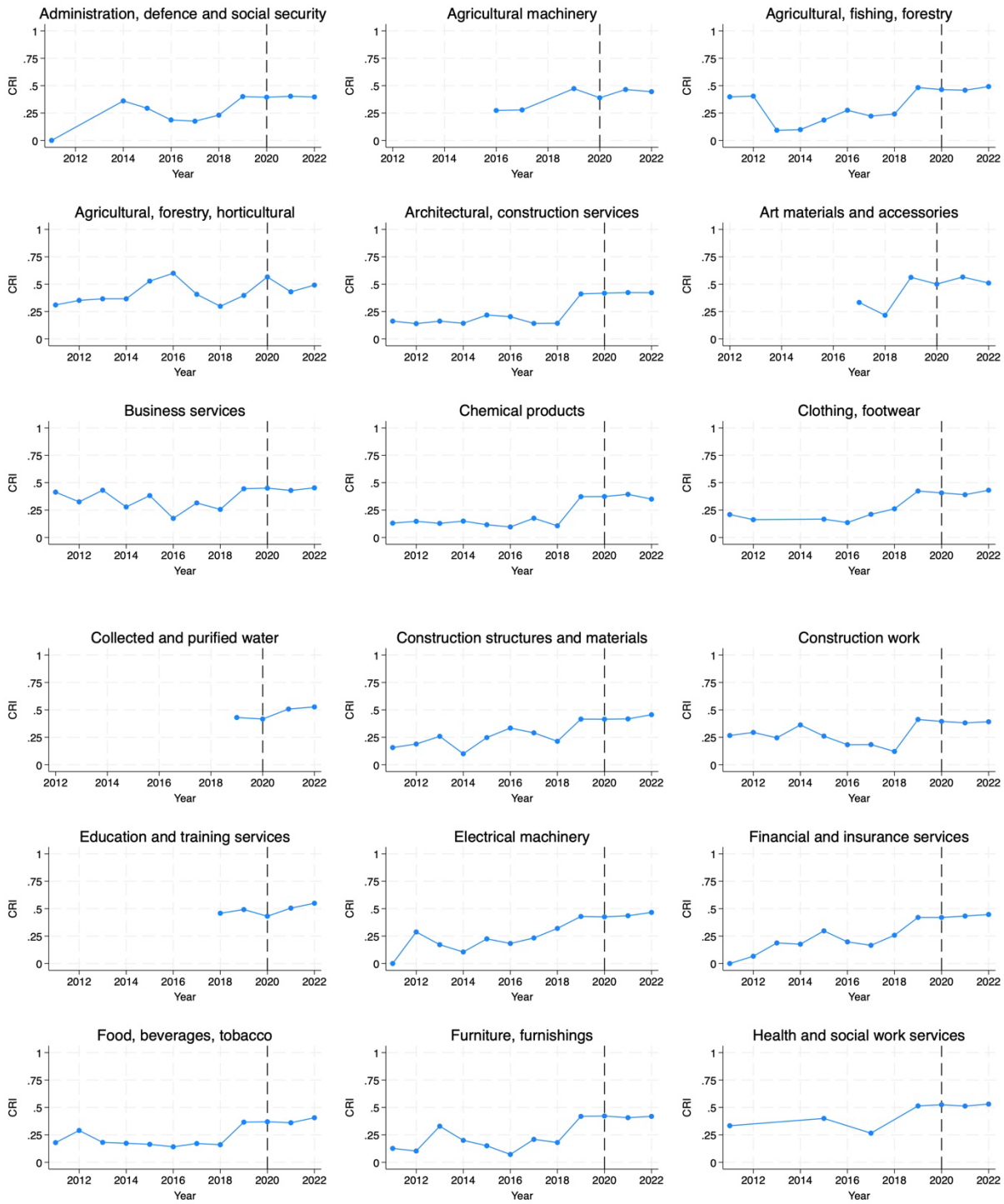
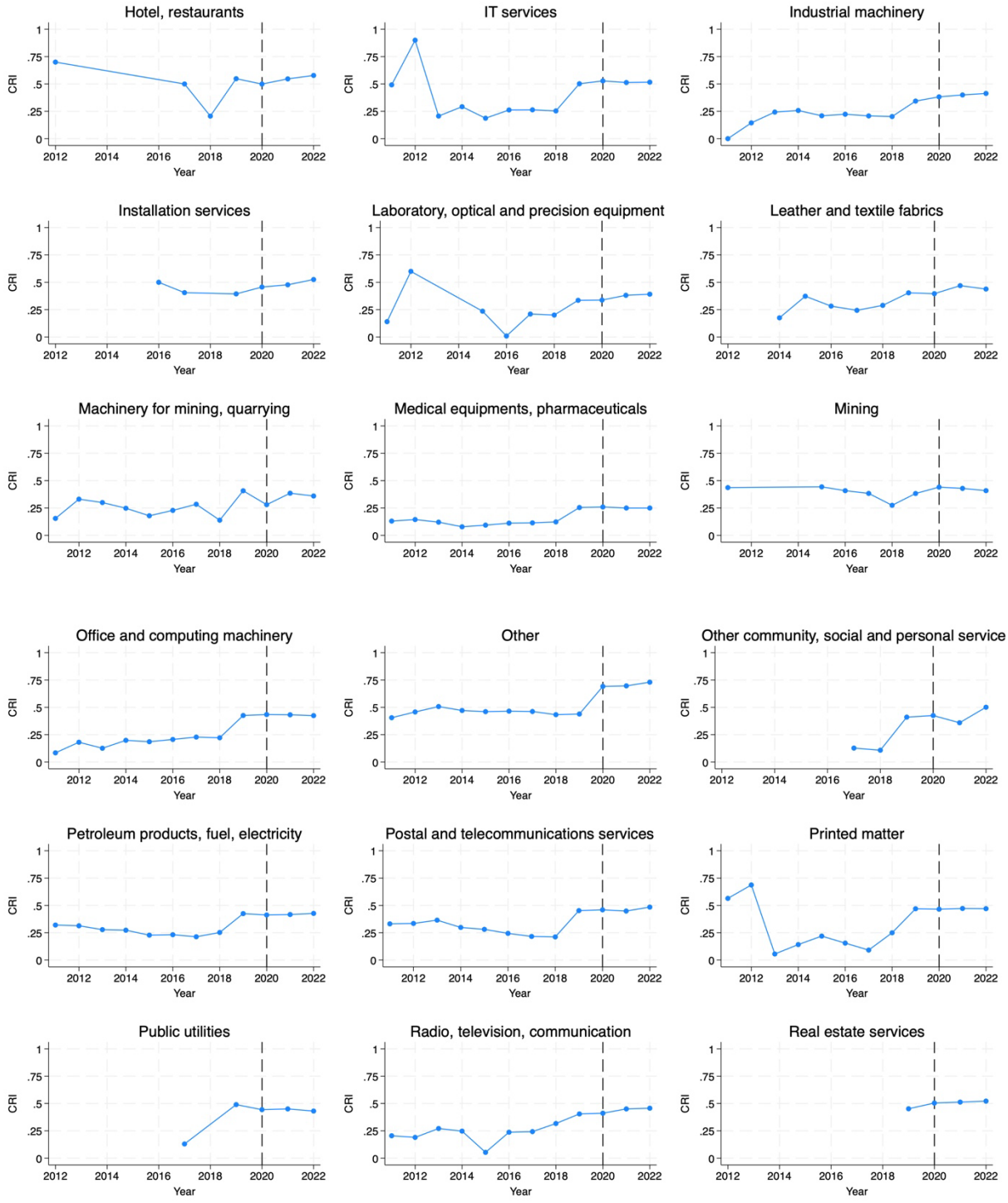
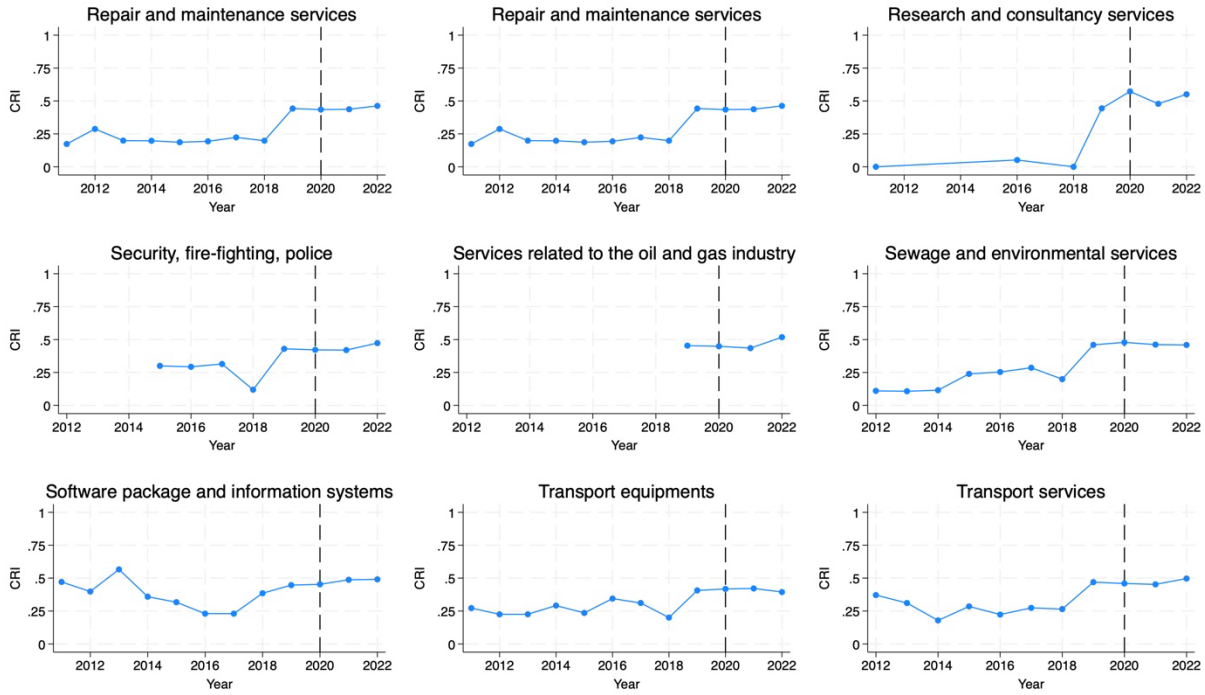


Figure A1.f: Annual trends for CRI by industry, 2011-2022. (dotted line shows the start of Covid-19 pandemic)




Hotel, restaurants
IT services
Industrial machinery
Installation services
Laboratory, optical and precision equipment
Leather and textile fabrics
Machinery for mining, quarrying
Medical equipments, pharmaceuticals
Mining
Office and computing machinery
Other
Other community, social and personal service
Petroleum products, fuel, electricity
Postal and telecommunications services
Printed matter
Public utilities
Radio, television, communication
Real estate services
CRI
Year
0
.25
.5
.75
1
2012
2014
2016
2018
2020
2022


Repair and maintenance services
Repair and maintenance services
Research and consultancy services
Security, fire-fighting, police
Services related to the oil and gas industry
Sewage and environmental services
Software package and information systems
Transport equipments
Transport services
CRI
Year
0
.25
.5
.75
1
2012
2014
2016
2018
2020
2022

Appendix II: Additional public procurement network analysis results

Mapping corruption risk across geographical regions in North Macedonia

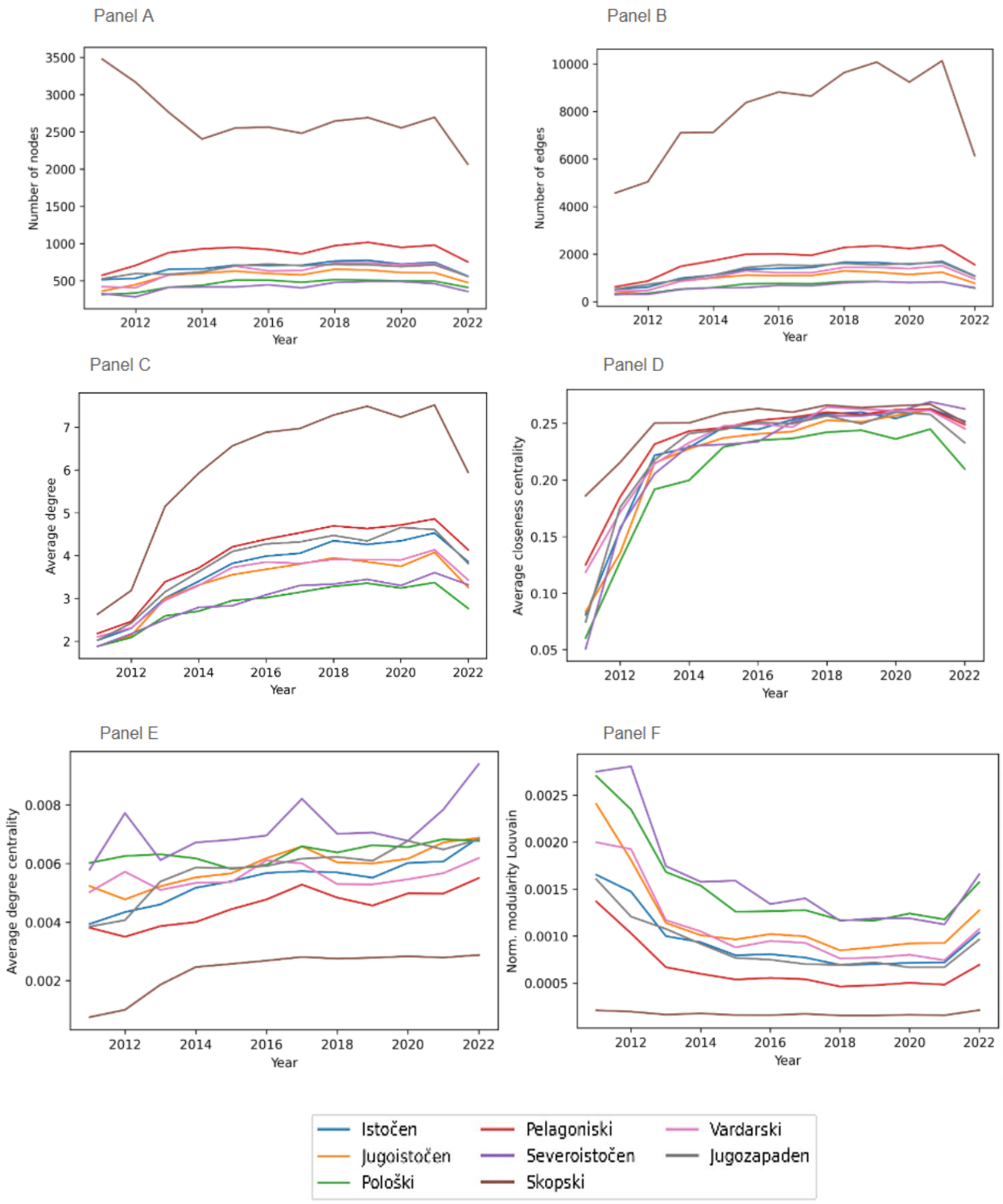
The study also examined the changes in various network metrics across different regions in North Macedonia. Skopski, the capital region, was found to have a higher total monetary value circulating in the network and more nodes compared to other regions. However, the study still analyzed the trends of these network metrics across all regions.

Figure A2.a shows the time trends of different network metrics for all regions. The number of ties (Panel A) increased over the years as more procurement data became available, with Skopski experiencing a higher rate of increase compared to other regions. The number of nodes (Panel B) remained stable across all regions, except for a drop in Skopski between 2012-2014. As the network becomes more connected over time, the average degree also increases (Panel C). The highest average node degree was observed in Skopski, while the lowest was found in Položki and Severoistočen.

With regards to network centralization, there was no clear difference observed in the average closeness centralization (Panel D) across regions over time. To put it differently, we do not observe any noticeable variations in the proximity between nodes in the network across different geographical regions. After analyzing the average degree of centrality (Panel E) across different geographical regions, we discovered that the level of interconnectedness increases over time for all regions. Additionally, the Severoistočen network consistently has a higher average degree of centralization score than other regions. This indicates that the Severoistočen network has a greater number of hub nodes than the other networks, making it more interconnected over time.

We also find that the Severoistočen and Položki regions exhibit the highest modularity score (Panel F) when compared to the other regions. This suggests that the network can be fragmented into more clearly defined communities in comparison to other networks. When this is considered alongside the earlier finding, it indicates that the Severoistočen and Položki networks comprise more communities that are internally well-connected but have relatively fewer connections between each other when compared to other networks.

Figure A2.a: Regional Network Metrics Trend Analysis for North Macedonia: 2011-2022



Sectoral analysis

The following figures exhibit the changes in each network metric, where a positive shift indicates an increase in the network metric after the government change and vice versa. We maintain the same analysis periods as mentioned earlier, specifically Jan 2011-May 2017 for the period before the government change and Jun 2017-Dec 2022 for the period after the government change.

Figures A2.b and A2.c display the changes in the networks' number of nodes and distinct ties of selected CPV divisions. The data confirms that most sectors have experienced an increase in nodes and distinct ties after the government change. The Repair and maintenance services sector (50) and the Petroleum products, fuel, electricity, and other sources of energy sector (09) have shown the highest increases in the number of nodes. On the other hand, the Machinery for mining, quarrying, construction equipment sector (43), and the Health and social work services sectors (85) have shown a decrease in the number of nodes. Almost all sectors experienced an increase in the distinct number of ties. We show the top 5 sectors with the highest increase in number of ties after the government change. For example, The Medical equipment, pharmaceuticals, and personal care products sector (33) and the Repair and maintenance services (50) sector have exhibited the highest increases in the number of distinct ties. This indicates that increased connectivity is to be expected in most sectors following the government change

Figure A2.b: Change in the number of nodes before and after the 2017 government change in North Macedonia

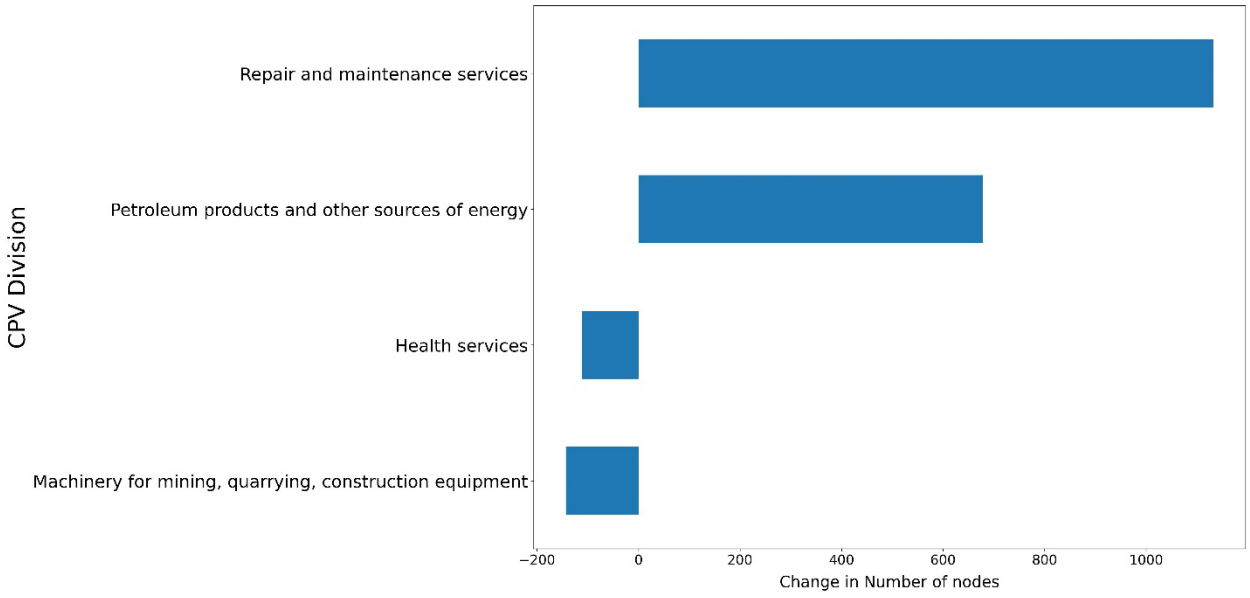
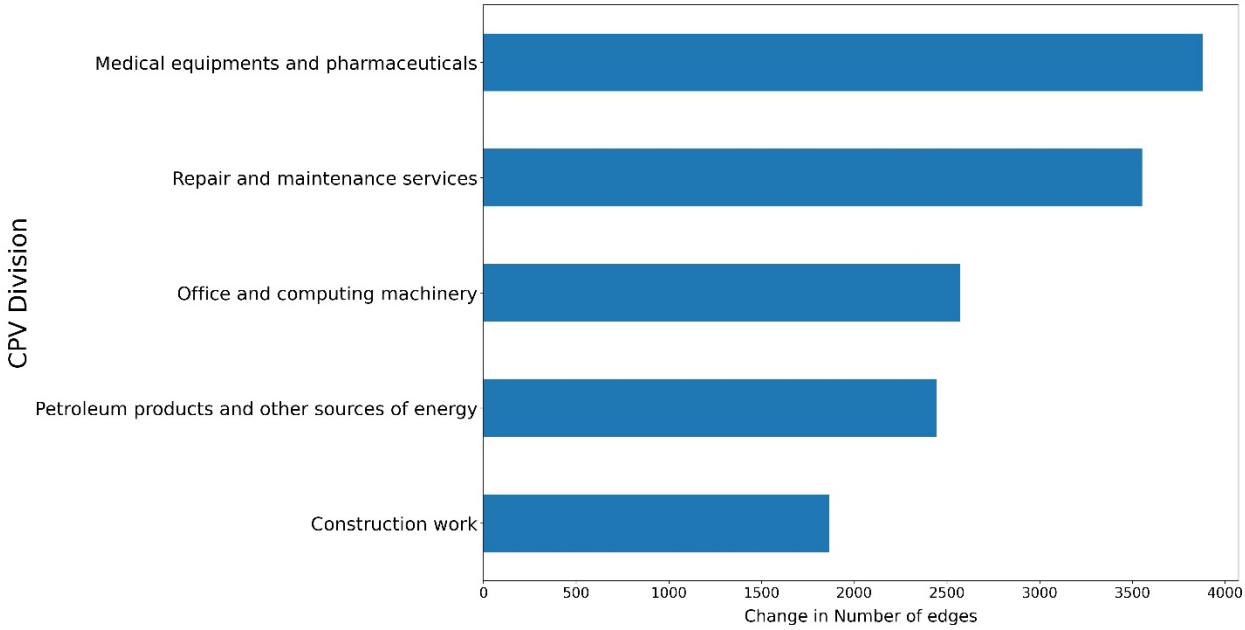


Figure A2.c: Change in the number of distinct ties before and after the 2017 government change in North Macedonia



Figures A2.d and A2.e examine the changes in the connectivity structure of each sector. All sectors experienced an increase in the average node degree after the government change - in figure A2.d we show the top 5 sectors that exhibit this trend. The Medical equipment, pharmaceuticals, and personal care products sector (33) and the Office and computing machinery sectors (30) had the most significant increases in the average node degree. Figure A2.e displays changes in assortativity in each sector. Assortativity measures the tendency of nodes to connect with other nodes with similar degrees. A higher assortativity score indicates that high-degree nodes tend to connect with other high-degree nodes, leading to networks that are highly connected within communities but weakly connected between communities. We observe a mixed picture regarding the assortativity scores across sectors. For example, the Research and development services and related consultancy services sector (73) and the Hotel, restaurant, and retail trade services sector (55) experienced the highest increase in assortativity. On the other hand, the Administration, defense and social security services sector (75) and the Chemical products sector (24) experienced the highest decrease in assortativity.

Overall, this suggests that the government change maybe associated with significant changes on the connectivity structures of various sectors, with most sectors experiencing an increase in average node degree. However, the changes in assortativity were mixed, indicating that some sectors became more highly connected within communities, while others became more random in their structure.

Figure A2.d: Change in the average node degree before and after the 2017 government change in North Macedonia

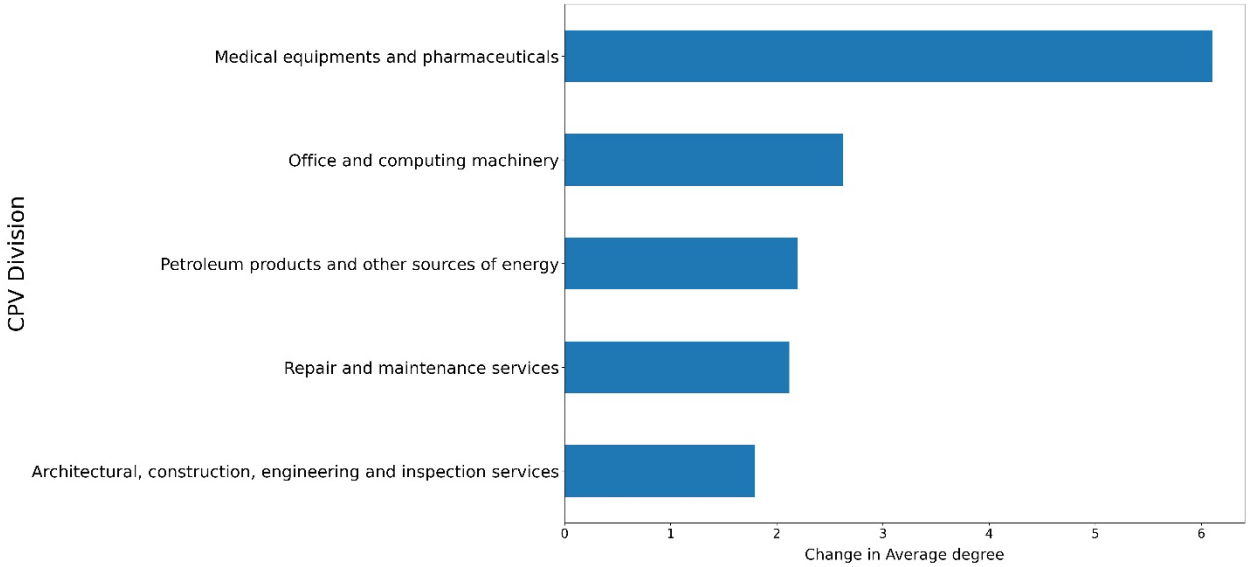


Figure A2.e: Change in assortativity before and after the 2017 government change in North Macedonia

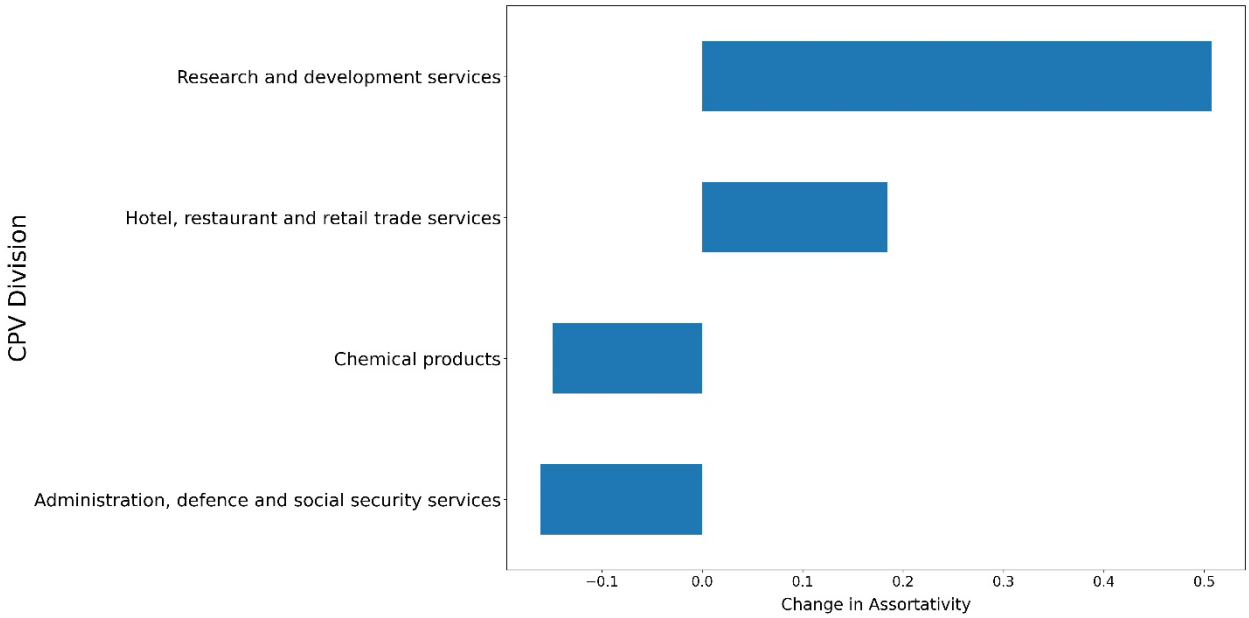


Figure A2.f illustrates changes in the average betweenness centrality score in selected sectors after the government change. The Medical equipment, pharmaceuticals, and personal care products sector (33) experienced the largest decline in its average betweenness centrality score from 3.244 to 0.004[11], indicating that nodes in this sector were less likely to act as bridges between loosely connected communities compared to the period before the government change. Similarly, the Postal and telecommunications services sector (64), Research and Development Services

[11] The Medical equipments, pharmaceuticals and personal care products sector was excluded from the figure due to its significant drop in centralization score, which would have obscured the changes in other sectors.

(73), and the Petroleum products (09) sectors also experienced a decrease in their average betweenness centrality score while the Agricultural machinery sector (16), the Mining, basic metals and related products sector (14) and the Leather and textile fabrics (19) experienced the highest increases in their average betweenness centralization scores, indicating that nodes from those sectors were more likely to act as bridges between weakly connected communities after the government change.

Figure A2.f: Change in the average betweenness centrality before and after the 2017 government change in North Macedonia

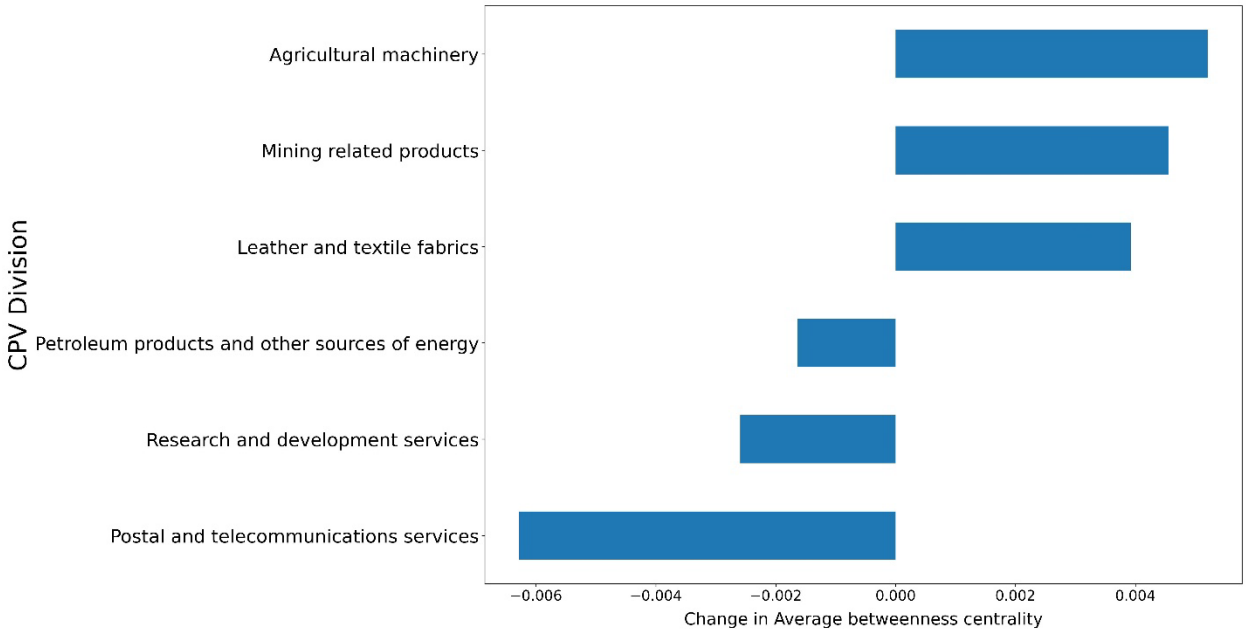


Figure A2.g illustrates changes in the Modularity score[12] of the network following the government change. The data shows a decrease in modularity across almost all sectors, with the largest declines occurring in the Architectural, construction, engineering, and inspection services sector (71) and the Business services: law, marketing, consulting, recruitment, printing and security sector (79). The Research and development services and related consultancy services sector (73) and Installation services sector (51) were the top sectors that experienced an increase in modularity. Further analysis of the Research and development services sector may be necessary to fully comprehend the alterations in network structure.

Table A2.a summarizes the changes in the network metrics of all sectors. Our observation shows that there is an overall increase in connectivity between sectors, leading to a decrease in modularity after the government change. Additionally, we notice sector specific changes in metrics such as assortativity and average betweenness centrality scores for certain sectors. Further investigation is necessary to better understand these changes and their implications in greater detail.

[12] To calculate the modularity, we employed the Louvain algorithm as implemented in the NetworkX Python package (Hagberg et al., 2018).

Figure A2.g: Change in the Modularity score (Louvain algorithm) before and after the 2017 government change in North Macedonia

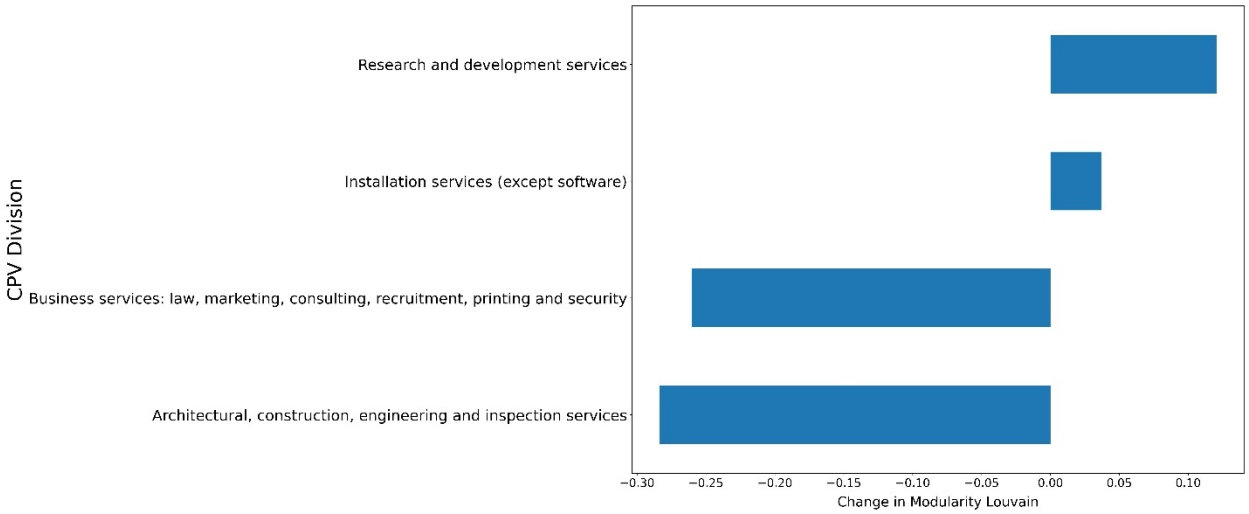


Table A2.a: CPV Sectors with the Major Changes in Network Structure following the 2017 Government Change in North Macedonia

	Increase	Decrease
Number of nodes	• Repair and maintenance services • Petroleum products, fuel, electricity and other sources of energy	• Machinery for mining, quarrying, construction equipment • Health and social work services
Number of ties	• Repair and maintenance services • Medical equipments, pharmaceuticals and personal care products	
Average Degree	• Medical equipments, pharmaceuticals and personal care products • Office and computing machinery	
Assortitavity	• Research and development services and related consultancy services • Hotel, restaurant and retail trade services	• Administration, defence and social security services • Chemical products
Average Betweenness Centrality	• Agricultural machinery • Mining, basic metals and related products	• Medical equipments, pharmaceuticals and personal care products • Postal and telecommunications services
Modularity (Louvain algorithm)	• Research and development services and related consultancy services • Installation services (except software)	• Architectural, construction, engineering and inspection services • Business services: law, marketing, consulting, recruitment, printing and security