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Testing Corruption Indicators: Statistical Analysis of a Hungarian Cartel

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ABSTRACT
The study analyzes the reliability of corruption risk indicators using Hungarian public procurement data, specifically focusing on EU-funded contracts associated with a cartel case revealed by the Hungarian Competition Authority (HCA) in 2016. The investigation aims to determine whether corruption risk indicators for public procurement contracts related to the identified cartel case (214 contracts) are significantly higher than those for similar contracts in different submarkets. The analysis utilizes data from the Corruption Research Center Budapest database, encompassing Hungarian public procurement information from January 1998 to July 2023, totaling around 340,000 contracts or contract lots. Since the cartel case detected by the HCA was part of the EU-funded KEOP program, covering contracts from 2015 to 2016 in the manufacturing sector, our analysis is limited to EU-subsidized contracts in the manufacturing sector awarded in 2015 and 2016.
Our findings highlight that the corruption risk indicator (single bid), endorsed by the EU Single Market Scoreboard, provides valuable insights for identifying anomalies in public procurement. For the identified cartel contracts, the likelihood of a contract being awarded to a single bidder (without competition) was significantly higher compared to contracts not associated with a cartel case. A similarly robust outcome was observed for the indicator measuring contracts concluded with more than three bids. The probability of contracts with more than three bids was significantly lower for cartel contracts than for others.
The indicator assessing the occurrence of rounded winner prices yielded a significant result for one of the three subsamples, and in another, it was significant only at the 10% level. These results affirm the significance of conducting statistical analyses on contracts and the calculation, as well as in-depth examination, of corruption indicators (single bid, more than three bids, and rounded winner price) to identify anomalies in public procurement.

JEL codes: D73; H57
Keywords: corruption, cartel, rounded prices, Hungary, EU subsidies

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Korrupciós mutatók tesztelése:
Egy magyar kartell statisztikai elemzése

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ÖSSZEFOGLALÓ

A tanulmány a korrupciós kockázatot mérő mutatók érvényességét vizsgálja. Magyar közbeszerzési adatokat használunk, és egy EU-s finanszírozású programhoz (KEOP) tartozó, a Gazdasági Versenyhivatal (GVH) által 2016-ban feltárt kartellügyhöz tartozó szerződéseket elemzünk. Megvizsgáljuk, hogy a feltárt kartellügy közbeszerzési szerződéseire (összesen 214 szerződés) vonatkozó korrupciós kockázati mutatók szignifikánsan magasabbak-e, mint a különböző részpiacok hasonló szerződéseinek korrupciós kockázata. Az elemzéshez a CRCB által létrehozott adatbázis adatait használjuk. Ez az adatbázis a magyar közbeszerzésekre, szerződésekre vagy szerződéses tételekre vonatkozó adatokat tartalmaz 1998 januárjától 2023 júliusáig, mintegy 340 000 szerződést, illetve szerződéses tételt. Mivel az uniós finanszírozású KEOP-program, amelyben a GVH feltárta a kartellt, 2015 és 2016 közötti szerződéseket tartalmazott a feldolgozóiparban, csak a feldolgozóiparban uniós támogatással finanszírozott és 2015-ben és 2016-ban odaítélt szerződéseket elemeztük. Megállapítottuk, hogy az EU Single Market Scoreboard által is ajánlott korrupciós kockázati mutató (egyetlen ajánlat) értékes információkat nyújt a közbeszerzésekben előforduló anomáliák felderítéséhez. A szóban forgó kartellszerződések esetében annak az esélye, hogy a szerződésnél egyetlen (verseny nélküli) ajánlatot adtak be, jelentősen magasabb volt, mint a kartellügyben nem érintett szerződések esetében. Hasonlóan meggyőző eredményt kaptunk a legalább négy ajánlattevővel kötött szerződéseket mérő mutató esetében is. A legalább négy ajánlattevővel kötött szerződések valószínűsége szignifikánsan alacsonyabb volt a kartellszerződéseknél, mint a többi szerződésnél. A kerekített győztes árak előfordulását mérő mutató a három alminta egyikében szignifikáns eredményt adott, míg a másikban csak 10%-os szinten volt szignifikáns. Az eredmények megerősítik, hogy érdemes elvégezni a közbeszerzési szerződések statisztikai elemzését és a korrupciós mutatók (egyetlen ajánlattevő, háromnál több ajánlattevő és kerekített nyertes ár) kiszámítását és alaposabb vizsgálatát a közbeszerzési anomáliák felderítése érdekében.

JEL: D73; H57
Kulcsszavak: korrupció, kartell, kerekített árak, Magyarország, EU támogatások

1 Introduction

In this paper[1], we examine the validity of three indicators commonly used in investigating public procurement corruption, cartel activities, and fraud detection, utilizing data from a Hungarian public procurement cartel case. The study aimed to test whether the statistical analysis of these indicators could have signaled the detected anomaly, i.e., whether using these indicators aids in detecting anomalies in public procurement. Specifically, the study investigates whether these indicators can help identify public procurement contracts, companies, or contracting authorities associated with these anomalies.

We use Hungarian public procurement data and analyze contracts from a cartel case uncovered by the Hungarian Competition Authority (HCA) in 2016 following an investigation[2]. The case was summarized as follows in the HCA's first communication on the subject:

> *"The HCA found that the investigated companies subject to the procedure may have engaged in discussions and exchanged information from 2015 onwards on the bidding behavior to be adopted in the context of the tendering procedures for the procurement of diagnostic imaging equipment under the call for proposals KEOP-5.6.0/E/15-2015 "Support for the procurement of energy-saving healthcare equipment," in particular on the determination of the winning undertakings and the prices offered.*
>
> *Their conduct is likely to constitute a breach of the provisions of the Competition Act and of the Treaty on the Functioning of the European Union prohibiting restrictive agreements."*[3]

We investigate whether the corruption risk indicators for the public procurement contracts of the discovered cartel case (214 contracts in total) are significantly higher than the corruption risk of similar contracts in different subsamples. All 214 contracts were in the manufacturing sector; they were funded by EU subsidies and awarded in 2015 or 2016. For this purpose, we analyzed three sub-samples: (i) all contracts funded by EU and awarded in 2015 or 2016 (sample_cpmi=1); (ii) contracts in group (i) and contracts in the manufacturing sector where the contracting authorities were the same as the contracting authorities in the cartel case (sample_issuer_cpmi=1); (iii) contracts in group (i) and contracts in the manufacturing sector where the winning firms were the same as the winning firms in the cartel case (sample_winner_cpmi=1).

Suppose the corruption risk indicators of the cartel contracts show a significantly higher corruption risk in the sub-samples tested than in the non-cartel contracts. In that case, this is interpreted as evidence of the validity of the corruption indicators. They can, therefore, be used to detect anomalies in public procurement (e.g., cartels, corruption). It is worthwhile to calculate

[1] The construction of the database was made possible by donations from Hungarian citizens and Hungarian companies to the CRCB. We hereby thank György Molnár for the suggestions provided for the paper.

[2] To our knowledge, the HCA initiated the procedure on this cartel case based on another source than the statistical analysis of public procurement data. We interviewed one of the journalists investigating the case, who stated that the HCA investigation was initiated based on a complaint. The leader of a company, approached by the organizers of the cartel to participate, filed a report to the HCA after choosing not to be involved in the cartel. This fact is also indicated by an HCA document cited by an article on 444.hu (See: http://bitly.ws/DsbF) that highlights only the names of two companies and their leaders in the initiating "Justification" section, while describing the facts of the cartel case. (https://assets.4cdn.hu/kraken/771g9OBdGqZUAvAss.jpeg).

[3] See: https://web.archive.org/web/20160527121354/https://www.gvh.hu/sajtoszoba/sajtokozlemenyek/2016_os_sajtokozlemenyek/kartellgyanu_miatt_inditott_eljarast_a_gvh.html.

them for different groups of winners and contracting authorities to take a cross-section of high corruption risk actors (issuers and winners) and to perform further calculations on this sub-sample. Otherwise, there is evidence that indicators measuring corruption risk are of questionable validity and cannot be used to detect cartels.

The relevant literature is summarized in the first part, followed by the description of the cartel case and the data used. After describing the empirical strategy and the results obtained, we discuss the interpretation of the results.

2 Literature

The case surrounding KEOP-5.6.0/E/15-2015 can be deemed both as corruption and market collusion (Tóth et al. 2014). This is because the ruling of the Hungarian Competition Authority suggests that not only the market players, but also those drafting the tenders were involved in the conspiracy (Gazdasági Versenyhivatal 2020, §231-232, §236). Consequently, we test three indicators, one of which has mainly been used as an indicator of corruption risk, the other as an indicator of cartel risk and the third used by the fraud detection.

Empirical tests on indicators of corruption risk mainly concern testing perception-based indicators. These indicators rely on evaluative surveys and aim to compare the aggregate level of corruption between countries or regions. A large body of literature found a weak correlation between corruption indices relying on evaluative versus non-evaluative surveys, pointing to the weaknesses of perception based indicators (Donchev and Ujhelyi 2014; Gutman, Padovano, and Voigt 2020; Razafindrakoto and Roubaud 2010). Other studies also question the reliability of these indicators, comparing them with objective measures such as missing expenditures (Olken A. 2009). A handful of empirical tests argued that the inaccuracy of perception based indices have been overstated (Charron 2015).

It is also important to note that different indicators of corruption may be suitable for different research questions (Goel and Nelson 2011). While survey based indicators may be the only accessible resource if we want to quantify the overall level of corruption in a given country, measuring the narrower field of corruption in public procurement could be done by objective, micro-level data (Knack 2007). Our paper aims to contribute to the literature testing these types of indicators. Our proxy relies on the widely used single-bid model, measuring the share of won procurement contracts that had no more than one bid.

There are few publications on testing the validity of objective corruption risk indicators. The papers undertaking this task verify their indicators by demonstrating a strong correlation between high corruption risk and investigations by the local corruption authorities (Decarolis and Giorgiantonio 2022; Ferwerda, Deleanu, and Unger 2017; Lisciandra, Milani, and Millemaci 2022). Our test of the single-bid indicator aims to contribute to this narrow body of literature.

More has been published on the empirical tests of indicators of cartel risk. Similarly, as in the case of objective indicators of corruption risk, these tests measure the correlation between these indicators and suspicion or punishment by competition authorities (Bergeijk 2007; Bergman et al. 2020; Chotibhongs and Arditi 2012; Huber and Imhof 2019; Imhof, Karagök, and Rutz 2018; Ishii 2014; Jiménez and Perdiguero 2012; Porter and Zona 1993; Signor et al. 2019).

Most cartel risk indicators rely on proxies of price anomalies. Our indicator starts with a similar intuition. We assume that if prices correctly reflect costs, they are not rounded. As a result,

buyers deem rounded prices higher (Hukkanen and Keloharju 2019; Leib et al. 2021; Thomas, Simon, and Kadiyali 2010). So, in the case of a competitive market, rounded prices should only occur occasionally. Hence, we use the share of rounded prices as a proxy for cartel risk. To our knowledge, this indicator has yet to be tested (Ishii 2014).

3 The HCA's Investigation

In the European Union, subsidies are allocated to less economically developed countries under the EU Cohesion Policy to foster economic convergence between member states. These funds are financed from the EU budget, are non-refundable, and are ultimately allocated to specific projects by the administration of the recipient member states.[4] In the funding period between 2014 and 2020, Hungary received EUR 22.5 billion worth of subsidies under the EU Cohesion Policy.[5]

EU institutions have already recognized Hungary's systematic misuse of EU funds by the time of the present case. In 2016, the European Anti-Fraud Office (OLAF) reported that it had to make financial recommendations on 4.16% of payments to Hungary from the EU Structural Funds and Agriculture (a broader set of EU funds that includes the EU Cohesion Funds) in the period between 2013 and 2016. This figure was almost ten times higher than the EU average (0.43%) and was by far the highest among all member states.[6]

A significant case OLAF uncovered concerned a company then co-owned by István Tiborcz, son-in-law of Prime Minister Viktor Orbán.[7] The case concerned the misuse of EU funds provided for public lighting renovation. In its 2017 report, OLAF stated that in one part of the project *"…an organised fraud scheme is identified, involving an artificial increase of the cost estimation through the use of falsified documents during the project application, the illegal participation of the staff of the works company to the drafting of the project application, tender orientation in view to award the contract to a company linked to one of the consultants, possible illegal agreement between the works contractor and one of the manufacturers."*.[8] OLAF estimated the financial impact at EUR 43 million.[9]

KEOP-5.6.0/E/15-2015 was one program in Hungary funded by the EU Cohesion Policy; the first section was announced on 11 May 2015. It provided subsidies for Hungarian hospitals and healthcare providers to replace outdated diagnostic imaging equipment.[10] Until February 2016, HUF 33.4 billion (EUR 100 million)[11] was allocated in 220 contracts under the program.[12] The Hungarian Competition Authority (HCA) launched an investigation into handling KEOP-5.6.0/E/15-2015 on 11 April 2016. It is suspected that the involved parties coordinated with the

[4] European Commission. 'Cohesion Fund'. http://bitly.ws/HdY6 (June 5, 2023).
[5] European Commission. 'Hungary'. *Cohesion Open Data Platform*. http://bitly.ws/HdYH (June 5, 2023) and https://www.palyazat.gov.hu/new_hungary_development_plan
[6] European Anti-Fraud Office. 2016. The OLAF Report 2016. Luxemburg. http://bitly.ws/HHZH (June 8, 2023).
[7] Reuters. 2018. 'Hungarian Police Investigating Fraud in EU-Funded Projects'. http://bitly.ws/HIaT (June 8, 2023).
[8] European Anti-Fraud Office. 2017. *Final Report, Case No OF/2015/0034/B4*. Brussels: European Anti-Fraud Office. http://bitly.ws/HI9K (June 8, 2023). 4.
[9] European Anti-Fraud Office. 2017. *Final Report, Case No OF/2015/0034/B4*. Brussels: European Anti-Fraud Office. http://bitly.ws/HI9K (June 8, 2023). 3.
[10] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §13 and Környezet és Energia Operativ Program (KEOP) https://www.palyazat.gov.hu/doc/534
[11] Throughout the paper, we use EUR/HUF conversion rate of 19 December 2019, at the time when the HCA delivered its judgement on the present case. It was EUR 1 = HUF 331.39.
[12] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §14

help of two individuals representing Chemium Kft. and VMD Zrt. The HCA alleged that the activities took place intending to secure the future winners of biddings and set the winning prices.[13] While the names of individual persons are classified in the publicly available document, the investigative journalist Zsolt Sarkadi claims in his article on 444.hu[14] based on an HCA document, that the two individuals were Sándor Harmat[15] and Gáspár Maróth.[16] In 2019, the HCA found no irregularities concerning VMD Zrt., but it did so in case of Chemium Kft. Once the investigation was concluded, it also noted that only the formal individual played a central role in the process.[17] The HCA also did not fine Chemium Kft., citing the fact that it had not realized any financial benefits from the tenders under investigation.[18]

The HCA investigated 29 companies, alleging that their activities under KEOP-5.6.0/E/15-2015 were in breach of competition law. The companies under investigation initially were:

- Siemens Healthcare Kft.,
- GE Hungary Kft.,
- PHILIPS Magyarország Kft.,
- Variotrade Kft.,
- HOGE Orvosi Műszer Kft.,
- Premier G. Med Kft.,
- Med&Trade Co. Bt.,
- INNOMED MEDICAL Zrt.,
- Getronics Magyarország Kft.,
- PASCAL TEAM Kft.,
- Silver Wood - IT Kft.,
- MEDIMAT Kft.,
- MEDI-CONT Kft.,
- VMD Kórházi Technológiai Zrt.,
- Novelmedix Zrt.,
- Artmed Kft.,

[13] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §2
[14] Sarkadi, Zsolt. 2018. 'Tízmilliárdokat adott az EU, hogy jobb legyen a magyar egészségügy, de ezt is szétlopták'. *444.hu*. http://bitly.ws/DsbF.
[15] Sándor Harmat is a Hungarian businessman accused of acting on behalf of Chemium Kft. in the present case. Chemium Kft. was found guilty by the HCA. However, Chemium Kft. was not fined since the HCA claimed it did not realize any revenue from the tenders under investigation. In another case in 2013, Harmat was found guilty as a first-degree defendant for breach of business confidentiality. The court found that Harmat, together with a colleague of his at Diagon Kft. (a company dealing with diagnostic equipment in healthcare), downloaded more than 11.000 confidential documents of the company, after which he moved to its competitor Diachem Kft. and shared them with its executive. The court further found they also attempted to share these documents with a Russian company in 2008. See: hvg.hu, February 6, 2013. 'Börtön helyett pénzbüntetés lett a diagon-ügy ítélete'. http://bitly.ws/Fm8h.
[16] Gáspár Maróth was born in 1972. Gáspár Maróth studied Medicine at Semmelweis University in Budapest. During the first Orbán government (1998-2002), he worked on healthcare-related matters in the Prime Minister's cabinet. After Fidesz lost the elections in 2002, he mainly worked in the private sector, holding a stake in 9 companies. In 2009, he sold one of his companies to Zoltán Spéder. Between 2011 and 2015, he co-owned another company with Zsolt Incze. Spéder and Incze are businessmen with close political ties to the leaders of Fidesz. He was the executive of VMD Zrt., one of the companies investigated by the Hungarian Competition Authority in 2016. In 2019, the HCA found no irregularities committed by VMD Zrt. In 2016, he became the executive of HM EI Zrt., a company executing procurements for the Hungarian Ministry of Defense. After 2017, he worked as the Director of Armament at the Hungarian Ministry of Defense. Between 2018 and 2022, he was the Government Commissioner for Defense Development at the Prime Minister's Office. He is the owner of the Defense Acquisition Agency, which was founded in 2019. Since 2022, he has been the State Secretary for Defense Policy and Defense Development at the Hungarian Ministry of Defense. Since 2023, he has been Head of Eastern Europe Coordination at Rheinmetall AG, a German automotive and arms manufacturing company. See: Galavits, Patrik. 2023. 'How Viktor Orbán Decided to Arm Hungary'. *Direkt36.hu*. http://bitly.ws/Fm9Y (June 8, 2023).
[17] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §699
[18] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §43, §53, §55, §58

- Euromedic Technology Kft.,
- EUROMEDIC DENT Kft.,
- Medirex Zrt.,
- Mediszer Kft. and
- Chemium Zrt.

The HCA later added the following companies to the list of investigated companies:

- Siemens Termelő, Szolgáltató és Kereskedelmi Zrt.,
- HUNG-RAD Kft.-t,
- DR. SAS CLINIC Plasztikai és Sebészeti Kft.,
- EUROMEDIC-PHARMA Gyógyszernagykereskedelmi Zrt.,
- HOGE SYSTEMS Szolgáltató Kft.,
- Premier G. Med Egészségügyi Szolgáltató Kft.,
- Premier G. Med Vagyonkezelő Szolgáltató Kft.,
- PREMIER G. MED CARDIO Kereskedelmi Kft. and
- PREMIER G. MED ONKO Kereskedelmi Kft.[19]

During the investigation, the HCA found that coordination among market players took place both before and after KEOP-5.6.0/E/15-2015 was officially announced. This is because players received information well before the official announcement of the tenders that an opportunity to receive EU-subsidies for diagnostic imaging equipment will open.[20] The involved parties then used three main coordination techniques the HCA later found to be in breach of competition legislation.

First, knowing about the upcoming tenders, market actors coordinated in executing so-called "needs-assessments". The motive behind these assessments was for market players to maintain their market shares.[21] They contacted healthcare institutions to assess the kinds of imaging equipment they need, and the producers and distributors they prefer.[22] The healthcare institutions encouraged their preferred suppliers to bid for their tenders.[23] This information was then condensed in electronic spreadsheets, spread among the involved parties. The spreadsheets often included the names of companies who should "take" each tender, and the price at which those tenders should be taken.[24] Based on these pre-allocations, the HCA found that producers entered preliminary contracts with their suppliers even prior the announcement of the tenders.[25]

Second, the parties engaged in so-called "over-specification of tenders". Healthcare institutions collaborated with producers to draft their tenders. In these tenders, there were technical criteria for the equipment to be acquired. Through informal talks, the involved parties often ensured that the technical criterion of each tender is such that only the desired producer can meet it.[26] While the involved parties recognized when a given tender unfairly disqualified them from

[19] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §1, §5
[20] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §60, §70, §73
[21] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §88-113, §150
[22] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §190
[23] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §192
[24] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §84-87, §152-154, §198, §318-319
[25] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §175-176
[26] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §231-232, §236

applying,[27] they did not seek legal remedy,[28] since they understood that the process aims to ensure everyone's desired market share.[29]

The third channel came once KEOP-5.6.0/E/15-2015 was announced. Initially, market players had expected a lower amount of subsidies to be distributed under KEOP-5.6.0/E/15-2015.[30] However, market players became aware that this budget would be significantly expanded and had already been planning on using the above mechanisms to allocate the expanded budget once it is announced.[31] But once the expansions had been announced, many producers realized that they would be unable to supply the amount that was informally allocated to them by the deadlines set by the healthcare institutions.[32] To manage the problem, representatives of each company met, and agreed to manage capacity issues collectively.[33]

On 19 December 2019 the HCA delivered its final verdict.[34]

The HCA noted that the following companies have undergone a common settlement procedure, in which they admitted their guilt.

- Euromedic Technology Kft.,
- Philips Magyarország Kft.,
- HOGE Orvosi Műszer Kft.,
- Siemens Healthcare Kft. and
- Siemens Termelő, Szolgáltató és Kereskedelmi Zrt.[35]

In a separate settlement procedure, Mediszer Kft. also admitted its guilt prior to the verdict.[36]

The HCA found the activities of the following companies to be in breach of competition law:

- Siemens Healthcare Kft.,
- Siemens Termelő, Szolgáltató és Kereskedelmi Zrt.,
- GE Hungary Ipari és Kereskedelmi Kft.,
- PHILIPS Magyarország Kft.,
- HOGE Orvosi Műszer Kft.,
- Premier G. Med Kft.,
- Euromedic Technology Kft.,
- Chemium Zrt.,
- Medirex Zrt. and
- Mediszer Kórháztechnika és Kereskedelmi Kft.[37]

The HCA fined the following companies:

- Siemens Healthcare Kft. for HUF 25609800 (EUR 77279),

[27] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §249-254
[28] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §392
[29] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §256
[30] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §241
[31] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §245-248
[32] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §411
[33] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §419
[34] Gazdasági Versenyhivatal. 2020. 'Fines Amounting to a Total of EUR 4.8 M Imposed for Collusion in the Public Procurement of Diagnostic Imaging Equipment'. http://bitly.ws/HItm (June 8, 2023).
[35] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §8
[36] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §687
[37] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §I

- GE Hungary Ipari és Kereskedelmi Kft. for HUF 341088000 (EUR 1029264),
- PHILIPS Magyarország Kft. for HUF 146818000 (EUR 443036),
- Premier G. Med Kft. for HUF 308200000 (EUR 930022),
- Euromedic Technology Kft. for HUF 299784000 (EUR 904625),
- Medirex Zrt. for HUF 162624000 (EUR 490732), and
- HOGE Orvosi Műszer Kft. for HUF 158526000 (EUR 478366).[38]

The HCA closed its investigation against all other companies involved.

4 Data and indicators

The analysis uses data from the database created by the Corruption Research Center Budapest (CRCB). This exceptional dataset contains data on Hungarian public procurement, contracts, or contract lots from January 1998 to July 2023, with around 340,000 contracts or contract lots. Since the EU-funded KEOP program in which the HCA detected the cartel included contracts from 2015 to 2016 in the manufacturing sector, only contracts funded by EU subsidies in the manufacturing sector and awarded in 2015 and 2016 were analyzed from the CRCB database. Two thousand seven hundred twenty-eight such contracts and contract sections are available in the CRCB database[39].

Rounded winning prices indicate that the firm used non-cost pricing in their pricing decision, or expected price competition by the winners in the procurement would be weak.

Rounded prices typically occur when the subsequent winner expects weak price competition. Rounded prices are usually upward-rounded. This phenomenon can be seen by comparing the incidence of rounding with the expected strength of price competition (ESPC[40]) variable. When the winning prices are not rounded, the estimated value exceeds the winning prices by 6.6 percent on average. When they are rounded, the estimated value exceeds the winning prices by only 3.1 percent. In the sample_cpmi sample, these values are 3.5 percent and -1.5 percent (see table 4.1.).

Table 4.1: Mean of ESPC by winner price rounding (by 10^5)

	ROUND5 (10^5)	Mean	Standard Error	N
All contract	Non-rounded	6.64	0.06	152,699
	Rounded	3.07	0.08	38,164
sample_cpmi	Non-rounded	3.46	0.45	1,751
	Rounded	-1.54	0.65	2,178

[38] Gazdasági Versenyhivatal. 2020. *Vj/19-1405/2016*. §II
[39] See separate CSV file on the CRCB website for analyzed contract data at https://www.crcb.eu/?p=3483.
[40] ESPC = [(net estimated value – net contract value) / net estimated value]*100

5 Empirical Strategy

During the analysis, we used the following equation:

$$I_i = \alpha_i + \beta_i CPMI_i + \sum_{j=1}^{k} \gamma_{ij} X_{ij} + \varepsilon_i$$

where

I the indicator measuring corruption risk (SB), control of corruption risk (MTTB), rounded winner price (ROUND5) by dummy variables, and CPMI [0,1] is also a dummy variable with a value of 1 if the procurement was carried out under the KEOP-5.6.0/E/15 program examined by the HCA (in 214 cases, CPMI=1) and 0 if it was another procurement. *X* is a vector of variables describing other characteristics of the procurement contracts (contract size, year, type of procedure).

For measuring the prevalence of single-bid contracts, we use an indicator called 'Corruption Risk' (CR) using the following rule:

CR = 0, if the tender was conducted with more than one bid,

= 1, if there was only one bid.

We created an indicator based on the number of bids to distinguish the contracts with more than three bids (MTTB).

MTTB = 0, if the tender was conducted with no more than three bids,

=1, if there were more than three bids for the contract.

We interpret the MTTB as a proxy for control of corruption risk. If the share of tenders with more than three bids is high, the proportion of independent competitors is also high, which means more robust control of corruption. There is a minimal incentive for corrupt actors to organize three or more losing 'bidders' when organizing three formally independent bidders is enough to meet the formal requirements.

For measuring the prevalence of rounded winner price, we use an indicator ROUND5 using the following rule:

ROUND5 = 0, if the winner price was not rounded by 100.000,

= 1, if the winner price was rounded by 100.000

For every estimation, we ran a logit estimation with variable SB, MTTB, and ROUND5, and we used three subsamples of public contracts: sample_cpmi, sample_winner_cpmi and sample_issuer_cpmi (See Table 5.1.).

Table 5.1. Characteristics of sub-sample used

Name of subsample	Definition	N
sample_cpmi	all contracts funded by EU and awarded in 2015 or 2016	2,747
sample_winner_cpmi	sample_cpmi and contracts in manufacturing and won by companies in investigated KEOP program	450
sample_issuer_cpmi	sample_cpmi and contracts in manufacturing and issued by contracting authorities in investigated KEOP program	690

6 Results

6.1 Descriptive Statistics

Let's examine all EU-funded contracts in the manufacturing sector carried out between 2015 and 2016 by contracting authorities or awarded to winning firms implicated in the cartel case. Subsequently, we categorize these contracts into two subgroups: those associated with the cartel case and those unrelated. The findings indicate that the risk of corruption is higher in cartel-related contracts compared to others, the control of corruption is weaker in the former group, and the proportion of rounded winning prices is higher in cartel contracts. Additionally, the net value of cartel contracts generally exceeded that of other contracts (See Fig. 1-4).

Table 6.1.1. Descriptive Statistics of Analyzed Indicator of Contracts in Samples by Involvement of Cartel Case

Sample	Indicator	Contracts in the Cartel Case			Other Contracts		
		Mean	Standard Error	N	Mean	Standard Error	N
sample_cpmi	SB	0.762	0.029	214	0.422	0.010	2533
	MTTB	0.010	0.007	214	0.117	0.006	2533
	ROUND5	0.347	0.033	213	0.183	0.008	2508
sample_winner_cpmi	SB	0.752	0.032	206	0.516	0.032	244
	MTTB	0.010	0.007	206	0.062	0.015	244
	ROUND5	0.341	0.033	205	0.246	0.028	244
sample_issuer_cpmi	SB	0.752	0.030	206	0.419	0.22	484
	MTTB	0.010	0.007	206	0.120	0.015	484
	ROUND5	0.341	0.033	205	0.163	0.017	479

The descriptive statistics for the analyzed indicators highlight significant differences between the contracts associated with the cartel case and those unrelated (See Table 6.1.1.). Contracts within the cartel sample exhibit an exceptionally high corruption risk of 0.72 (with a maximum value of 1.00), whereas in the control sample, the average values are 0.42 and 0.52. This discrepancy is significant, considering the relatively small standard errors. A similar trend is observed in the control of corruption: it is notably low for cartel contracts (only 1 percent of contracts had more than three competitors, compared to 6-12 percent in the control samples). The share of rounded winning prices was 34-35 percent for the cartel contracts, in contrast to the much lower percentages of 16, 18, and 25 in the control samples.

Fig. 6.1-4. Distribution of Winners and Contracting Authorities by Analyzed Indicators and Involvement of Cartel Case (CPMI)

Fig. 6.1a. Corruption Risk & Winners

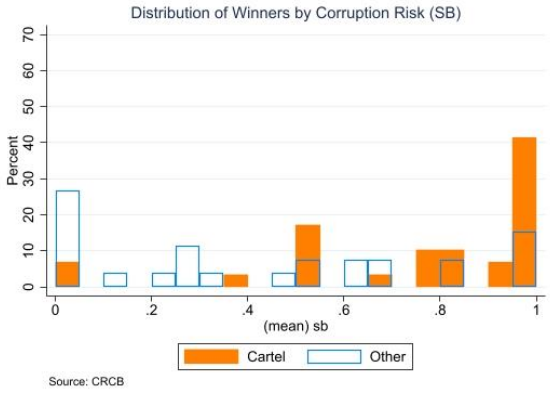


Fig. 6.1b. Corruption Risk & Contracting Authorities

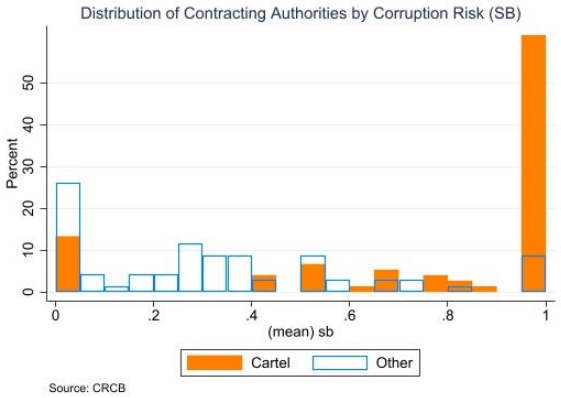


Fig. 6.2a. Control of Corruption Risk & Winners

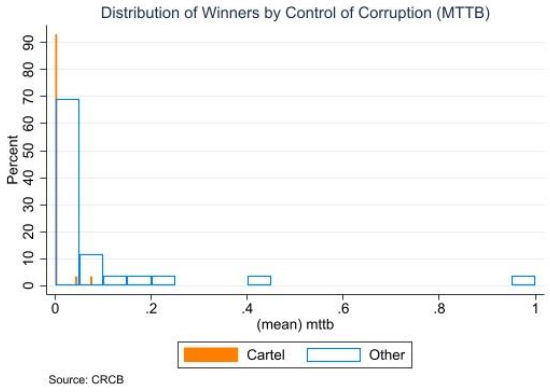


Fig. 6.2b. Control of Corruption Risk & Contracting Authorities

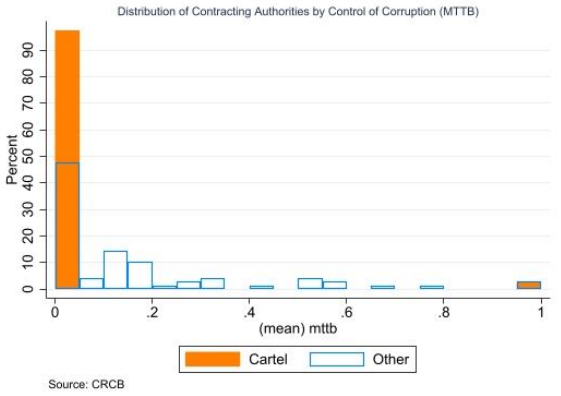


Fig. 6.3a. Rounded Winner Price & Winners

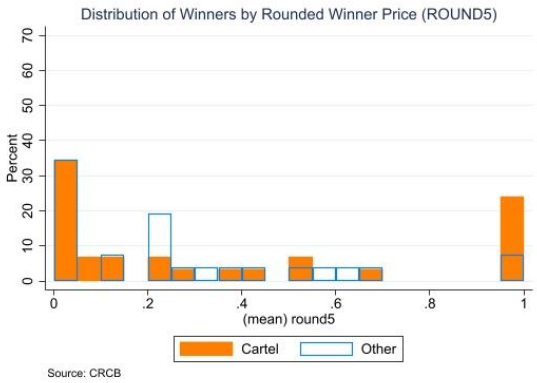


Fig. 6.3b. Rounded Winner Price & Contracting Authorities

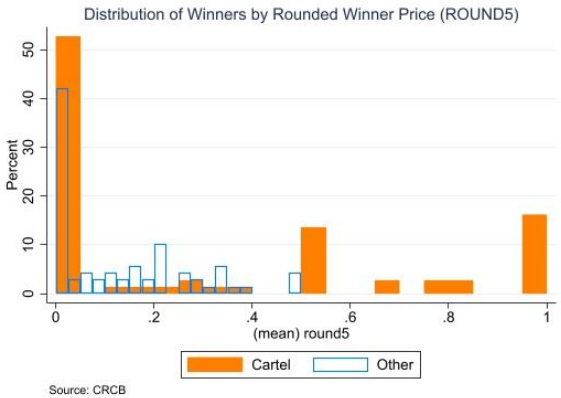


Fig. 6.4a. Ln of Net Contract Value & Winners

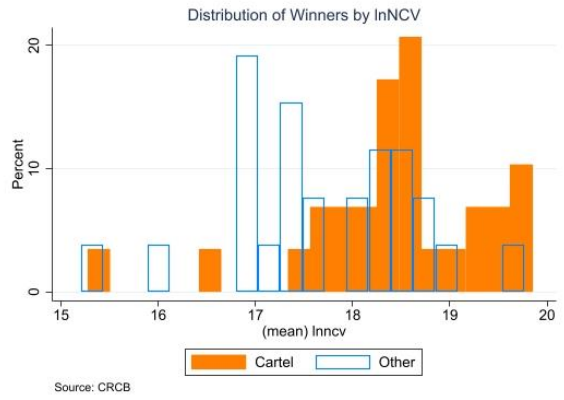
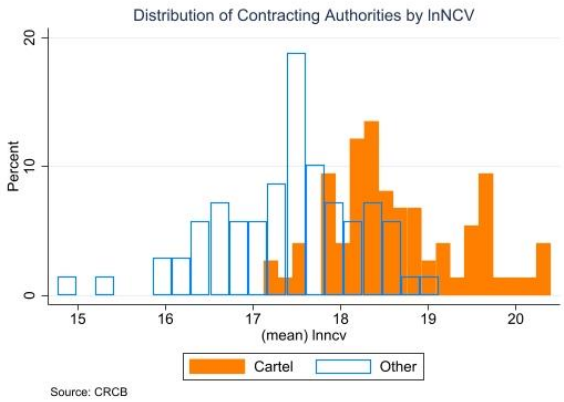


Fig. 6.4a. Ln of Net Contract Value & Contracting Authorities



6.2 Estimations

We present the estimation results in Table 6.2.1 (for detailed results, refer to Annex A2). Regarding the single-bid (SB) indicator, across all three sub-samples, this corruption risk indicator was significantly higher for public procurement contracts associated with cartel cases compared to those not involved in cartels. The odds ratio for single-bid tenders in cartel case contracts was 4.5 to 2.1 times higher than for other contracts. Similar patterns emerged for tenders with more than three bids (MTTB): the percentage of cartel contracts with at least four bids was significantly lower (with odds ratios of 0.06, 0.11, and 0.25), indicating a weak control of corruption risk.

Results related to the rounded winner price indicator are somewhat less robust. Significant results were found only for the sub-sample "sample_issuer_cpmi" and the sub-sample "sample_winner_cpmi" (with the latter being significant only at the 10% level). These results indicate that contracts involved in cartel cases are 1.6 to 2.1 times more likely to have rounded prices of HUF 100,000 than contracts not associated with cartels.

The robustness tests support the results (see A3).

Table 6.2.1. Results of logit estimations

Indicators	Odds Ratio Standard Error Case Number	Sampes sample_cpmi	sample_issuer_cpmi	sample_winner_cpmi
SB	or	4.552***	3.337***	2.108***
	se	(0.792)	(0.756)	(0.510)
	N	2,728	687	449
MTTB	or	0.061***	0.114***	0.259*
	se	(0.044)	(0.085)	(0.206)
	N	2,728	687	449
ROUND5	or	1.241	2.421***	1.610*
	se	(0.204)	(0.596)	(0.395)
	N	2,721	684	449

Notes: or: Odds Ratio; se: Standard Error; N: Case Number; SB [0,1]: Single Bid; MTTB [0,1]: More than Three Bids; ROUND5 [0,1]: Rounded Winner Price by 10^5. The Type of Procedure (LTI), ln Net Contract Value (LNNCV) and the Year of Contract (YEAR) are included in the estimations. See Annex A2.
****: p < 0.01 **: p < 0.05 *: p < 0.1*

7 Discussion

In this study, we assessed the validity of three corruption indicators using Hungarian data, specifically contract data derived from a cartel case detected by the Hungarian Competition Authority (HCA). Our findings underscore the significance of the corruption risk indicator (SB), also endorsed by the EU Single Market Scoreboard, in identifying anomalies in public procurement. For the identified cartel contracts, the likelihood of a contract being awarded to a single bidder (without competition) was significantly higher than for contracts not associated with a cartel case. A similarly robust outcome was observed for the indicator measuring contracts concluded with more than three bids (MTTB), suggesting its utility in detecting anomalies.

The indicator assessing the occurrence of rounded prices yielded significant results for one of the three subsamples, with another being significant only at the 10% level. However, in both cases, the results indicated that contracts involved in cartel cases had a higher likelihood of having rounded winning prices than contracts not associated with cartels. These results highlight that cartel firms had already exposed themselves through their pricing decisions, indicating a higher confidence level in the absence of competition in the tendering process.

Overall, our study affirms the value of conducting statistical analyses on contracts and thoroughly examining corruption indicators, including single bid, more than three bids, and rounded winner price, to effectively identify anomalies in public procurement.

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Annex

A1. The Public Procurement Data Used

The database was created by the CRCB by downloading the unstructured data (in html format) from the Public Procurement Authority website. The downloaded data were cleaned, consolidated, converted into numeric and alphabetic variables. CPMI==1 means that the contract is one of the contracts under the KEOP programme examined by the Hungarian Competition Authority, CPMI==0, other contract. In total, there were 214 contracts (contracts lots) in the cartel case investigated by the HCA.

Table A1.1: Number of contracts or contract lots per year in the cartel case under investigation

year	cpmi 0	1	Total
1998	1,315	0	1,315
1999	5,152	0	5,152
2000	5,906	0	5,906
2001	5,632	0	5,632
2002	6,920	0	6,920
2003	6,077	0	6,077
2004	4,520	0	4,520
2005	3,930	0	3,930
2006	6,084	0	6,084
2007	4,949	0	4,949
2008	10,996	0	10,996
2009	18,463	0	18,463
2010	22,556	0	22,556
2011	15,070	0	15,070
2012	15,149	0	15,149
2013	21,961	0	21,961
2014	23,129	0	23,129
2015	22,836	206	23,042
2016	17,054	8	17,062
2017	17,288	0	17,288
2018	22,807	0	22,807
2019	19,330	0	19,330
2020	16,591	0	16,591
2021	18,043	0	18,043
2022	17,655	0	17,655
2023	11,055	0	11,055
Total	340,468	214	340,682

Table A1.2: The list of url of contracts (contracts lots) in the investigated cartel case

	url
394788.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_124_2016/
394789.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_25542_2015/
394790.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_20535_2015/
394791.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15998_2015/
394792.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16146_2015/
394793.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_17869_2015/
394794.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_26244_2015/
394795.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15369_2015/
394796.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15302_2015/
394797.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16100_2015/

394798.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15201_2015/
394799.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_20106_2015/
394800.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16445_2015/
394801.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16782_2015/
394802.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15981_2015/
394803.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16070_2015/
394804.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15753_2015/
394805.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_17566_2015/
394806.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_2460_2016/
394807.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_27840_2015/
394808.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16237_2015/
394809.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16000_2015/
394810.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_14911_2015/
394811.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15359_2015/
394812.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15662_2015/
394813.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15369_2015/
394814.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15462_2015/
394815.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16146_2015/
394816.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16046_2015/
394817.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15250_2015/
394818.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16135_2015/
394819.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_19715_2015/
394820.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16840_2015/
394821.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_21071_2015/
394822.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_1548_2016/
394823.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_17566_2015/
394824.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16138_2015/
394825.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_14834_2015/
394826.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15909_2015/
394827.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16877_2015/
394828.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_20724_2015/
394829.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15248_2015/
394830.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_19698_2015/
394831.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15575_2015/
394832.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15241_2015/
394833.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_19706_2015/
394834.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_24731_2015/
394835.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_16782_2015/
394836.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15814_2015/
394837.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_14468_2015/
394838.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15357_2015/
394839.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15241_2015/
394840.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_19706_2015/
394841.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15248_2015/
394842.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_124_2016/
394843.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_14024_2015/
394844.	https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_21849_2015/
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395007. | https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_15518_2015/ |
395008. | https://www.kozbeszerzes.hu/adatbazis/megtekint/hirdetmeny/portal_18992_2015/ |
        +-------------------------------------------------------------------------------+
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Table A1.3: List of winning companies in cartel cases under investigation by the HCA

company_short_name	company_url	tax_no
A R T M E D kft.	http://www.artmed.hu	12223466241
Chemium Zrt. "f. a."	http://www.chemium.hu	25596913241
DR. SAS CLINIC Kft.	https://drsas.hu	12232684241
EUROMEDIC Technology Kft.	www.euromedic-hungary.com	23996599241
EUROMEDIC-PHARMA Zrt.	www.euromedic-hungary.com	11087388244
GE Hungary Kft.	www.ge.com/hu	13113267244
Getronics Magyarország Kft.	www.getronics.com	10532782241
HOGE Kft.	www.hoge.hu	10246887241
HOGE SYSTEMS Kft.	www.hogesystems.hu	10811502241
HUNG-RAD Kft.	no website found	25591925243
INNOMED MEDICAL Zrt.	www.innomed.hu	12221275242
MED & TRADE Co. Bt.	www.medandtrade.hu	21726785243
MEDI-CONT Kft.	www.medi-cont.hu	11462125208
MEDIMAT Kft.	www.medimat.hu	12367494243
MEDIREX Zrt.	www.medirex.hu	11909879242
MEDISZER Kórháztechnikai és Kereskedelmi Kft.	https://mediszer.hu	10321056241
NovelMedix Zrt	www.novelmedix.hu	25075081213
PASCAL TEAM Mérnöki Kft.	www.pascalteam.hu	10876013241
PHILIPS Magyarország Kft.	www.philips.hu	10272031244
PREMIER G. MED CARDIO Kft	https://www.premiergmed.hu	14772423241
Premier G. Med Egészségügyi Kft	https://www.premiergmed.hu	25365801241
PREMIER G. MED Kft.	https://www.premiergmed.hu	12179295241
PREMIER G. MED ONKO Kft	https://www.premiergmed.hu	14772416241
Premier G. Med Vagyonkezelő Kft	https://www.premiergmed.hu	25421396241
Siemens Healthcare Kft.	http://www.siemens-healthineers.com	25296826242
Siemens Zrt.	www.siemens.hu	10495892244
Silver Wood - IT Kft	http://www.sw-it.net	23293827242
VARIOTRADE Kereskedelmi és Szolgáltató Kft.	http://www.variotrade.hu	10529539243
VMD Zrt.	www.vmd.hu	13215613241

Table A1.4: List of contracting authorities (issuers) in the cartel case under investigation

1	albert schweitzer korhaz-rendelointezet
2	allami szivkorhaz
3	almasi balogh pal korhaz
4	b-a-z megyei korhaz es egyetemi oktato korhaz
5	bacs-kiskun megyei korhaz
6	bajcsy-zsilinszky korhaz es rendelointezet
7	bekes megyei pandy kalman korhaz
8	betegapolo irgalmas rend - budai irgalmasrendi korhaz
9	budapest fovaros iii. kerulet obuda-bekasmegyer onkormanyzat
10	budapesti szent ferenc korhaz
11	bugat pal korhaz
12	csolnoky ferenc korhaz
13	csongrad megyei dr. bugyi istvan korhaz
14	csongrad megyei egeszsegugyi ellato kozpont hodmezovasarhely-mako
15	csornai margit korhaz
16	deak jeno korhaz
17	dombovari szent lukacs korhaz
18	dr. rethy pal korhaz-rendelointezet
19	egyesitett szent istvan es szent laszlo korhaz- rendelointezet
20	fejer megyei szent gyorgy egyetemi oktato korhaz
21	felso-szabolcsi korhaz
22	gottsegen gyorgy orszagos kardiologiai intezet
23	grof esterhazy korhaz es rendelointezeti szakrendelo
24	grof tisza istvan korhaz
25	heim pal gyermekkorhaz
26	jahn ferenc del-pesti korhaz es rendelointezet
27	jasz-nagykun-szolnok megyei hetenyi geza korhaz-rendelointezet
28	javorszky odon korhaz
29	kanizsai dorottya korhaz
30	kaposvari egyetem
31	kemenesaljai egyesitett korhaz
32	kenezy gyula korhaz es rendelointezet
33	keszthelyi korhaz
34	kiskunhalasi semmelweis korhaz
35	koch robert korhaz es rendelointezet
36	lumniczer sandor korhaz-rendelointezet
37	magyar honvedseg egeszsegugyi kozpont
38	magyar imre korhaz
39	margit korhaz paszto
40	markhot ferenc oktatokorhaz es rendelointezet
41	markusovszky egyetemi oktatokorhaz
42	mazsihisz szeretetkorhaz

43	mohacsi korhaz
44	nagyatadi korhaz
45	nyiro gyula korhaz-orszagos pszichiatriai es addiktologiai intezet
46	oroshazi korhaz
47	orszagos klinikai idegtudomanyi intezet
48	orszagos koranyi tbc es pulmonologiai intezet
49	orszagos onkologiai intezet
50	orszagos sportegeszsegugyi intezet
51	paradfurdoi allami korhaz
52	pest megyei flor ferenc korhaz
53	peterfy sandor utcai korhaz-rendelointezet es baleseti kozpont
54	petz aladar megyei oktato korhaz
55	satoraljaujhelyi erzsebet korhaz
56	semmelweis egyetem
57	siofoki korhaz-rendelointezet
58	somogy megyei kaposi mor oktato korhaz
59	soproni erzsebet oktato korhaz es rehabilitacios intezet
60	szabolcs-szatmar-bereg megyei korhazak es egyetemi oktatokorhaz
61	szegedi tudomanyegyetem
62	szent borbala korhaz
63	szent janos korhaz es eszak-budai egyesitett korhazak
64	szent lazar megyei korhaz
65	szent margit korhaz
66	szent pantaleon korhaz - rendelointezet dunaujvaros
67	szent rokus korhaz es intezmenyei
68	szigetvari korhaz
69	toldy ferenc korhaz es rendelointezet
70	tolna megyei balassa janos korhaz
71	tudogyogyintezet torokbalint
72	uzsoki utcai korhaz
73	vaszary kolos korhaz, esztergom
74	veszprem megyei tudogyogyintezet
75	zala megyei korhaz

A2. Logit Estimations Results

A2.1. Corruption Risk (SB)

	Samples		
	SAMPLE_CPMI	SAMPLE_ISSUER_CPMI	SAMPLE_WINNER_CPMI
CPMI	4.55***	3.337***	2.108***
	(0.792)	(0.756)	(0.510)
LTI	1.324***	1.354*	1.391
	(0.117)	(0.240)	(0.334)
LNNCV	0.971	1.047	1.127*
	(0.023)	(0.052)	(0.072)
YEAR (2016)	0.824	0.255***	0.282***
	(0.102)	(0.085)	(0.114)
constant	1.053	0.353	0.139
	(0.440)	(0.300)	(0.156)
Pseudo R^2	0.0314	0.0990	0.0767
Number of observations	2,728	687	449

Notes: odds ratios are in the cells and standard errors are into brackets. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: Rounded Winner Price by 10^5. The type of procedure (LTI) [0,1]: if 1, the procedure was not open, 0 otherwise; ln net contract value (LNNCV); the year of contract (YEAR).
****: p < 0.01 **: p < 0.05 *: p < 0.1*

A2.2. Control of Corruption Risk (MTTB)

	Samples		
	SAMPLE_CPMI	SAMPLE_ISSUER_CPMI	SAMPLE_WINNER_CPMI
CPMI	0.061***	0.114***	0.259*
	(0.044)	(0.085)	(0.206)
LTI	0.068***	0.189***	0.167*
	(0.014)	(0.081)	(0.180)
LNNCV	1.099***	0.947	1.079
	(0.034)	(0.075)	(0.146)
YEAR (2016)	0.765	0.729	1.689
	(0.126)	(0.317)	(1.137)
constant	0.065***	0.509	0.019
	(0.036)	(0.676)	(0.046)
Pseudo R^2	0.1967	0.1254	0.1049
Number of observations	2,728	687	449

Notes: odds ratios are in the cells and standard errors are into brackets. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: rounded winner price by 10^5. The type of procedure (LTI) [0,1]: if 1, the procedure was not open, 0 otherwise; ln net contract value (LNNCV); the year of contract (YEAR).
****: p < 0.01 **: p < 0.05 *: p < 0.1*

A2.3. Rounded Winner Price by 10^5 (ROUND5)

	Samples		
	SAMPLE_CPMI	SAMPLE_ISSUER_CPMI	SAMPLE_WINNER_CPMI
CPMI	1.241	2.421***	1.610*
	(0.204)	(0.596)	(0.395)
LTI	1.218*	0.600**	0.806
	(0.143)	(0.130)	(0.197)
LNNCV	1.452***	1.165**	1.105
	(0.047)	(0.078)	(0.077)
YEAR (2016)	0.982	1.332	1.086
	(0.157)	(0.427)	(0.438)
constant	0.000***	0.017***	0.058
	(0.000)	(0.020)	(0.073)
Pseudo R^2	0.0705	0.0572	0.1049
Number of observations	2,721	684	449

Notes: odds ratios are in the cells and standard errors are into brackets. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: rounded winner price by 10^5. The type of procedure (LTI) [0,1]: if 1, the procedure was not open, 0 otherwise; ln net contract value (LNNCV); the year of contract (YEAR).
****: p < 0.01 **: p < 0.05 *: p < 0.1*

A3. Robustness Tests

To test the robustness of our results, we initially ran probit estimates instead of logit estimates. Subsequently, we employed the methodology recommended by Young and Holsteen (2017) using the Stata 'mrobust' command across all samples, and then omitting 20 percent of cases. The results are presented in A3.1. and A3.2.

A3.1. Probit Estimation Results

		Sampes		
Indicators	Coefficients Standard Error Case Number	sample_cpmi	sample_issuer_cpmi	sample_winner_cpmi
SB	Coeff.	0.9339***	0.7351***	0.4531***
	Se	(0.1021)	(0.1375)	(0.1483)
	N	2,728	687	449
MTTB	Coeff.	-1.2776***	-0.9522***	0.5457*
	Se	(0.3165)	(0.3005)	(0.2862)
	N	2,728	687	449
ROUND5	Coeff.	1.311	0.5269***	0.2898*
	se	(0.1017)	(0.1455)	(0.1477)
	N	2,721	684	449

*Notes: coefficients are in the cells and robust standard errors are into brackets. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: rounded winner price by 10^5. ***: p < 0.01 **: p < 0.05 *: p < 0.1*

A3.2. Young and Holsteen's Model Uncertainty Robustness Test

A3.2a. Entire Samples

		Sampes		
Indicators	Mean Coefficients Robustness Ratio Case Number	sample_cpmi	sample_issuer_cpmi	sample_winner_cpmi
SB	Mean Coeff.	1.5068	1.3295	0.8980
	RR	*8.5398*	*5.9515*	*3.5417*
	N	2,728	687	449
MTTB	Mean Coeff.	-2.7633	-2.4485	-1.6132
	RR	*-3.7047*	*-3.1704*	*-2.0068*
	N	2,728	687	449
ROUND5	Mean Coeff.	0.5538	0.9302	0.4735
	RR	1.4859	*3.0428*	*1.9630*
	N	2,721	684	449

Notes: The robustness ratio is the mean estimate divided by the total standard error. The mean coefficients, the robustness ratios, and the case numbers are in the cells. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: rounded winner price by 10^5. The higher values of RR than critical t values are in italics.

A3.2b. With Samples Omitting 20 Percent of Cases

		Sampes		
Indicators	Mean Coefficients Robustness Ratio Case Number	sample_cpmi	sample_issuer_cpmi	sample_winner_cpmi
SB	Mean Coeff.	1.4999	1.3172	0.9177
	RR	*8.5269*	*5.5418*	*3.7006*
	N	2,728	687	449
MTTB	Mean Coeff.	-2.7966	-2.4224	-1.6219
	RR	*-3.7843*	*-3.1229*	*-2.0062*
	N	2,728	687	449
ROUND5	Mean Coeff.	0.5538	0.9677	0.4958
	RR	1.4859	*3.2898*	*2.0248*
	N	2,721	684	449

Notes: The robustness ratio is the mean estimate divided by the total standard error. The mean coefficients, the robustness ratios, and the original case numbers are in the cells. SB [0,1]: single bid; MTTB [0,1]: more than three bids; ROUND5 [0,1]: rounded winner price by 10^5. The higher values of RR than critical t values are in italics.