

Analysing Corruption as Black Holes – Intensity of Competition, Corruption Risks & Price Distortion

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CRCB

- Non-profit, non-partisan organisation
- From 2013
- recent topics:
 - Measuring corruption risks
 - Analysing corrupt system and kleptocratic state in Hungary with hard data
 - Measuring the quality of legislation with hard data
 - Corruption risks, price distortion & competition at EU level

MAIN MESSAGES

Intensity of Competition, Corruption Risks & Price Distortion

| | intensity of competition | corruption risks | price distortion |
|--------------------------|--------------------------|------------------|------------------|
| intensity of competition | - | Negative *** | Negative ** |
| corruption risks | | - | Positive *** |
| price distortion | | | - |

- An important approach to deal with the contract prices (& price distortion) to detect corrupt transactions / institutions / systems

- In the period of 2006-2015 the Italian public tenders are characterised by
 - High corruption risks
 - Low intensity of competition
 - The high level of price distortion (overpricing) can also be detectable

- Rome lies in the middle amongst the European capitals
- Huge diversity amongst the largest Italian cities

MOTIVATIONS

Public Procurement & Corruption

- Public procurement is one of the most important field of *grand corruption*
- 10-25% of GDP in EU countries [OECD]
- A tool to detect corrupt activities / systems: saving taxpayers' money
- Analysis government policies concerning PP

Corruption & Public Procurement

- Anecdotic evidences / lack of hard data
- A lot of suspicious (corrupt?) cases
- The amount of direct social loss is very high

Loosing taxpayers' money: Three Nice Hungarian Cases

Viewpont

Disabled Access Lift



Empty database (Employee Tracking Survey)



2017.09.19.

Viewpont: cca. 130,000 euros



Disabled Acces Lift for only one step: 5,200 euros



Empty Database: (Employee Tracking Survey): cca. 775,000 euros



CONCEPTS & INDICATORS

Corruption... as... a black hole

Without measurement, it is not worth talking about

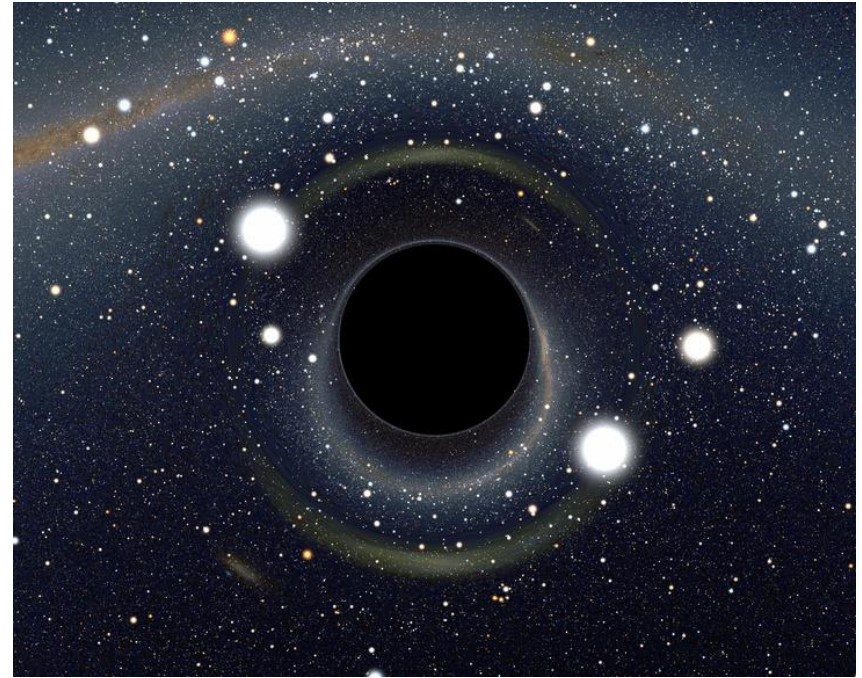
Black hole: not visible but measurable

- weight
- radius
- temperature
- distance

We are in the same way with corruption

Corruption could be analogous to the black hole

- Not observable, but
- We can estimate its prevalence
- Where does it happen?
- How much social loss does corruption generate?



Corruption & Competition

Corruption & Competition

condition of corruption (=> corruption risk)

=> corrupt transaction

=> outcomes of the corrupt acts
(=> price distortion / overpricing)

Two operationalized concepts:

corruption risk

contract price distortion

irregularities in winning odds (i.e. cartel, collusion & bid rigging)

Corruption & Competition

Operationalized concepts:

intensity of competition

competitive pressure (markups)

Three operationalized concepts

corruption

corruption risk

price distortion

competition

intensity of competition

Analysed information / variables

1. Date of publication of contract award
2. Type of procedure
3. Net contract value
4. Common procurement vocabulary (cpv) code
5. Number of bids
6. Address of issuer

Indicators: Corruption Risk

1. Transparency Index (TI) [0,1];
 - 0: the tender was issued without announcement;
 - 1: the tender was issued with announcement.

Indicators: Corruption Risk

2. Single bid (SB) [0,1];

0: tender with competition

1: tender without competition,
with single bid

Indicators: Corruption Risk

3. Indicator of corruption risk (CR2) with two components (TI and SB) [0, 0.5, 1];

$$CR2 = \frac{(1-TI)+SB}{2}$$

Price distortion: The Benford's Law

Price distortion / overpricing

fraud analytics, auditing, forensic accounting:

- First digit test (Benford's law)
- First two digit test (Benford's law)
- Last two digit test (rounding data test)
- Recurring data test
- Summation test

Benford's Law

A set of numbers is said to satisfy Benford's law if the leading digit d ($d \in \{1, \dots, 9\}$) occurs with probability:

$$P(d) = \log_{10}(d+1) - \log_{10}(d) = \log_{10} \left(\frac{d+1}{d} \right) = \log_{10} \left(1 + \frac{1}{d} \right).$$

Benford's Law

| digits | $\log(d)$ | $\log(d+1)$ | $P(d) = \log(d+1) - \log(d)$ | cum $[P(d)]$ |
|--------|-----------|-------------|------------------------------|--------------|
| 1 | 0.000 | 0.301 | 0.301 | 0.301 |
| 2 | 0.301 | 0.477 | 0.176 | 0.477 |
| 3 | 0.477 | 0.602 | 0.125 | 0.602 |
| 4 | 0.602 | 0.699 | 0.097 | 0.699 |
| 5 | 0.699 | 0.778 | 0.079 | 0.778 |
| 6 | 0.778 | 0.845 | 0.067 | 0.845 |
| 7 | 0.845 | 0.903 | 0.058 | 0.903 |
| 8 | 0.903 | 0.954 | 0.051 | 0.954 |
| 9 | 0.954 | 1.000 | 0.046 | 1.000 |

Price distortion by First Digit Test (Benford's Law)

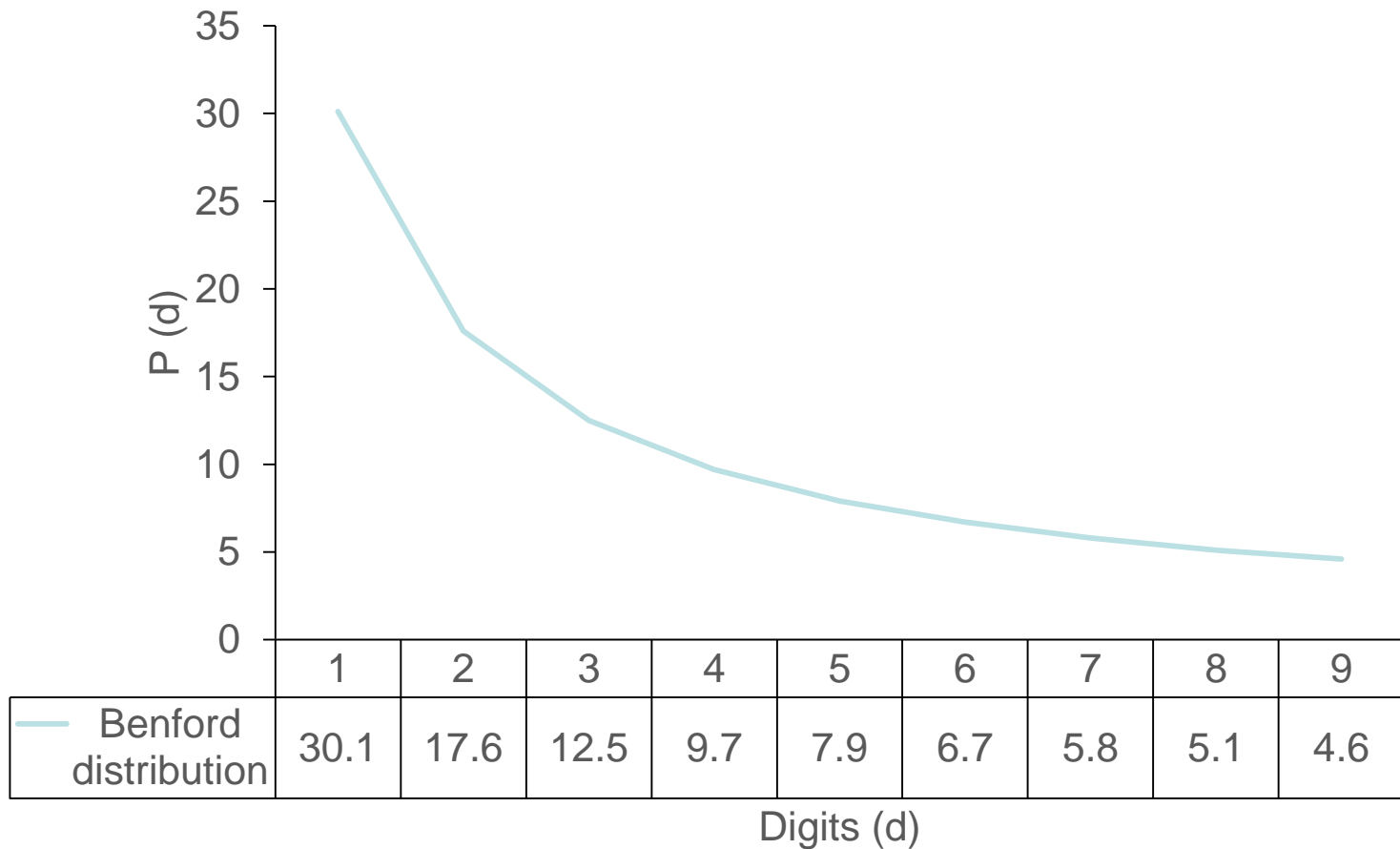
Measurement of the weight of price distortion by Mean Squared Error (MSE):

$$MSE = \frac{1}{n} \sum_{i=1}^n (\hat{Y}_i - Y)^2$$

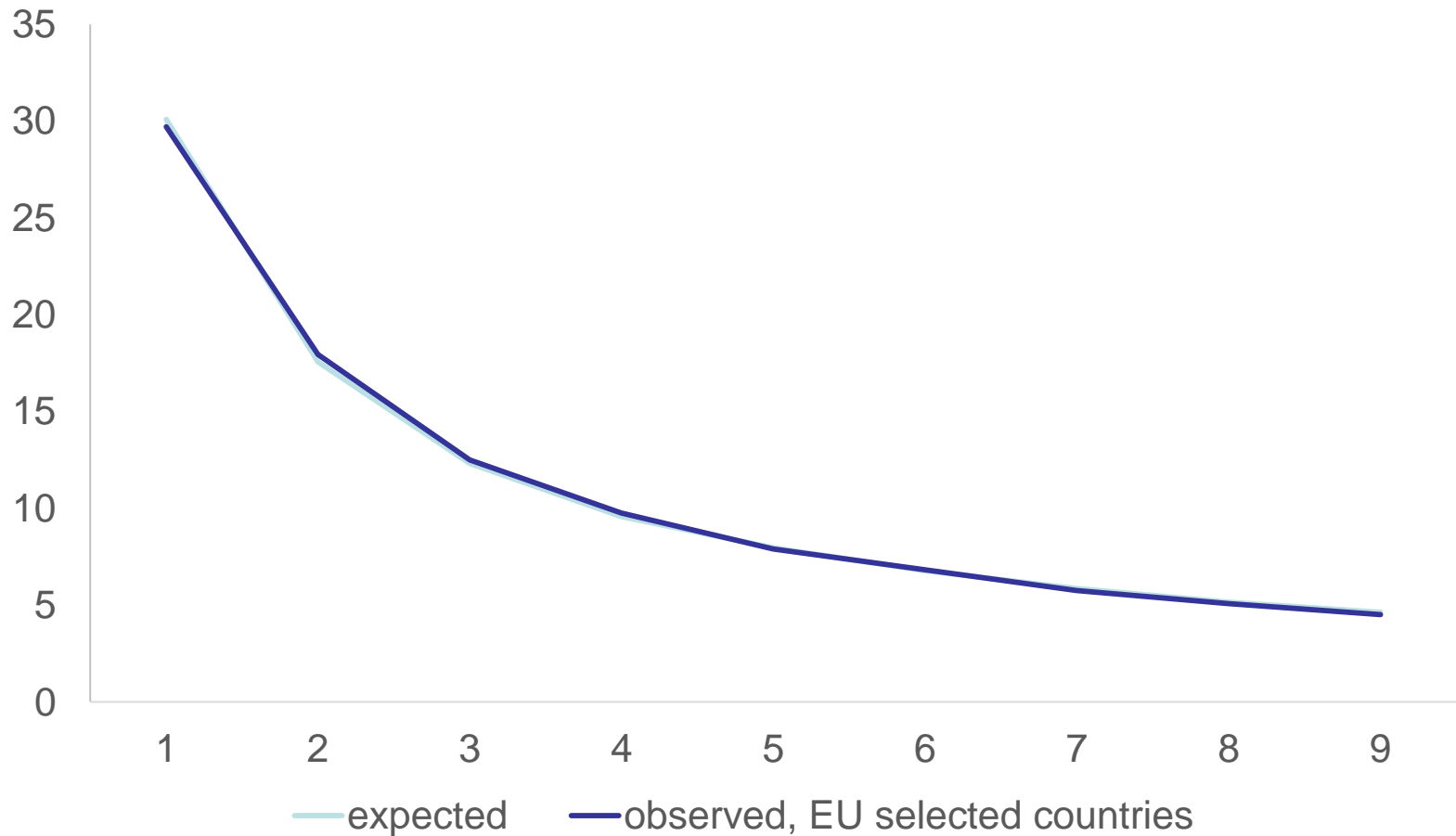
where \hat{Y} is the predicted value and Y is the observed value in percentages.

Benford's Law

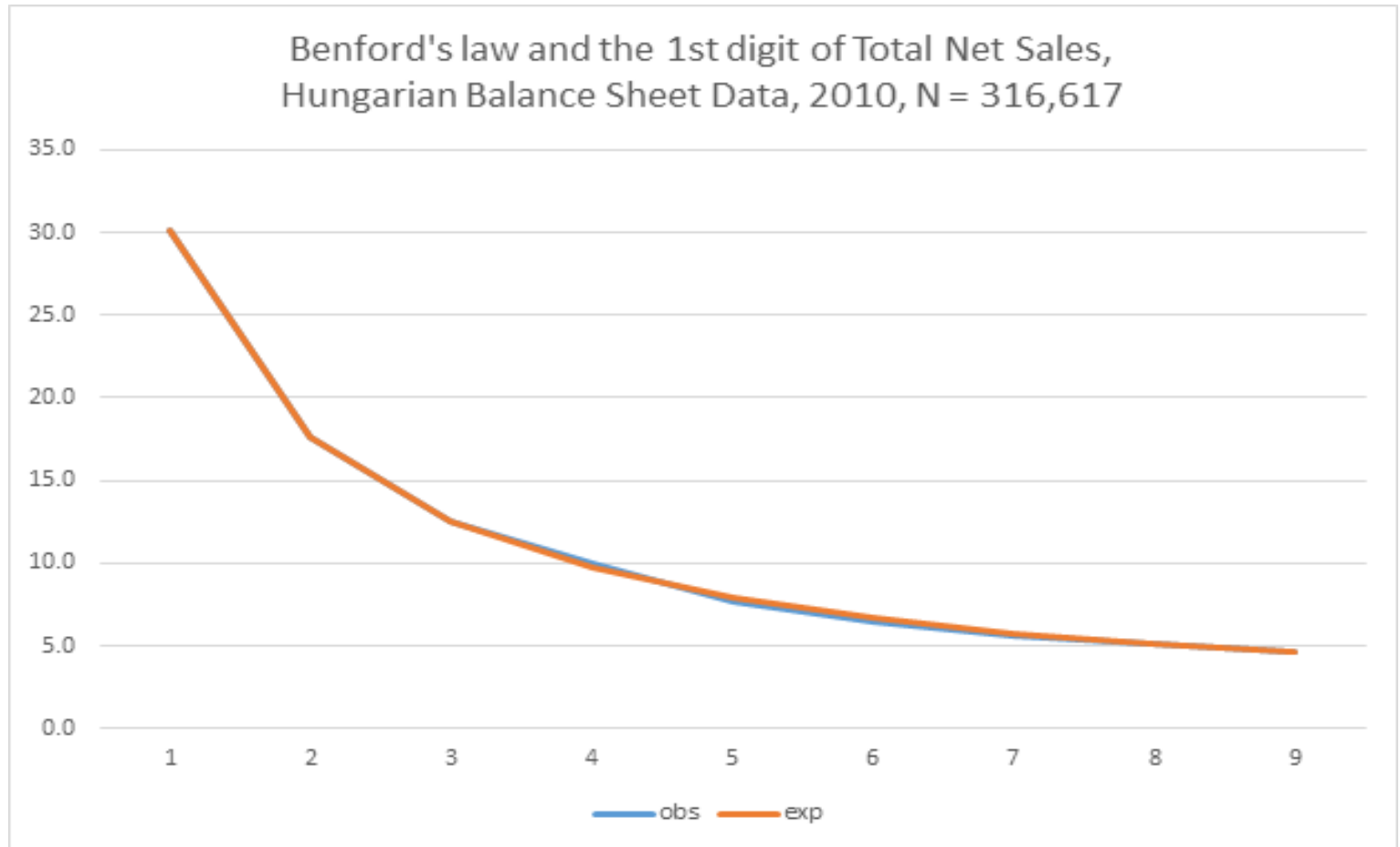
The distribution of first digits, according to Benford's law



Expected and observed distribution by 1st digits, %: Contract Price of Public Tenders in selected EU Countries, 2006-15, N = 2,164,493



Expected and observed distribution by 1st digits: Total Net Sales of the Hungarian companies, 2010, N = 316,617



Benford's law: applications

- Analysis of predictive models in economics [Hal Varian, 1972]
- Fraud detection in sociological research [Dieckman, 2007]
- Administrative surveys, census, USA [Nigrini, 2015]
- Fraud detection at clinical research, USA [Lee et al., 2015]
- Analysis of fraud at elections, Iran [Roukema, 2015]
- Detection of tax evasion, USA [Nigrini, 1992]
- Detection of fraud, embezzlement at company level, USA [Nigrini, 2012]
- Detection of price distortion and corruption at public tenders [CRCB, 2016]

Indicators: Price Distortion

1. First Digit Test (FDT)
2. Rounded data (by 1000 Euros) test

Indicators: Intensity of Competition

ICIO: Index of Competition Intensity

| Number of bids | ICIO |
|----------------|------|
| 2 | 0.0 |
| 3-5 | 0.5 |
| 6- | 1.0 |

Intensity of Competition, Corruption Risks & Price Distortion

| | intensity of competition | corruption risks | price distortion |
|--------------------------|--------------------------|------------------|------------------|
| intensity of competition | - | Negative | Negative |
| corruption risks | | - | Positive |
| price distortion | | | - |

ILLUSTRATIVE RESULTS:

Italy & Rome

Data

European data

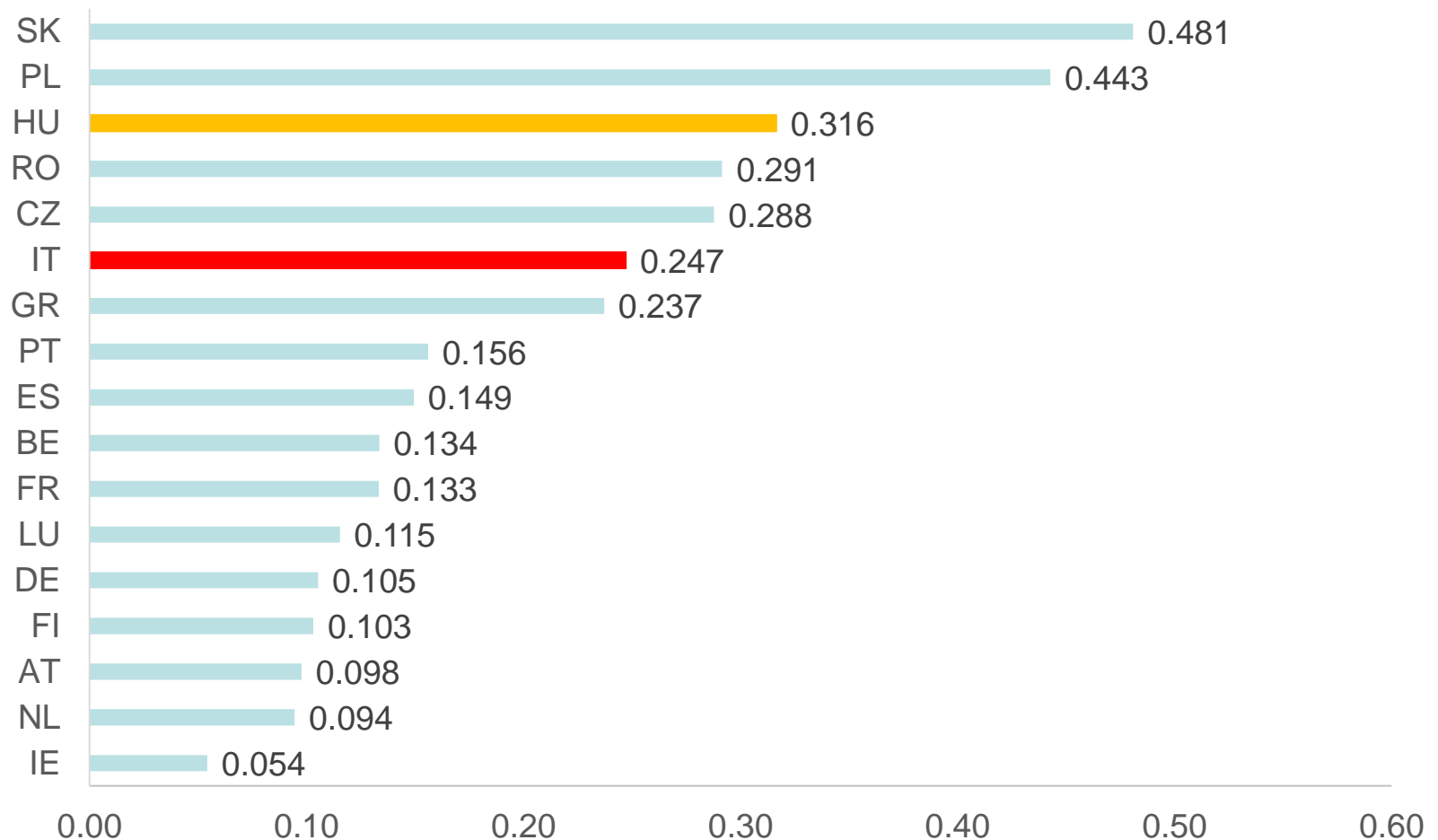
contract level data

period of time: 2006-15

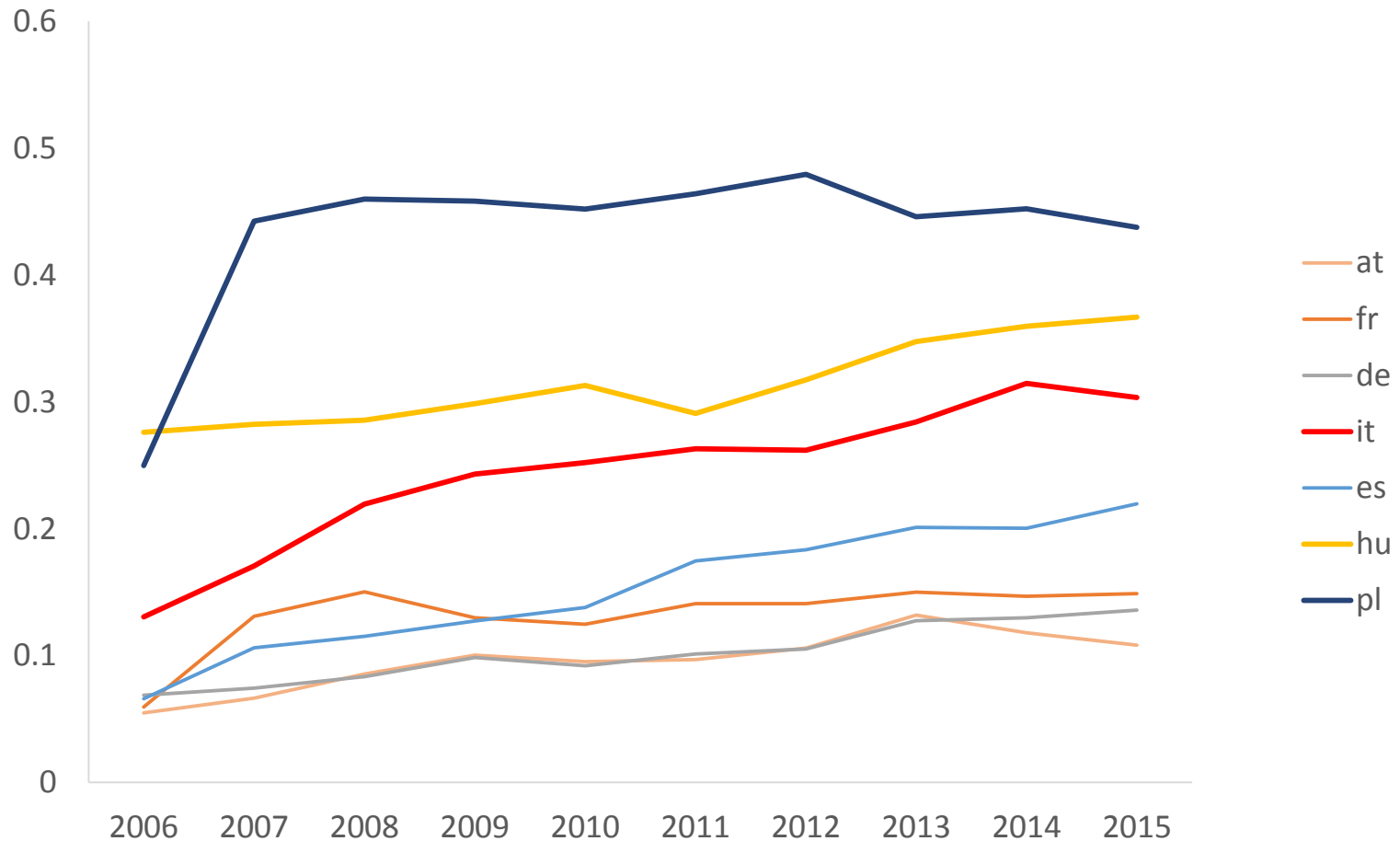
N = 3,407,938 (without framework aggr.)

TED

Corruption Risks (SB) in selected EU countries, 2006-15, N = 2,268,357



Corruption Risks (SB) in selected EU countries, 2006-15, N = 2,268,357



Corruption risks (SB) in selected EU countries, 2006-15, N = 1,627,669

Logistic regression

Number of obs = 1627669

LR chi2(32) = 203725.07

Prob > chi2 = 0.0000

Pseudo R2 = 0.0997

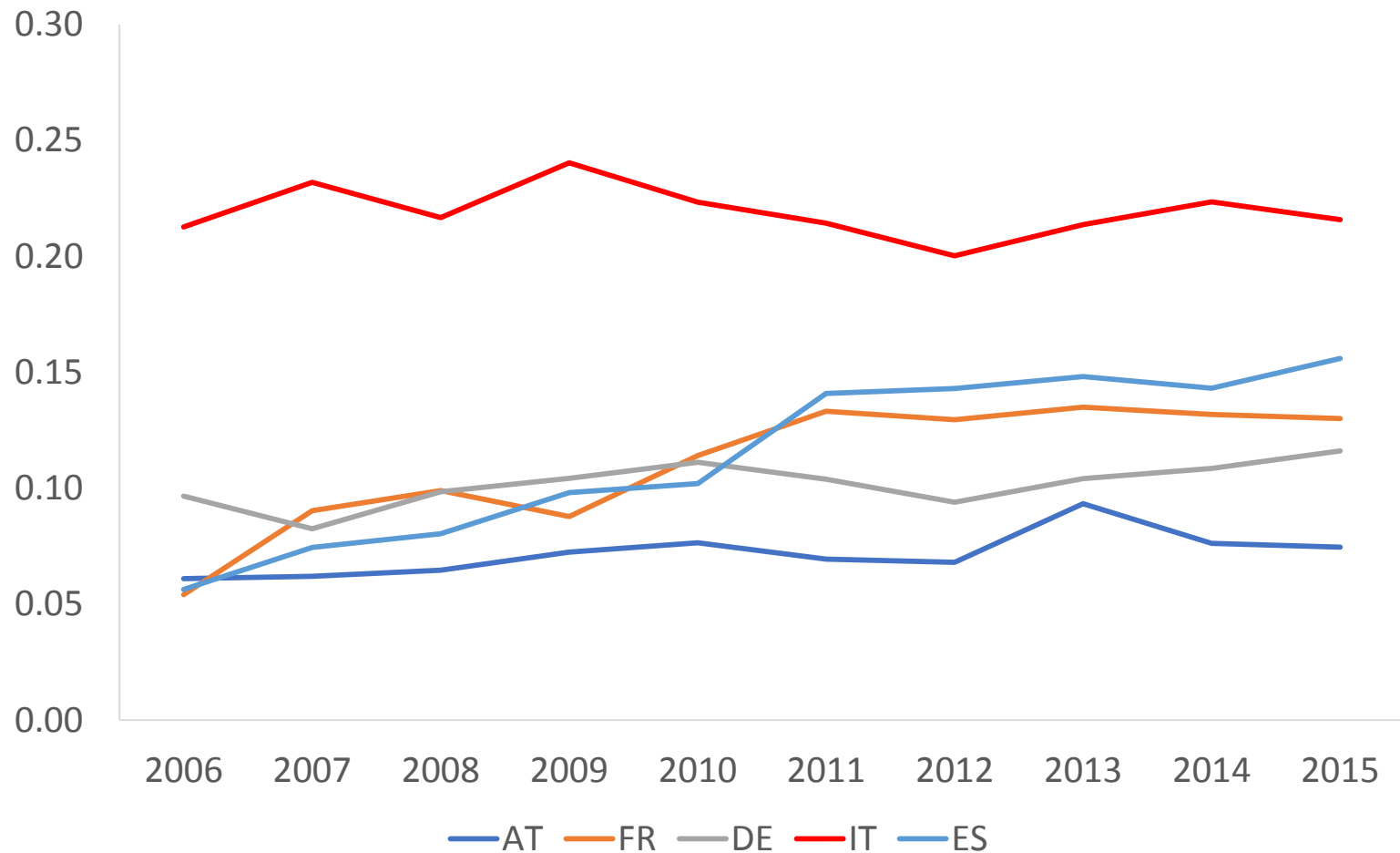
Log likelihood = -920257.13

| sb | Coef. | Std. Err. | z | P> z | [95% Conf. Interval] | |
|--------------|-----------------|-----------------|--------------|--------------|----------------------|-----------------|
| c1 | -.1573529 | .0535564 | -2.94 | 0.003 | -.2623216 | -.0523842 |
| c2 | .1410912 | .0469196 | 3.01 | 0.003 | .0491306 | .2330519 |
| c4 | .3117757 | .0433765 | 7.19 | 0.000 | .2267593 | .3967921 |
| c5 | -.0521325 | .0440967 | -1.18 | 0.237 | -.1385604 | .0342954 |
| c6 | .8216704 | .0459109 | 17.90 | 0.000 | .7316867 | .911654 |
| c7 | -.0326468 | .0884227 | -0.37 | 0.712 | -.2059522 | .1406586 |
| ITALY | .8668656 | .0435026 | 19.93 | 0.000 | .7816021 | .9521292 |
| c9 | .1910426 | .0691248 | 2.76 | 0.006 | .0555605 | .3265246 |
| c10 | -.226006 | .0543176 | -4.16 | 0.000 | -.3324664 | -.1195455 |
| c11 | .2066396 | .0544929 | 3.79 | 0.000 | .0998356 | .3134437 |
| c12 | .1359792 | .0440635 | 3.09 | 0.002 | .0496164 | .222342 |
| c13 | 1.259937 | .0440447 | 28.61 | 0.000 | 1.173611 | 1.346263 |
| c14 | 1.838455 | .0429929 | 42.76 | 0.000 | 1.75419 | 1.922719 |
| c15 | 1.781993 | .0462396 | 38.54 | 0.000 | 1.691365 | 1.872621 |
| c16 | 1.10447 | .0437681 | 25.23 | 0.000 | 1.018686 | 1.190254 |
| c17 | .9217513 | .0441043 | 20.90 | 0.000 | .8353085 | 1.008194 |

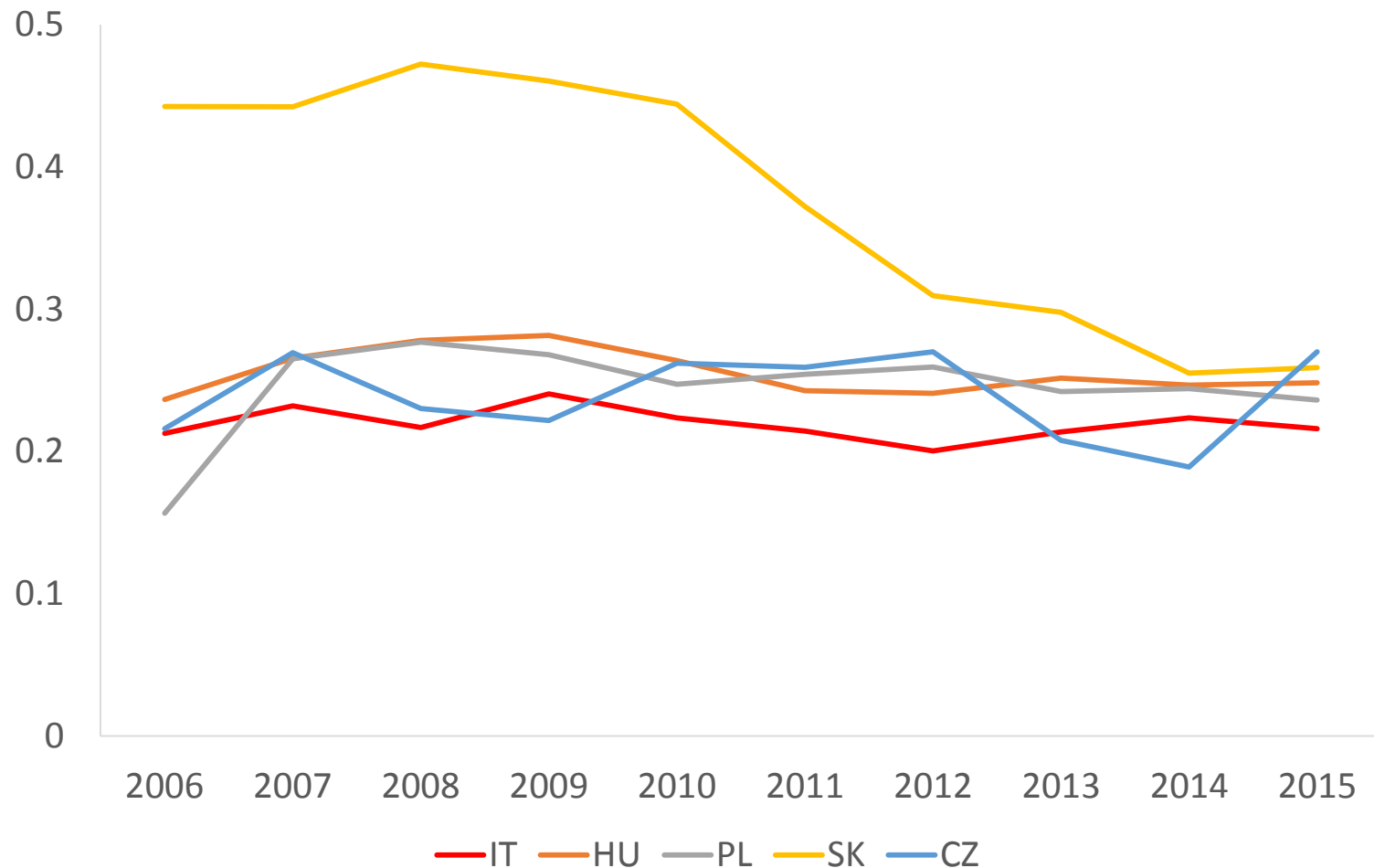
Source: CRCB;

Note: controlled by sector, year, eufund, lnncv, reference country is Finland

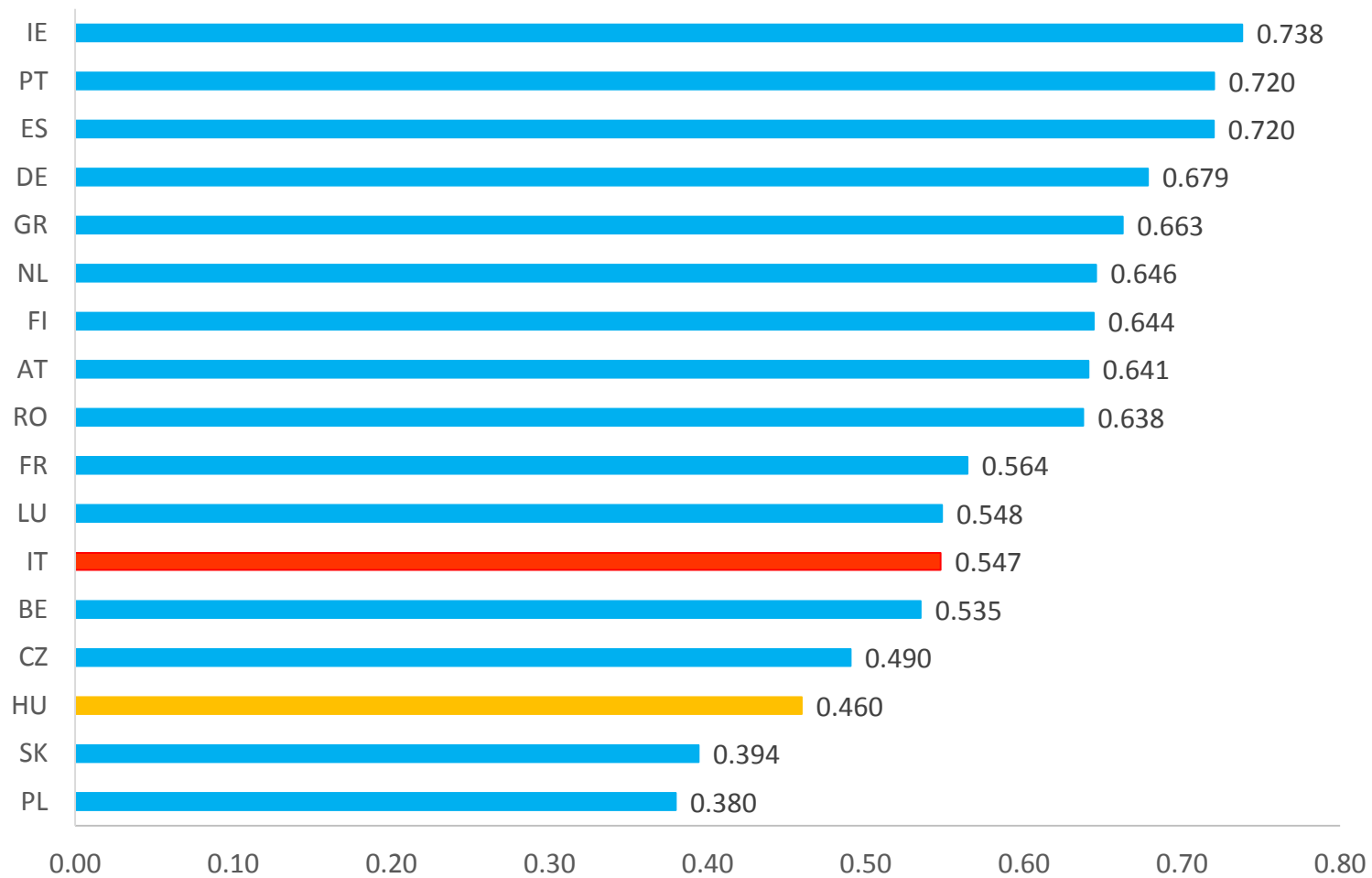
Corruption Risks (CR2) in Italy and other EU countries, 2006-15, N = 2,268,357



Corruption Risks (CR2) in Italy and other EU countries, 2006-15, N = 2,268,357



Intensity of Competition (ICIO) in selected EU Countries, 2006-15, N = 1,623,384



Intensity of Competition (ICIO) in selected EU countries, 2006-15, N = 1,096,968

Ordered logistic regression

Log likelihood = -1092892.9

Number of obs = 1096968
LR chi2(32) = 175228.85
Prob > chi2 = 0.0000
Pseudo R2 = 0.0742

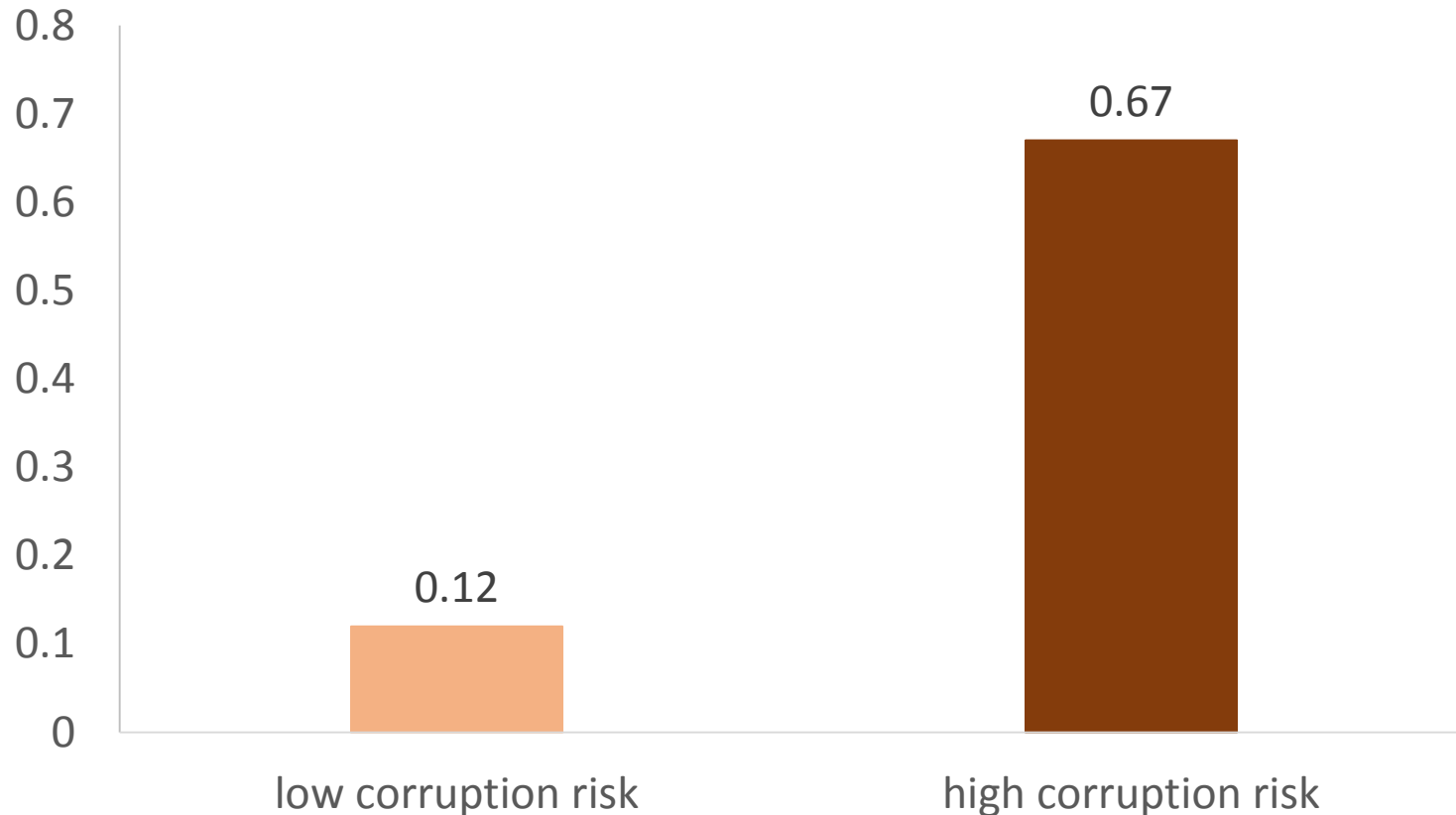
| icio | Coef. | Std. Err. | z | P> z | [95% Conf. Interval] | |
|--------------|------------------|----------------|--------------|--------------|----------------------|-----------------|
| c1 | .3504223 | .0330318 | 10.61 | 0.000 | .2856811 | .4151635 |
| c2 | -.0732828 | .030885 | -2.37 | 0.018 | -.1338162 | -.0127493 |
| c4 | -.155098 | .0283489 | -5.47 | 0.000 | -.2106609 | -.0995351 |
| c5 | .5704223 | .0286568 | 19.91 | 0.000 | .514256 | .6265885 |
| c6 | .6025827 | .0325634 | 18.50 | 0.000 | .5387597 | .6664057 |
| c7 | .3588001 | .0589561 | 6.09 | 0.000 | .2432483 | .4743519 |
| ITALY | -.0129874 | .028895 | -0.45 | 0.653 | -.0696205 | .0436457 |
| c9 | .2551698 | .04537 | 5.62 | 0.000 | .3440934 | .1662462 |
| c10 | .3740723 | .0340249 | 10.99 | 0.000 | .3073847 | .4407599 |
| c11 | .9149856 | .0380604 | 24.04 | 0.000 | .8403885 | .9895827 |
| c12 | .9991438 | .029092 | 34.34 | 0.000 | .9421246 | 1.056163 |
| c13 | -.5021186 | .0299267 | -16.78 | 0.000 | -.5607738 | -.4434633 |
| c14 | -.8091539 | .0282714 | -28.62 | 0.000 | -.8645648 | -.7537429 |
| c15 | -.6709219 | .035559 | -18.87 | 0.000 | -.7406164 | -.6012275 |
| c16 | .6520287 | .0295792 | 22.04 | 0.000 | .5940545 | .7100028 |
| c17 | -.2311968 | .0298096 | -7.76 | 0.000 | -.2896225 | -.1727711 |

Source: CRCB;

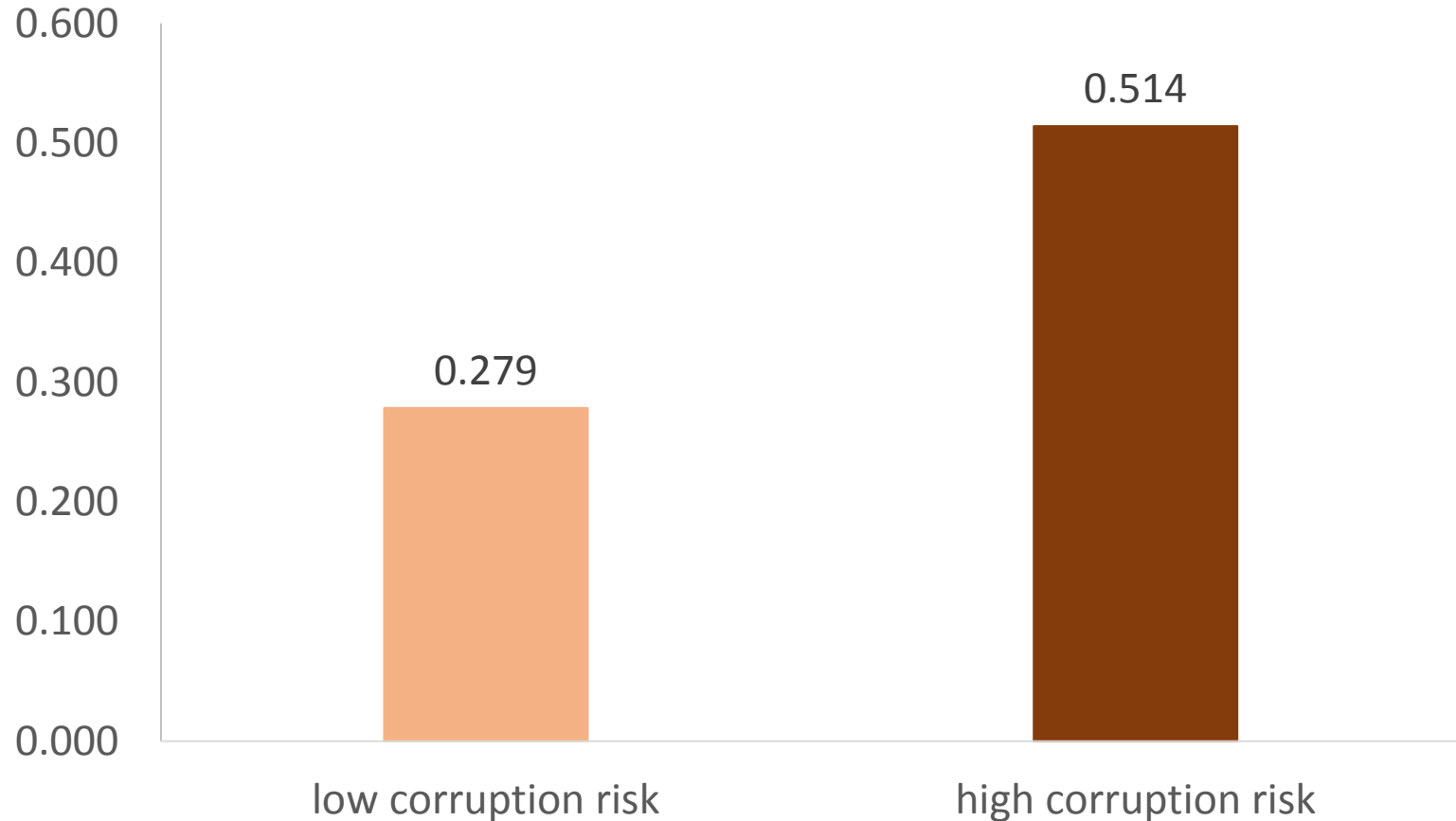
Note: controlled by sector, year, eufund, Inncv, reference country is Finland

Corruption Risks & Price Distortion

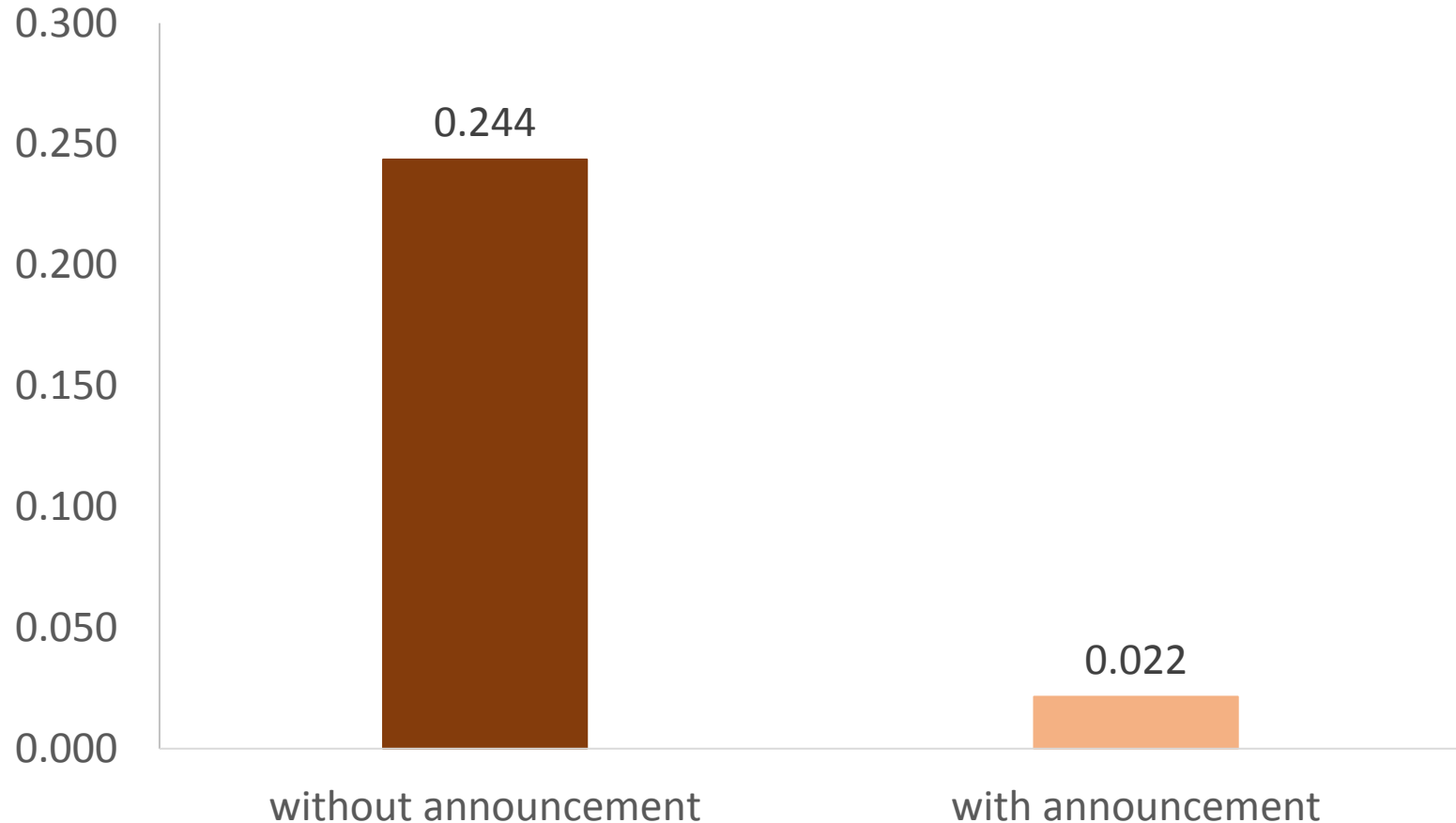
Corruption Risks (SB) & Price Distortion (FDT) in EURO area, 2006-15, MSE, N = 2,181,124



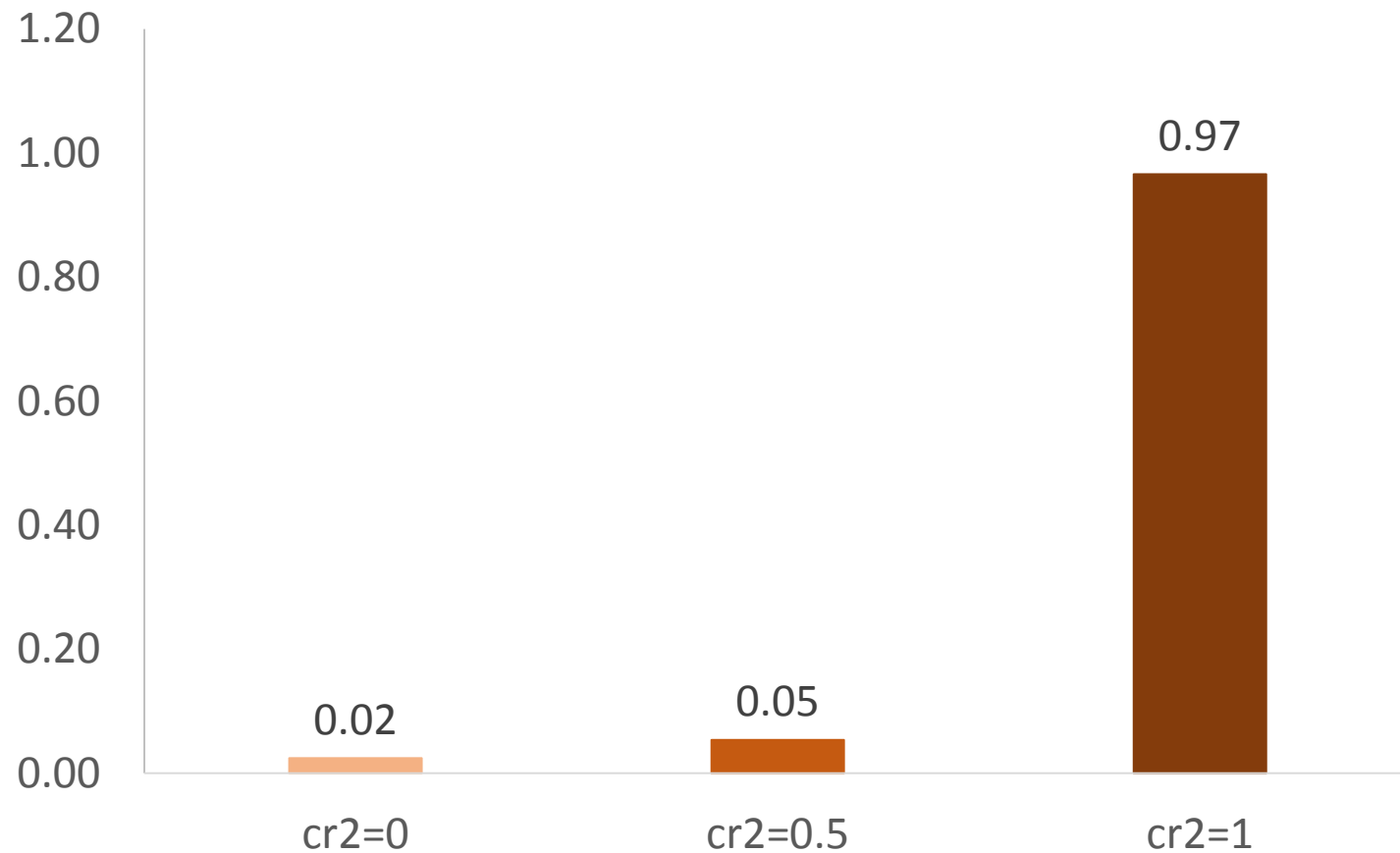
Corruption Risks (SB) & Price Distortion (FDT) in Italy, 2006-15, MSE, N = 121,028



Transparency Index (TI) & Price Distortion (FDT) in EU, 2006-15, MSE, N = 2,431,675

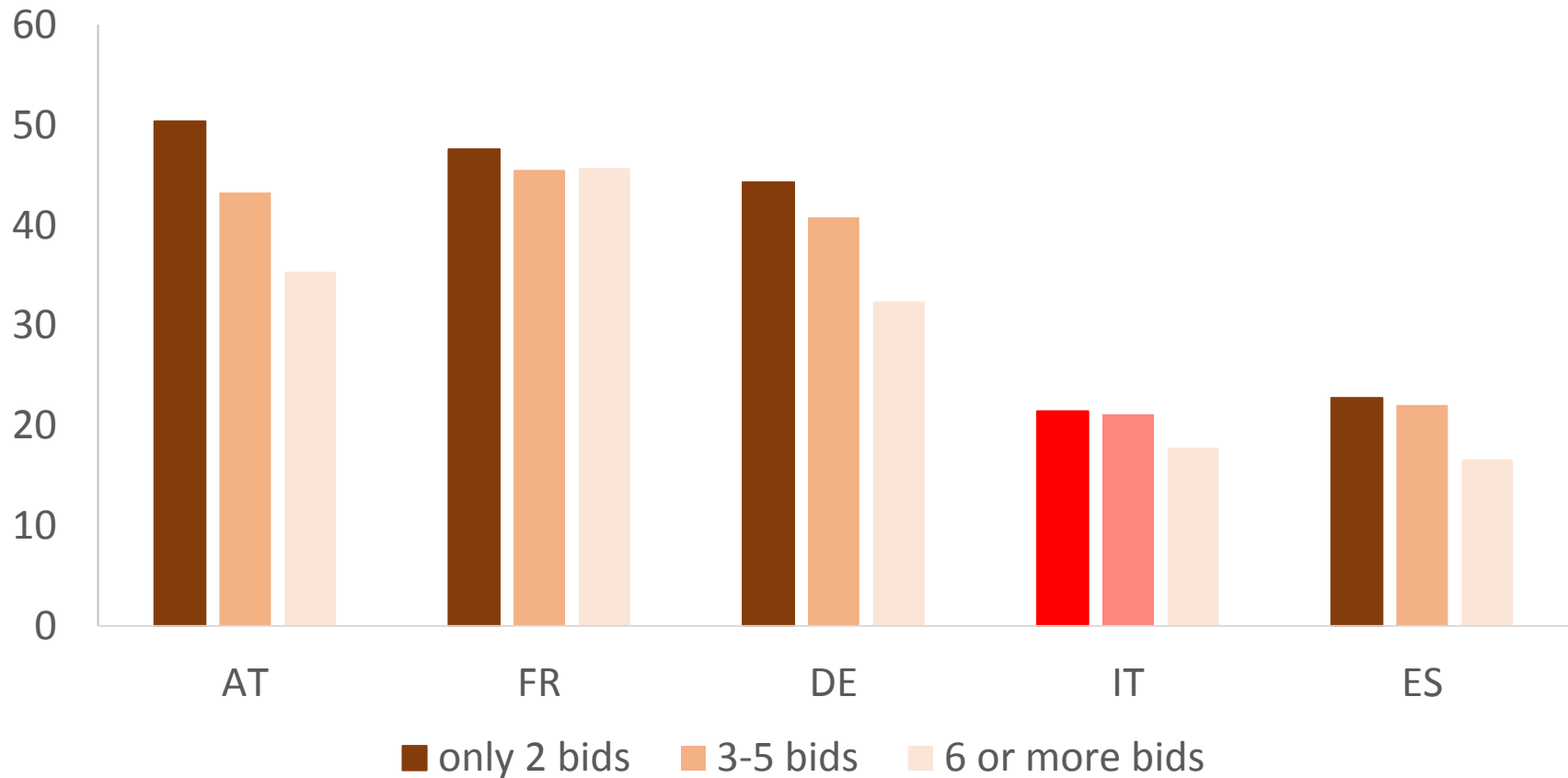


Corruption Risks (CR2) & Price Distortion (FDT) in EU, 2006-15, MSE, N = 2,181,124



Intensity of Competition & Price Distortion

Intensity of Competition (ICIO) & Price Distortion (ROUND3) in selected EU Countries, 2006-15, N = 850,047



Corruption Risk & Intensity of Competition

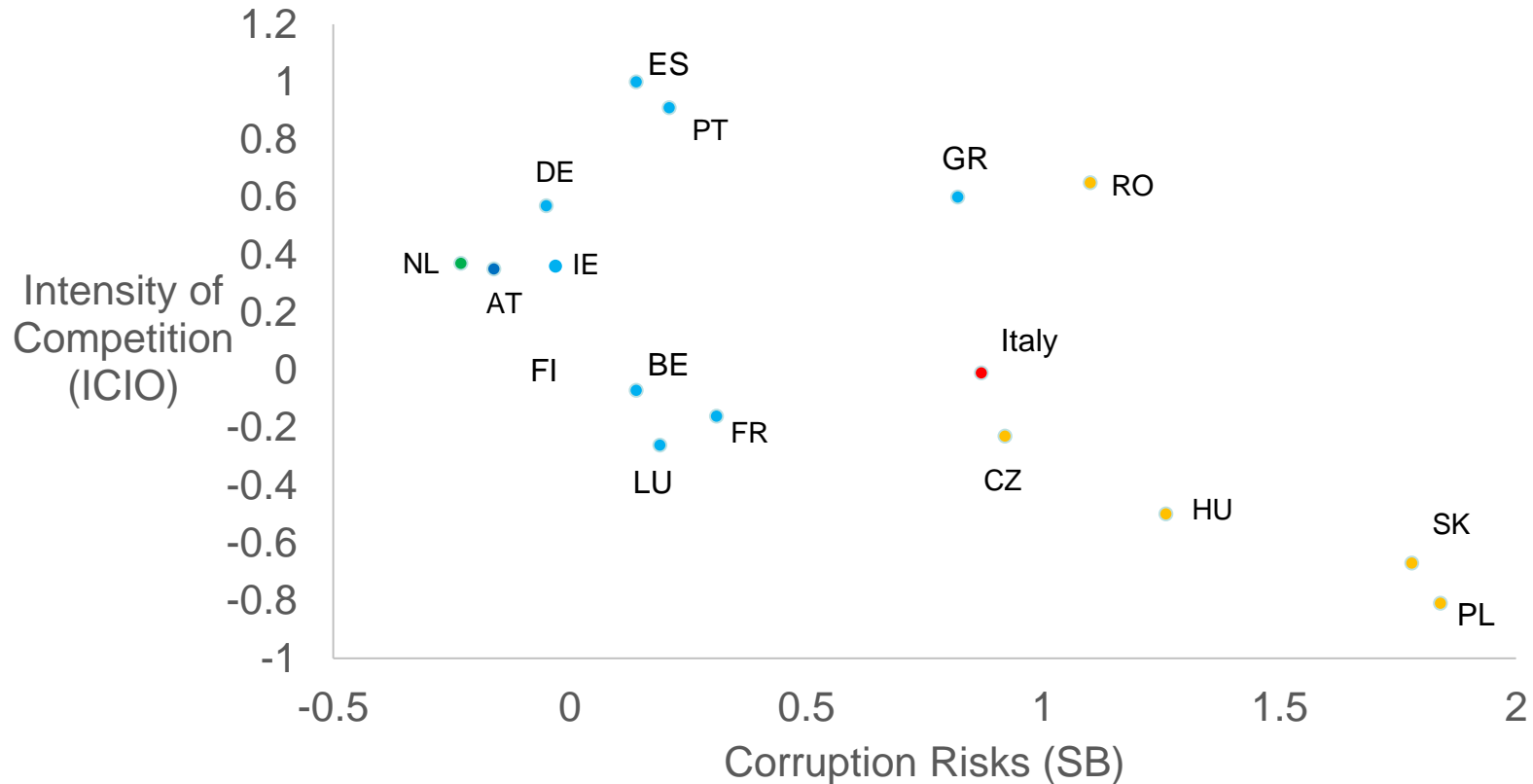
Corruption Risks & Intensity of Competition in selected EU Counties, 2006-15



Source: CRCB;

Note: controlled by sector, year, eufund, Inncv, reference country is Finland

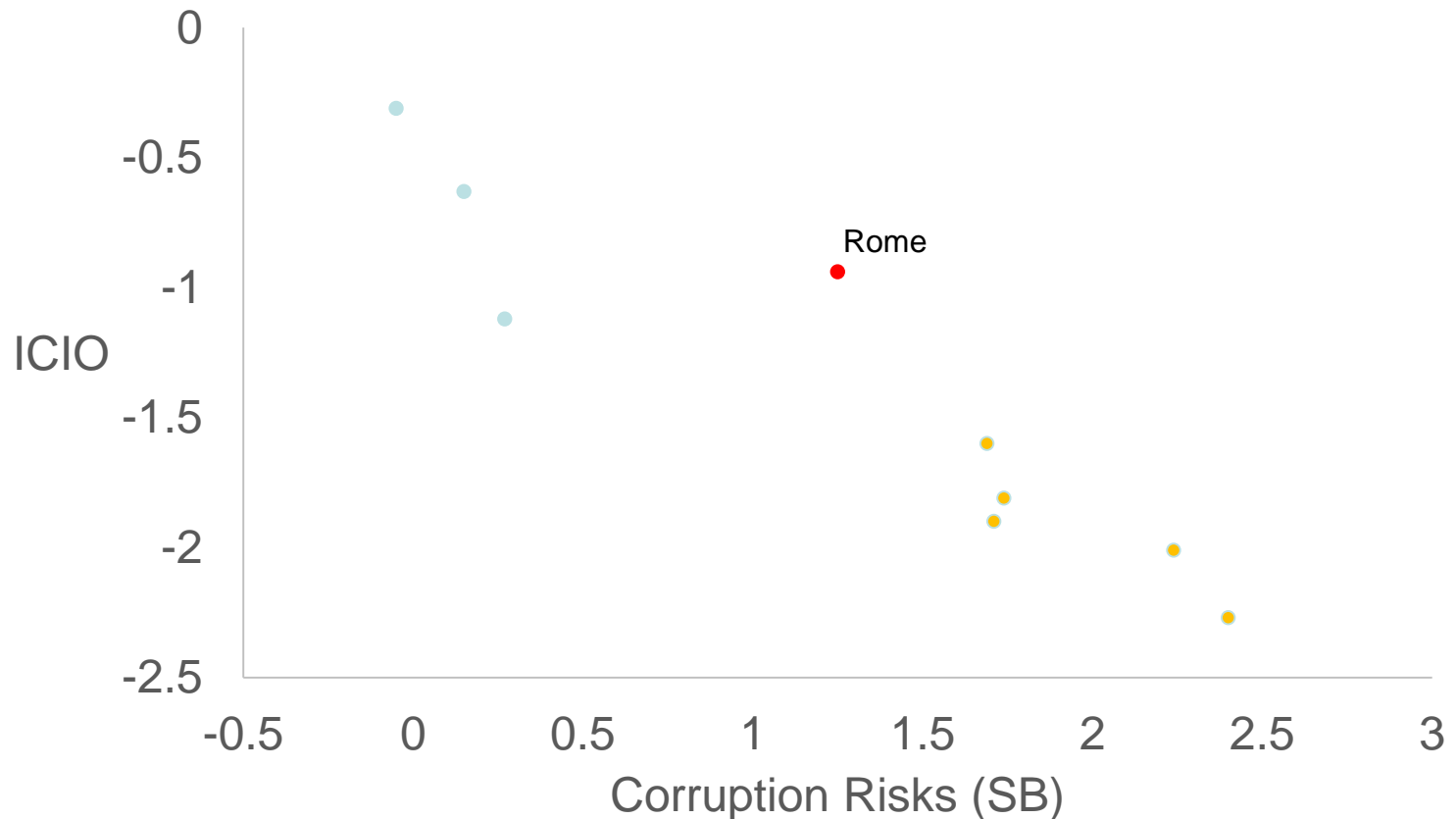
Corruption Risks & Intensity of Competition in selected EU Counties, 2006-15



Source: CRCB;

Note: controlled by sector, year, eufund, Inncv, reference country is Finland

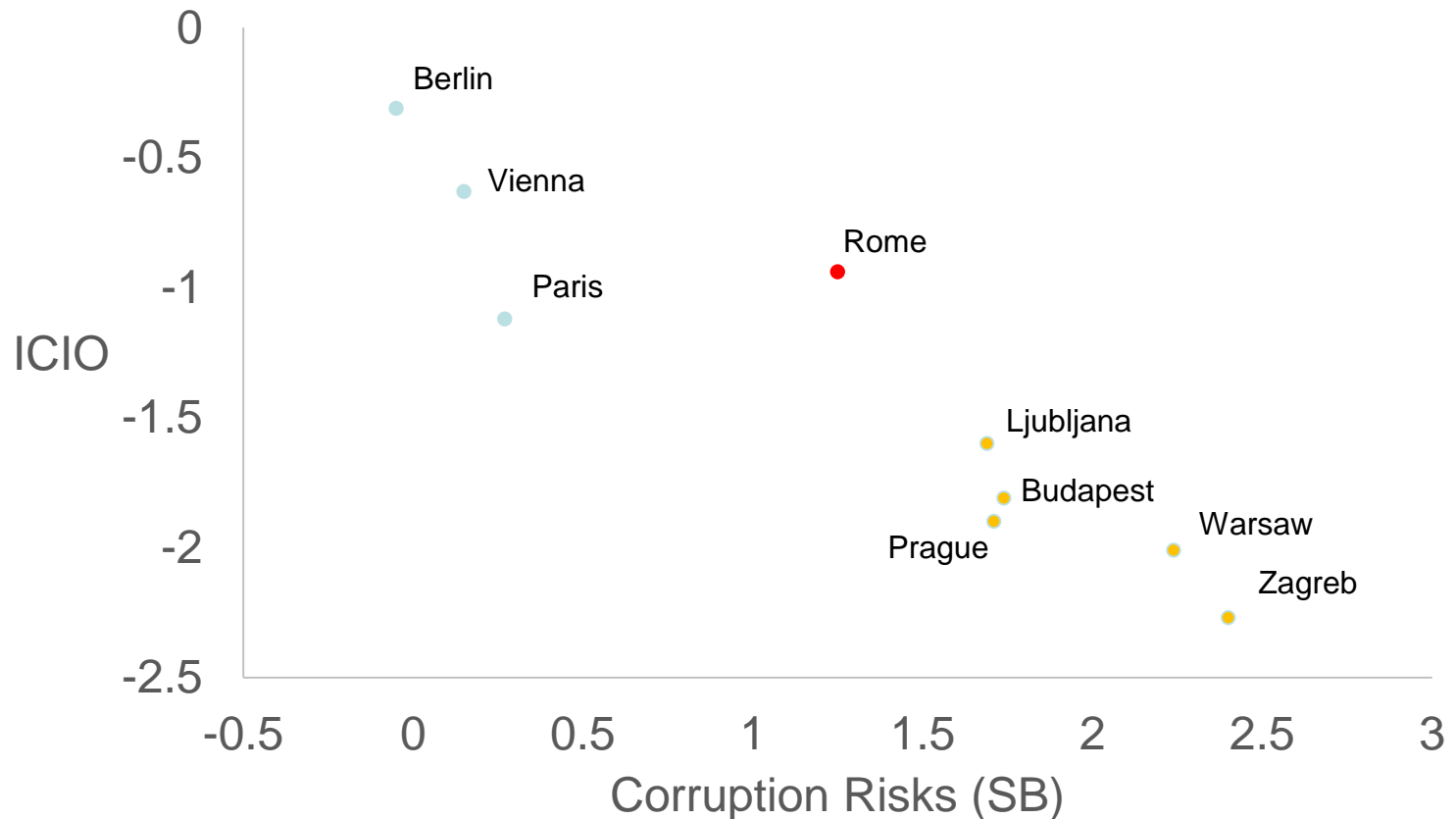
Corruption Risks & Intensity of Competition in selected EU Capitals, 2006-15



Source: CRCB;

Note: controlled by sector, year, eufund, Inncv, reference capital is Amsterdam

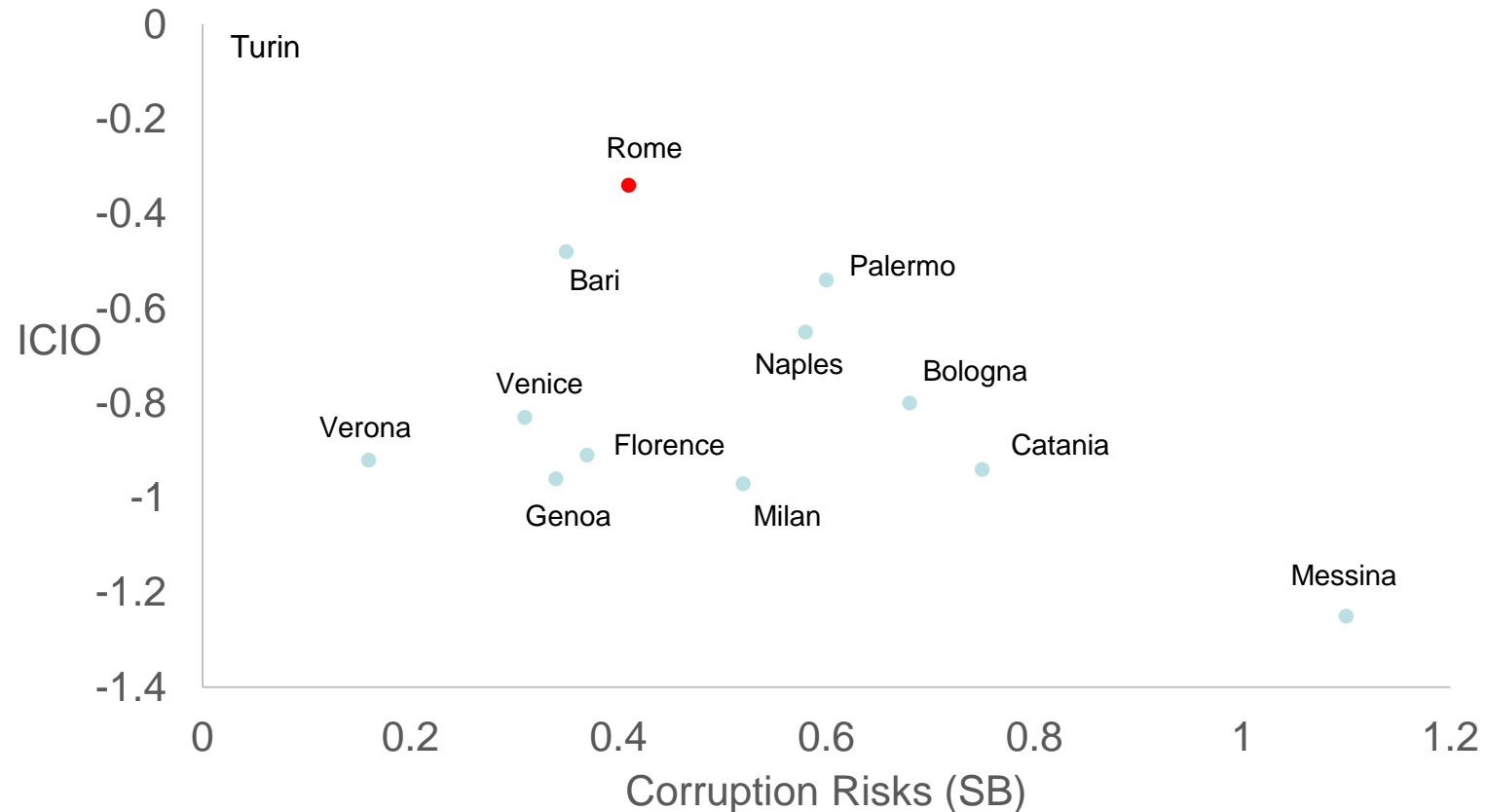
Corruption Risks & Intensity of Competition in selected EU Capitals, 2006-15



Source: CRCB;

Note: controlled by sector, year, eufund, Inncv, reference capital is Amsterdam

Corruption Risks & Intensity of Competition in the 13 largest Italian cities, 2006-15



Source: CRCB;

Note: controlled by sector, year, eufund, Inncv, reference city is Turin

SUMMARY

Intensity of Competition, Corruption Risks & Price Distortion

| | intensity of competition | corruption risks | price distortion |
|--------------------------|--------------------------|------------------|------------------|
| intensity of competition | - | Negative *** | Negative ** |
| corruption risks | | - | Positive *** |
| price distortion | | | - |

- An important approach to deal with the contract prices (& price distortion) to detect corrupt transactions / institutions / systems

- In the period of 2006-2015 the Italian public tenders are characterised by
 - High corruption risks
 - Low intensity of competition
 - The price distortion (overpricing) can also be detectable

- Rome lies in the middle amongst the European capitals
- Huge diversity amongst the largest Italian cities

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Thank you for your attention!

Corruption Research Center Budapest

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Limits of our approach

The "white elephant" projects [Rose-Ackerman, 2006]

without corruption, or with high
intensity of competition,

but

these projects are useless
where social utility tends to be zero

Limits of our approach

The "white elephant" projects

| | | Corruption | |
|------------------|-------------------------|------------|---------------|
| „white elephant” | $U \text{ (pt)} \sim 0$ | YES | NO |
| other projects | $U \text{ (pt)} > 0$ | YES | Social Loss=0 |

1st "white elephant" - losing EU taxpayer money (Bicycle Cross Track in Hatvan, closed):



2nd "white elephant" - losing EU taxpayer money (Adventure Park in Sáradsadány: closed)



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