Objective corruption risk indicators using donor project and contracts data

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1. Our approach to validating corruption risk indicators

To validate our red flags we use macro level perception-based indicators and test if these move together with the country-level averages of our red flags. We also try to find testable micro level relationships either on contract- or project-level data and check if different red flags are consistent with each other. The three donors largely differ in the range of available variables and red flags. World Bank data is the richest, while we have much more limited opportunities in case of IDB and EuropeAid.

As macro validation, we checked the correlations with some well-established perception-based corruption indicators on country-level (similarly to Fazekas and Kocsis (2015)): World Governance Indicators' Control of Corruption, Transparency International's Corruption Perception Index, and Global Competitiveness Index's Favoritism in decisions of government officials (indicator 1.07[1]). All three perception indices indicate lower corruption with higher values, so we expect to see negative correlations (Kaufmann, Kraay, & Mastruzzi, 2009; Transparency International, 2012; World Economic Forum, 2010). This strategy has been originally used for national procurement data and for procurement notices published on Tender Electronic Daily (TED), the procurement page of the European Union; however, the corruption risks of procurement from development aid sources might not go hand in hand with the corruption patterns of national procurement. Furthermore, following from the regulations of the donor institutions (Fazekas & Tóth, 2014) contracts below country-specific thresholds are not published on donor websites, thus we cannot even track the full amount of development aid

[1] In your country, to what extent do government officials show favoritism to well-connected firms and individuals when deciding upon policies and contracts? [1 = always show favoritism; 7 = never show favoritism]

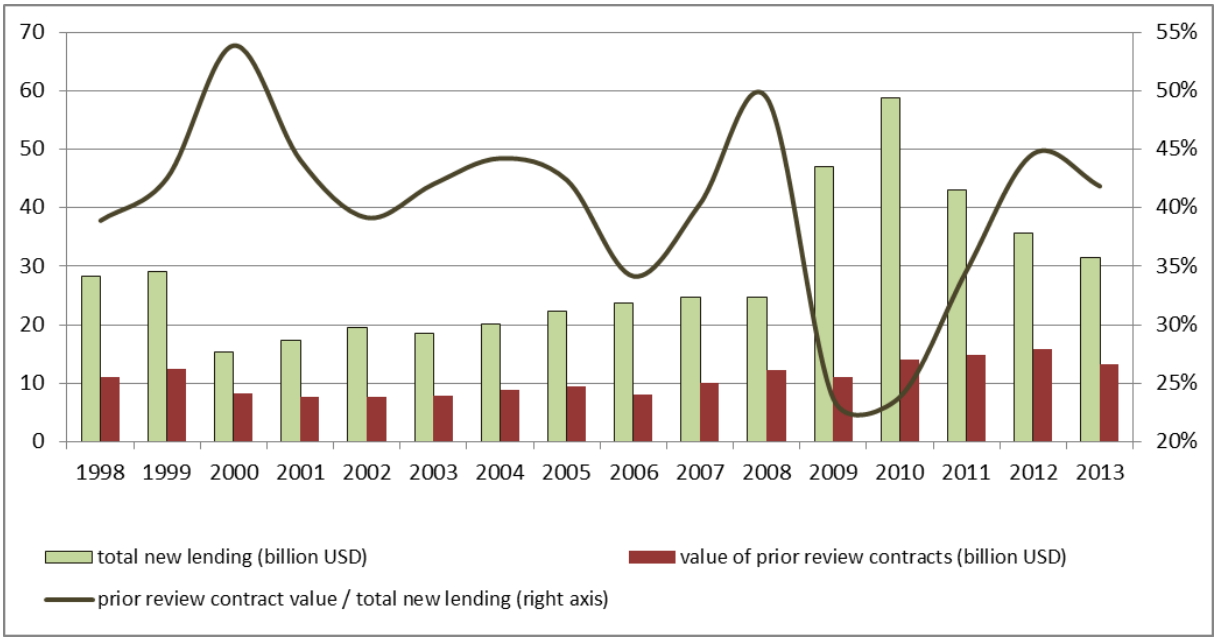
spent through corruption (see Figure 1-Figure 4 in the next chapter). It might be the case that suspicious transactions are managed below the threshold value and larger contracts are kept transparent. Consequently, we do not necessarily expect to see strong correlations with these indicators, but still, some level of correlation would strengthen the validity of our red flags.

As micro validation, we explore the relationship between the indicators of our own calculations on contract-level data to see if they show a coherent picture. For example, in order to use non-open procedures as a red flag we should see positive correlation with single bidding, showing that non-open or restricted procedures indeed go together with lower competition. We cannot necessarily test whether there is a causal effect, but we mostly check whether correlations point to the expected direction and are significant. Our primary approach is to estimate logit models that predict single bidding using different set of control variables, e.g. country, CPV codes, sector, contract value. We treat single bidding as a direct outcome of corrupt behaviour and we would like to see how much the red flags that capture suspicious aspects of the procurement process correlate with single bidding. However, this method works only if we have a large enough sample size including several observations in each country; otherwise we can find spurious relationships. When single bidding is not available we have limited possibilities for micro validation, but we can always check the raw correlations between separate indicators.

2. Share of aid spending captured by micro-level datasets

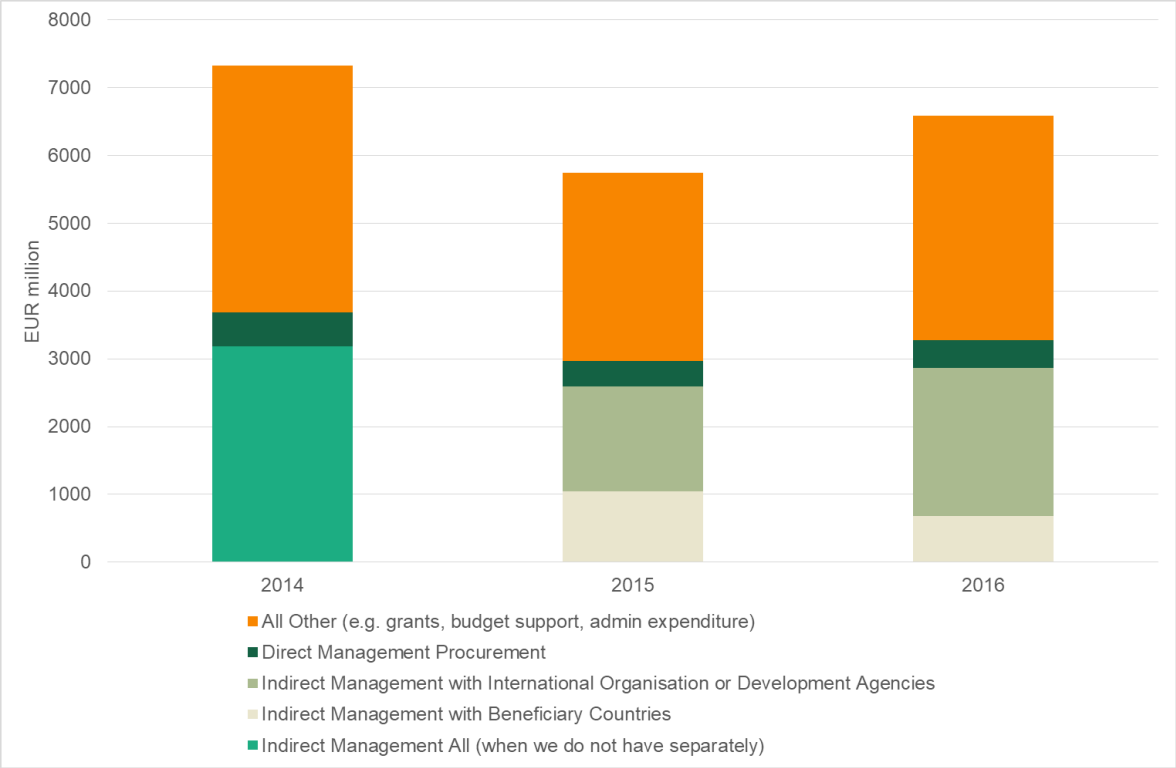
The figures in this chapter summarise how much of aid spending we see in our databases compared to the total aid spending of the donors. Figure 1 shows the share of prior review contracts in the case of World Bank. Prior review contracts have to be published on the World Bank website (red columns), whereas other contracts are only published on the national procurement websites (difference between light-green and red columns). Thus, the black line shows the share of lending amount for which contracts are available to us in the World Bank database. The publication rules are similar in case of the other two donors.

Figure 1 Share of prior review contracts for World Bank (1998-2013).



Source: World Bank, own calculations

Figure 2. Proportion of all DEVCO payments by management modes (2014-2016).

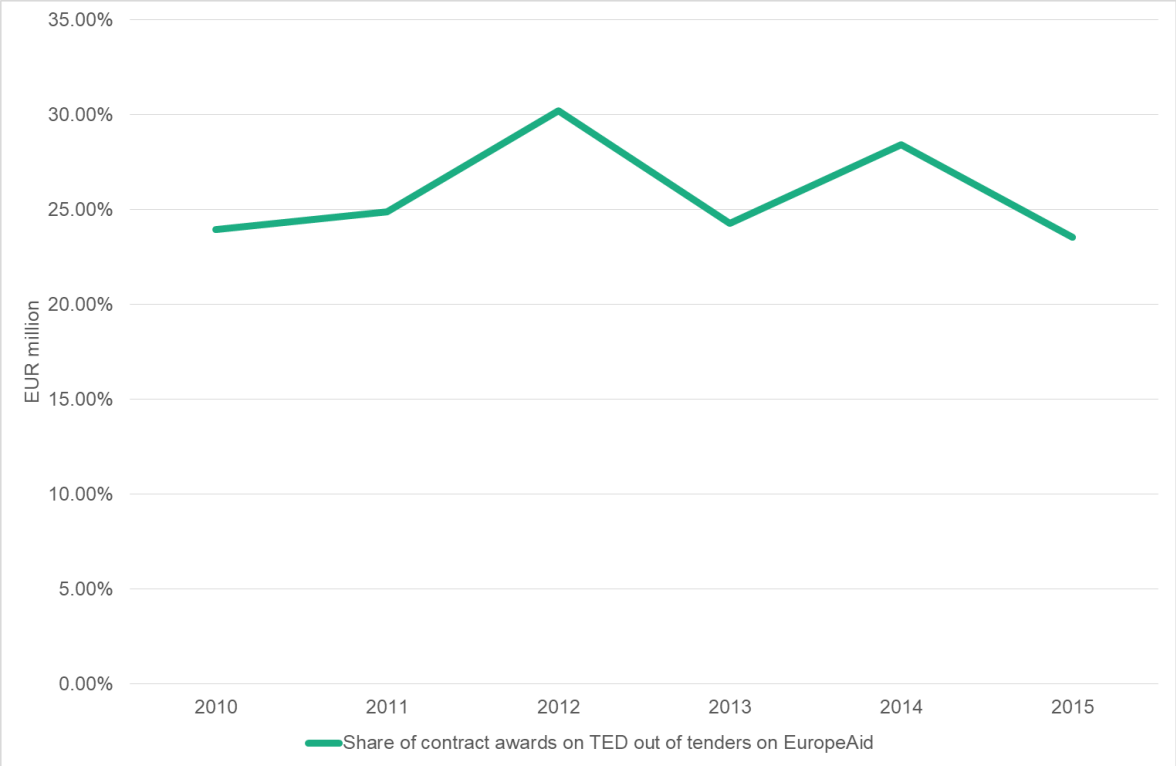


Source: Annual Activity Report 2014, 2015, 2016 https://ec.europa.eu/info/publications/annual-activity-report-2016-international-cooperation-and-development_en , https://ec.europa.eu/info/publications/annual-activity-report-2015-international-cooperation-and-development_en , https://ec.europa.eu/info/publications/annual-activity-report-2014-international-cooperation-and-development_en

Figure 2 shows the proportion of payments by the Directorate-General for International Cooperation and Development (DG DEVCO) by management mode. Spending via direct and indirect management refer to procurement spending via the European Commission directly or via the Beneficiary Countries or International Organisations and Development Agencies indirectly. According to the procurement guidelines[2] each tender in direct or indirect management mode has to be published on the EuropeAid website, so about half of the development spending appears on EuropeAid website.

[2] https://ec.europa.eu/info/publications/annual-activity-report-2014-international-cooperation-and-development_en

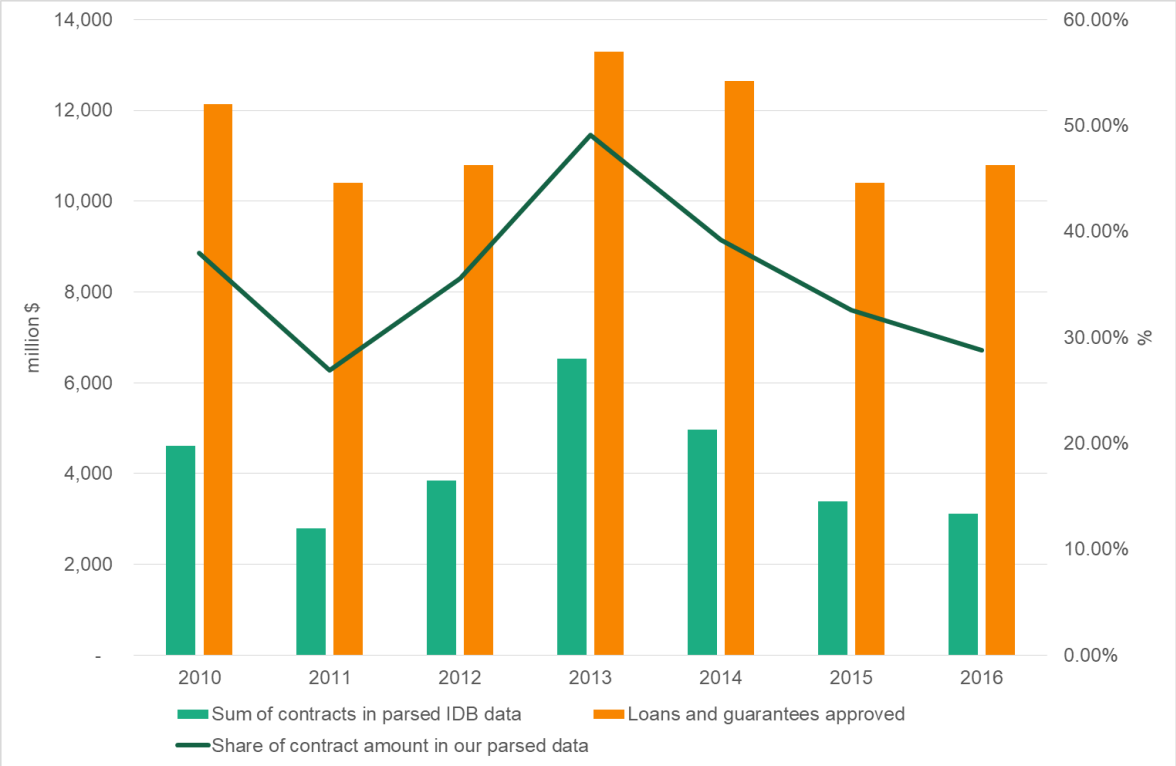
Figure 3 Share of contract awards published on TED out of tenders on EuropeAid



Source: Parsed EuropeAid website, parsed TED website

On Figure 3 we show how many of the tenders on EuropeAid we can see also on Tender Electronic Daily (TED). According to the procurement guidelines only international calls for tender have to be published on TED additionally to the EuropeAid website. International calls must be used when the contract value is above a certain threshold (EUR 300,000 for supplies and services and EUR 5,000,000 for works). To calculate this share we used the EuropeAid reference number to merge our parsed data from TED and EuropeAid website to see how many matches there are. The graph shows the share in numbers, but not based on contract value, but the graph can be taken as a lower bound for the share of contract value published on TED as the tenders we see on TED have higher values.

Figure 4 Share of contract amount in our IDB database out of total IDB lending



Source: IDB parsed database, IDB Annual Reports 2014, 2015, 2016 http://www.iadb.org/en/about-us/annual-reports,6293.html

On Figure 4 we depicted the share of contract value appearing in our parsed IDB database out of total new lending approved in a given year. Loans and guarantees approved come from IDB Annual Reports and show the amount approved in a given year. Sum of contract amount is from the data that we generated by parsing the IDB website and adds up the value of contracts signed in a given year.

3. Source-by-source results

World Bank

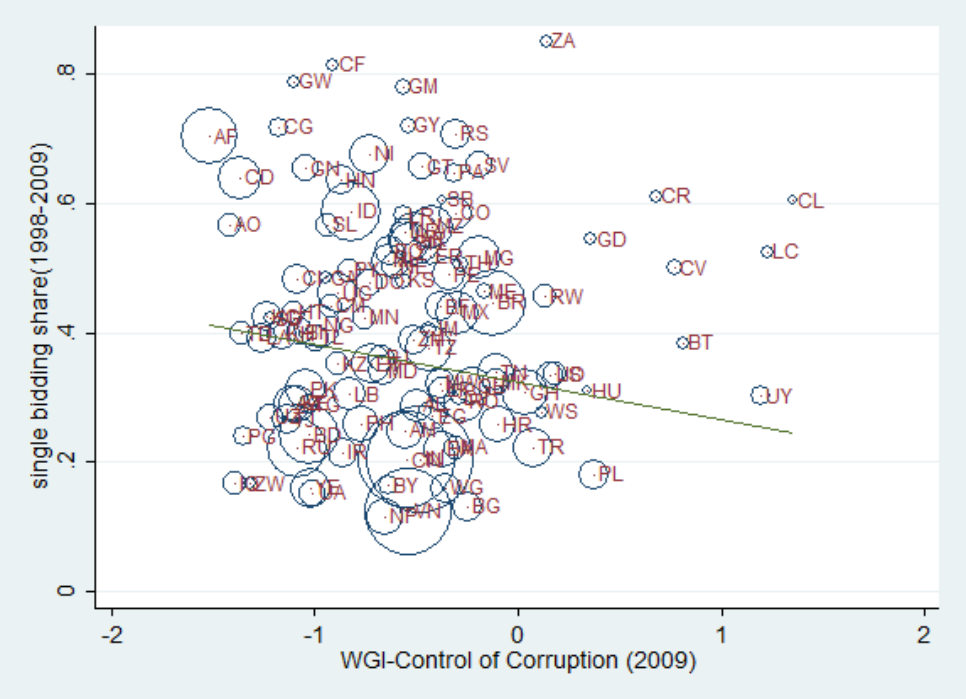
The correlations with perception-based indicators for our most important red flag, single-bidding, are presented in Table 1. Single bidding is our most straight-forward red flag. In order to secure that resources are allocated to specific favoured individuals other competitors should be somehow ruled out from competition. Unless fake competitors are commissioned single bidding is necessary, but not sufficient sign of a tender. Unfortunately, we have data about the number of bidders only until 2009 for World Bank; and we do not have this data for the other two donors at all.

Table 1 Correlation of single bidding and perception-based corruption indicators

		TI - CPI (2009)	WGI - CoC (2009)	GCI - Fav (2009)
Weighted with number of contracts	Single bidding	-0.20	-0.15	-0.20
	1 / bidder nr.[2]	-0.19	-0.14	-0.19
Weighted with sum of contract values	Single bidding	-0.18	-0.11	-0.15
	1 / bidder nr.[2]	-0.17	-0.10	-0.14

Note: Only countries with more than 100 contracts are considered

Figure 5 Relationship between single bidding ratio and WGI Control of Corruption indicator.



Notes: The size of bubbles represents the number of contracts in that country. Number of contract per country used as weights. Only countries where there are more than 100 contracts are included.

Raw correlations are very close to zero and are insignificant, but when dropping countries with fewer contracts from the sample the correlations become higher and more significant. In Table 1 we present correlation coefficients for countries with more than 100 contracts and use total value and number of contracts weights. We can see that all correlation coefficients are negative as we expected, but are not too high in absolute value. In Figure 5, we depict the average 1998-2009 single bidder ratio with their 2009 WGI Control of Corruption scores to illustrate the relationship between the two. It is obvious that it is not a very strong and well-defined correlation, but it is evidently negative.

Correlation coefficients between our other red flags (average for contracts before 2015) and the perception indicators (2015) for the World Bank data are summarized in the Appendix. As we have expected, these relationships are not especially strong. The strongest red flags seem to be supplier tax haven registry and the indicator for project cost overrun above 120%.

In the case of World Bank, we also use single bidding for checking micro-level validity, by checking to what extent our different red flags predict single-bidding in a tender (Table 2). Results are mostly in line with our expectations, except supplier tax haven, where we see a negative coefficient.

Table 2 Micro validity testing. Coefficients from logit models predicting single bidding on tender level.

Red flag	Coefficients on single bidding		
Procedure is restricted, single source or consultancy	2.16**	1.98**	
Non-open procedure	2.67**	2.67**	
Consultancy spending	1.75**	1.49**	
Supplier is from tax haven	-0.31**	-0.36**	-0.22**
Supplier is from tax haven and small state	0.02	-0.32**	-0.20**
Signature period <14 days	0.41**	0.26**	0.11**
Signature period >93 days	0.01**	0.11**	-0.039*
Missing signature period	0.50**	0.66**	0.34**
Log(contract value)		x	x
Sector		x	x
Region		x	x
Country		x	x
Year		x	x
Other red flags			x

*Note: ** - significant at 0.01 level, * - significant at 0.1 level*

We used the database of Winters (2014) to validate our red flags also on the project level. Winters (2014) analyses the Implementation Completion Reports of World Bank projects using text mining techniques and searches for key words that let us assume the project was captured. We are testing whether our red flags show higher corruption risks in case of captured projects. Again, we do not expect very substantial significant results for several reasons. Winters (2014) have data only for 598 projects out of the approximately 6000 projects for which we have red flags. We did not find any supporting evidence that our red flags are in line with the capture variable of Winters, but we do not think it would undermine the validity of these red flags.

IDB

In case of IDB, we had fewer red flags to check and also much more limited possibilities for testing validity. Table 3 summarises the results of our macro validity checks. All the correlations support the validity of our red flags more or less, except for the non-open procedures indicator. In case of this red flag the correlations looked better when using value weights or number of contracts weights.

Table 3 Correlation of the country-average of our red flags until 2015 and perception-based corruption indicators of 2015 for IDB

	GCI - Fav	WGI - CoC	TI - CPI
Submission			
Non-open procedure	0.07	0.13	0.24
Consultancy spending	-0.21	-0.37	-0.34
Outcome			
Supplier is from tax haven	-0.24	-0.38	-0.37
Supplier is from tax haven and small state	-0.18	-0.39	-0.37
Publication share of awarded contracts	0.24	0.32	0.31

Note: for all red flags we expect to see negative correlations, except for the publication share of awarded contracts where we predict that a higher share of published contracts would suggest lower corruption levels.

As we do not have information about the number of bidders for IDB, we just checked how the different red flags correlate with each other. We used a project-level database to check correlations as the share of published contracts red flags is on the project-level. In case of contract-level indicators we calculated simple mean within a project. The results were mostly positive but not really strong. All red flags except the share of published contract awards are expected to have positive correlations with each other.

Table 4 Micro validation for IDB data. Correlation coefficients on project-level data.

	Share of published contract awards	*Non-open procedure*	*Consultancy spending*	*Supplier is from tax haven*	*Supplier is from tax haven and small state*
Share of published contract awards	1				
Non-open procedure	-0.0042	1			
Consultancy spending	-0.0629*	-0.0272	1		
Supplier is from tax haven	-0.0167	0.01	0.1083*	1	
Supplier is from tax haven and small state	-0.0105	0.0226	0.0947*	0.8449*	1

Note: everywhere, except for the first column, we expect to see positive correlations.

EuropeAid

For EuropeAid the only source from where we could get meaningful structured information is the TED website. However, only a subset of all EuropeAid tendering is published on the TED

website and for shorter time period. For the years 2011-2017 there is 1806 contract awards and 2230 contract notices on the TED website.

Due to the low sample size we only included those countries in the macro validity checks where there are at least 30 awards during the whole period – covering 58% of all the contracts – and checked the correlation of red flags with the 2015 value of the perception-based indicators. Only the red flag indicating long decision periods has negative correlation with all three perception indicators. Non-open procedures have substantial negative coefficients with the WGI Control of Corruption and the TI Corruption Perception Indicator, but as shown in Table 6, the micro validation shows unexpected results for this variable. Besides the above mentioned two, single bidding, no call for tender matched, advertisement period below the minimum and above the typical values are the red flags that show sign of validity.

Table 5. Correlation of the country-average of our red flags and perception-based corruption indicators of 2015 for EuropeAid

	GCI - Fav	WGI - CoC	TI - CPI
Non-open procedure	0.03	-0.58	-0.47
No CFT matched	-0.28	0.06	-0.04
Advertisement period 0-30 days	-0.04	-0.53	-0.46
Advertisement period >41 days	-0.16	0.27	0.51
Length of eligibility criteria (binary: above 1.075*CPV avg)	0.38	0.42	0.41
Decision period >146 days	-0.16	-0.26	-0.28
Single bidding	-0.40	0.17	-0.04

Note: countries in the sample are Algeria, Argentina, Egypt, Ethiopia, Ghana, Lebanon, Mali, Nicaragua, Tunisia, Turkey

In the micro validity testing (Table 6) we run logit models to predict single bidding. Except non-open procedure and no CFT matched all other red flags have a positive coefficient in our model specifications with varying significance levels.

Table 6. Micro validity testing. Coefficients from logit models predicting single bidding on tender level.

Red flag	**Coefficents on single bidding**		
Non-open procedure	-1.410***	-1.065***	-1.033***
No CFT matched	-0.196	-0.376*	-0.227
Advertisement period 0-30 days	0.534	0.547	0.461
Advertisement period >39 days	1.670***	0.890**	1.160***
Length of eligibility criteria (binary: above 1.025*CPV avg)	0.871***	0.831***	0.822***
Decision period >136 days	1.415***	0.649**	0.614*
CPV codes		x	x
Countries			x

4. Summary of validity test results and indicator selection

In Table 7 we summarised the results of the validity testing. For each red flag at each donor we considered a red flag to have high level of validity if at least two correlation coefficients are above 0.1 and two logit model coefficients are significant and positive and robust to specifications. One correlation above 0.1 and one significant coefficient would be categorised as moderate level of validity. Low validity level means that the direction of coefficients are as we expected but quite weak. No validity is the case when the coefficients point to the opposite direction than what we have expected.

Table 7 Summary table of validity testing

World Bank						
Indicator	**Definition**	**Level**	**Time span**	**macro validity**	**micro validity**	**shortlist**
Single-bidding	1=1 bidder per contract 0=2 or more bidders per contract	Tender (Contracts)	1998-2008	High		x
Non-open procedures	1=non-open procedure types (e.g. single source) 0=open procedure types (e.g. international competitive bidding)	Tender (Contracts)	1998-2016	High	High	x
Spending on consultancy	1=consultancy procured 0=non-consultancy type product purchased	Tender (Contracts)	1998-2016	Low (regional variability)	High	x
Signature period < 14 days	Time between award date and contract signature date is shorter than 14 days	Tender (Contracts)	1998-2013	High	High	x
Advertisement period length < 14 days	Time between publication and bidding deadline is shorter than 14 days	Tender (Call for Tenders)	2009-2016	Moderate	N/A**	x
Supplier tax haven registration	1=Foreign supplier registered in a tax haven 0=Foreign supplier registered in non-tax haven (or Domestic supplier)	Tender (Contracts)	1998-2016	Moderate	No	x
Share of published contract awards	Sum of contract awards amount / total project cost	Project	1998-2016	Low	Moderate	
Cost overruns (WB part)	Final project cost compared / original committed amount	Project	1998-2016	High	High	x
Inter-American Development Bank						
Indicator	**Definition**	**Level**	**Time span**	**macro validity**	**micro validity**	**shortlist**

Non-open procedures	1=non-open procedure types (e.g. single source) 0=open procedure types (e.g. internat.comp.bidding)	Tender (goods& works)	1991-2016	No	Low	
Spending on consultancy	1=consultancy procured 0=non-consultancy type product purchased	Tender	1991-2016	High	Moderate	x
Supplier tax haven registration	1=Foreign supplier registered in a tax haven 0=Foreign supplier registered in non-tax haven (or Domestic supplier)	Tender	1991-2016	High	Moderate	x
Share of published contract awards	sum of contract awards amount / total project cost	Project	1991-2016	Moderate	Low - Moderate	x
EuropeAid						
Indicator	**Definition**	**Level**	**Time span**	**macro validity******	**micro validity**	**shortlist**
Single-bidding	1=1 bidder per contract 0=2 or more bidders per contract	Tender (Contracts)	2011-2017	Moderate		x
Non-open procedures	1=non-open procedure types (mostly restricted) 0=open procedure type	Tender (Contracts or Call for tenders)	2011-2017	High	No	
No call for tender published	1=we can find the call for tender published on TED 0=we cannot find the call for tender published on TED	Tender	2011-2017	Moderate	No	
Advertisement period	1=0-30 days*** / 1=above 39 days 0=other	Tender	2011-2017	High / Moderate	Moderate / High	x
Decision period	1=<135 days, 0=more than 135 days	Tender	2011-2017	High	High	x
Length of eligibility criteria	1=deviation from CPV average is above 1.025 0=deviation from CPV average is at most 1.025	Tender	2011-2017	No	High	x

Notes:
* Micro validity checks mean relationship with single-bidding in case of World Bank and correlations across red flags, especially with tax haven in case of IDB.
** Cannot be linked to single-bidding, only macro validation is available
*** 30 days is the minimum according to regulations
**** As there are lot of countries with only 1-2 contracts, we checked macro validity on countries that have at least 30 contracts:
High: for macro at least two correlation coefficients with perception indicators are above 0.1; for micro at least two significant positive correlations in logit models predicting single-bidding
Moderate: for macro at least one correlation coefficients with perception indicators are above 0.1; for micro at least one significant positive correlations in logit models predicting single-bidding or consistent positive (not necessarily significant) coefficients
Low: very week relationship
No: results are of opposite direction compared to what was expected

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Appendix A

Table 8 Macro validation for World Bank data. Correlation between perception indicators (2015) and red flags (averages before 2015) for World Bank

	GCI - Fav	WGI - CoC	TI - CPI
Submission			
Procedure is restricted, single source or consultancy	-0.23	-0.03	-0.14
Non-open procedure	-0.24	-0.03	-0.27
Consultancy spending	-0.07	-0.01	0.06
Advertisement period is <14 days	-0.06	-0.02	-0.14
Assessment			
Signature period <14 days	-0.03	-0.17	-0.18
Signature period >93 days	0.07	0.02	0.11
Outcome			
Supplier is from tax haven	0.08	-0.04	-0.06
Supplier is from tax haven and small state	-0.12	0.09	-0.14
Cost overrun is above 120%	-0.11	-0.23	-0.24
Publication share of awarded contracts	-0.02	-0.09	-0.10

Source: Internal World Bank database

Note: for all red flags we expect to see negative correlations, except for the publication share of awarded contracts where we predict that a higher share of published contracts would suggest lower corruption levels.

Appendix B Compiling datasets

World Bank

In case of World Bank we parsed or downloaded data from four online sources on the World Bank website. Additionally, we used the internal dataset of World Bank including some more variables than the online sources. For our final analysis we used the World Bank database to which we have added project-level information from the Bank's project details page. We summarize the main information about each data sources in Table 9. In the first section of the table the primary data sources are listed. In the second section we describe the merged datasets we generated from the data sources. In the second section we included a column to show how many observations we could match between the given data sources.

Table 9 Summary of data sources for World Bank

Source	**Years**	**Number of observations**		**Level of observation and connectivity**
Data sources				
Major contract awards[3]	2000-	131,860	-	Contract-level with project ID and WB contract number
World Bank Projects & Operations[4]	1947-	16,000	-	Project-level with project ID
Notices (WB website)[5]	2005-*	36,917	-	Contract-level with project ID and WB notice number
Contracts (WB website)[6]	2002-**	142,533	-	Contract-level with project ID and WB contract number
Internal World Bank Database	1998-2014	245,126	-	Contract-level with project ID, no contract ID
Merged datasets				
	Years	**Number of observations**	**No. of matches**	**ID for merging**
Parsed contracts + major contract awards	2000-	150,460	123,933	Contract-level, WB contract number
Parsed & major contracts + notices (tender-level data)	2002-**	185,283	2,499	Contract-level, WB contract number
Project details + contracts & notices, project-level	1947-	16,810	5,302	Project-level, project ID
Parsed & major contracts + notices (tender-level data) + project details, tender-level	2002-**	185,283	181,670	Contract-level, project ID
WB Internal database + project details, project-level	1998-2014	17,239	6,028	Project-level, project ID

*There is a jump in the number of observations in 2009

**In 2002 there are only 1,723 contracts vs. yearly 10-13 years in later years

[3] https://finances.worldbank.org/Procurement/Major-Contract-Awards/kdui-wcs3/data

[4] http://projects.worldbank.org/

[5] http://projects.worldbank.org/procurement/procurementsearch?lang=en&srce=both

[6] See footnote 5

EuropeAid

Our main data source for red flag generation and validation was TED[7] due to the higher number of potential red flags we could generate compared to the EuropeAid website.

Table 10. Number of observations at different stages of dta cleaning and merging

Stage	1	2	3
Publication form type	Original Freq.	Lots after cleaning lot number	Lots without CN duplicates
Contract Award (CA)	1,806	1,911	1,911
Contract Notice (CN)	3,260	3,231**	2,970
Prior Information Notice	2,596	-	-
Total	7,662	5,142	4,881

**It is smaller than original data, because tender ID is missing in 31 cases in the original data

In our original parsed dataset we had 1,806 contract awards and 3,260 contract notices (call for tenders in TED terminology). To create our final dataset we matched contract awards to contract notices on the lot level. A contract notice often includes several lots and sometimes contract awards are published separately for the different lots. A one-to-many merging could be used in this case (i.e. for one CN more CAs can be merged), but sometimes contracting authorities do not find a suitable applicant right away and relaunch a contract notice for some lots later in new contract notices. So we parsed lot number to a separate variable from the lot titles in order to be able to match based on tender ID and lot number. For the tender IDs that match between CNs and CAs, we cleared the lot number manually.

Identifiers used for matching:

- Tender ID (e.g. EuropeAid/130735/D/SER/CO) is in fact the EuropeAid reference number, an ID for tenders that can be used to merge contract notices to contract awards.
- Document ID (e.g. 2012/S 153-254700): each document has its separate unique ID.
- Lot title: the title of the separate lots in a tender, we can gain the lot number from this text, so that we can match based on tender ID and lot number.

Steps

1. Original data
    a. CN: tender-lot level,
    b. CA: notice level, sometimes more lots in one CA notice
2. Generate cleaned lot-level data by parsing lot number from lot titles

[7] http://ted.europa.eu/TED/search/search.do Selecting "External aid programmes" and "European Development Fund and External aid" from the dropdown menu of European Institutions in the advanced search.

3. Generate CN data with unique tenders: when there is a CN relaunch for a lot, we keep the latest version of the notice

Table 11. Result of matching CN and CA data

Result	N
Not matched	2,319
Only CN	1,693
Only CA	626
Matched	1,285

IDB

We had three data sources for IDB: contract awards, procurement notices and project details[8]. We could not merge contract awards to call for tenders due to the lack of a unique ID. The only potential red flag from the procurement notice database without merging it with the contracts would have been advertisement period, but it turned out that this variable cannot be generated from the data. So we did not use the call for tender data later on.

We generated our red flags separately for the contracts and projects data sources and merged them on the project level, where we can see the average value of tender-level red flags for a given project. We used this project-level data for macro level validation and the two datasets separately for micro validation. Table 12 show the number of observations in each data set before and after merging.

Table 12. Preparing IDB database

	Years	**N**	**Level of observation and connectivity**
Data sources			
IDB Proc. notices	1999-*	15,441	Tender-level with project ID
IDB Contract awards	1961-	357,932	Tender-level with contract reference number and operation number
IDB Project details	1960-	20,905	Project level with project ID
Merged data			
CA data collapsed to project level	1960-	4,232	Project level with project ID
CA data matched to project data	1961-	4,232	Project level with project ID
*Peak on Jan 1 2001 (28%), proper number of observations since 2012			

[8] Scraped from this website: http://www.iadb.org/en/projects/project-procurement,8148.html