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The Impact of Corruption on Economic Growth, a Bootstrapping Analysis

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The impact of corruption on economic growth, a bootstrapping analysis

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Abstract: In this paper we evaluate the impact of corruption in economic growth and if in less developed countries the hypothesis "greasing the wheels" is valid.

Using an unbalanced panel data with 2907 observations from 174 countries and 23 years between 1995 and 2017 (data from Transparency International and World Bank), we estimate using bootstrapping that the impact of corruption on growth is negative (an estimate of 0.025pp per CPI point) and that the hypothesis "greasing the wheels" is not supported in the data. Our results are in accordance with the literature but are more robust because our database has much more observations.

JEL Codes: C15, C23, O47, D73

Keywords: Corruption, Economic Growth, Panel data, Bootstrapping

1. Introduction

Being unquestionable that there is a strong and negative statistical connection between the level of corruption and Gross Domestic Product *per capita* (the Spearman coefficient of correlation between Corruption Perception Index and GDP *per capita* constant 2010 US$ is 0.76, averages from 2007 to 2016), on a dynamic perspective, most of the literature advocates that corruption also harms economic growth (*e.g.*, Mauro, 1995; Rose-Ackerman, 1999; Aidty, 2009).

Corruption occurs when an individual with discretionary decision power overcomes limitations imposed by law and regulations on private activities in order to get an advantage, *i.e.*, misusing public power to receive a bribe, Lambsdorff (2007). Then, corruption is a principal-agent problem where the agent (public servant) deviates from the objectives of the principal (government) to gain an illicit advantage.

Corruption is mainly a problem between a private economic agent and a public authority, government or state owned company because private agents, having a more clear objective (profit maximization), they implement better control systems. Being mainly a public-private problem, corruption only occurs when there is some “government property”, for example, a permit to do a forbidden activity or the prohibition of entrance of competitors in a concentrated market, for which the “buyer” is willing to pay a price (*e.g.,* Shleifer and Vishny, 1993).

Although at a theoretical level corruption can be positive in countries with bad laws and regulations by alloying bureaucratic delays to be avoid and by motivating public servants to be diligent in order to receive bribes, *i.e.*, "greasing the wheels” (*e.g.*, Leff, 1964), in dynamic terms, the literature maintains that corruption is negative because corrupt people do not separate “good” from “bad” corruption and it is an incentive for public decision-makers to maintain and even to develop bad laws and regulations and to weaken institutional framework (*e.g.*, Rose-Ackerman, 1999).

At micro level the negative impact of corruption on economics occurs thought diverse channel, Shleifer and Vishny (1993). Corruption allows that activities be done in a defective manner (*e.g.*, violation of construction regulations), activities that should be prohibited are carried out (that induces poor allocation of scarce resources, *e.g.*, over fishing) and, by decreasing the protection of contracts, it decreases investment, innovation and FDI, Mauro (1995). It also induces the emergence of useless transaction costs in the economy and fiscal distortions.

By considering corruption as an economic transaction between public authority and private agents allows us to see that there is a connection between corruption and laws and regulations that limit private activities, *i.e.*, being bribe a percentage of the gain obtained by the private agent when laws and regulations are not respected (the shadow price), a less restrictive legal system will decrease the risk of corruption. This fact indicates that, at the aggregated level, fighting corruption passes by the liberalization of the economy, the privatization of state owned companies, transparent decisions processes and the reduction of the weight of the state in the economy, Acemoglu and Verdier (2000), coincident with the Washington Consensus and, at the individual level, by creating economic incentives to the agent which includes legal persecution and penalties for deviant behavior, Becker and Stigler (1974),.

Quantifying corruption is a significant aspect of developing anti-corruption strategy as it helps to identify priorities and to evaluate the potential impact of anti-corruption policies on economics. Nonetheless, being corruption a hidden and discreet phenomenon, its quantification is difficult and controversial mainly due to two reasons:

Firstly, an examination of the legislation of different countries shows minimum international consensus on definitions of corruption, its breadth and forms that leads to the ambiguous understanding of the phenomenon. Therefore, the level of corruption can be seen as bigger in countries where corruption is defined more widely.

Secondly, the national statistical data depends on the intensity of the fight against corruption. Countries with effective and comprehensive anti-corruption policy have more identified corruption cases. The reverse situation can be observed in countries with weak policy and preference to keep hided the level of corruption (*e.g.*, Kaufmann and Mastruzzi, 2007).

Systematization of approaches to the quantifying corruption allows identifying several groups:

1) Based on sociological surveys (*e.g.*, World Bank polls, Worldwide Governance Indicators);

2) Based on expert assessment (*e.g.*, Nations in Transit projects, International Country Risk Guide, Country Policy and Institutional Assessment);

3) Based on integrated assessment (*e.g.*, Corruption Perceptions Index by Transparency International).

CPI- Corruption Perceptions Index, CPI, is computed from 1995 forward being a composite index that results from the average of a variable number of perception-based indicators. It is measured in the scale 0-100 where 0 is for the most corrupt countries and 100 for the least corrupt ones (scale 0.0-10.0 in first years but easily transformed in the scale 0-100).

CPI is widely used as proxy for the level of corruption because it covers a wide range of countries, 188 countries with at least one observation, and the scientific community recognizes it as informative and relevant (*e.g.*, Aidty, 2009).

The use of CPI variable as regressor in a panel data poses statistical challenges because it is unbalanced (in the time span 1995:2017, CPI has 3153 observations for 188 countries that represents 26.7% of missing values), it is a stochastic variable with a standard error of 3.3 points (see, Table 1), it has positive trend (see, Table 2) and temporal stability is large (for one year lag, the auto-correlation coefficient is 0.987 and, for five years lag, it is 0.966).

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Avg.CPI	59,2	66,0	61,5	57,0	43,1	44,3	48,0	42,8	42,1	42,9	41,3	42,1
St.Error	6.4	5.6	4.1	4.1	3.5	3.8	3.3	3.3	3.4	2.7	2.5	2.4
N.Index	4.5	7.0	5.6	6.9	7.5	6.8	6.6	7.2	7.7	7.8	7.2	5.8
N.Countries	48	47	52	84	98	89	91	102	133	146	159	163
%W.Pop	77%	75%	77%	84%	86%	84%	86%	88%	94%	96%	97%	97%
Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Avg**
Avg.CPI	39,6	40,2	40,7	41,0	43,7	44,8	44,3	40,8	44,8	44,2	44,6	**43.1**
St.Error	2.5	2.6	2.8	2.6	2.5	3.1	3.2	3.2	3.2	3.0	2.9	**3.34**
N.Index	6.0	5.9	5.8	5.8	7.3	6.3	6.4	6.1	6.3	6.5	6.9	**6.51**
N.Countries	180	180	180	178	183	180	176	167	172	173	172	**137**
%W.Pop	97%	98%	98%	98%	98%	98%	98%	98%	98%	98%	84%	**92%**

Table 1 – Average and standard error of the CPI; average number of indicators used; number of evaluated countries and population included in those countries as % of world population, 1995:2017 (data: Transparency International; authors' calculations, simple average)

Variable	Trend	t-stat.	Signif.
GDPG	-0.035	-3.8	0.1%
GDPpc	0.203	52.3	0.1%
GCF	0.255	19.8	0.1%
PopG	-0.020	-24.7	0.1%
CPI	0.37	29.5	0.1%

Table 2 – Temporal trend of individual variables, 1995:2017, countries' population as weight, fixed effects.

2. Methodology and Results

To overpass the fact that the panel data in non-stationary, we will use a conceptually simple methodology: First we slice data sectionally and, them, we aggregate estimates. This methodology has the advantage of being conceptually simple; estimators are independent of the distribution of the error terms; and it allows direct assessment of whether corruption has a different impact in less developed countries.

We start the estimation procedure by estimating 23 sectional models, one for each year.

We use the growth model of Solow (1956) as theoretical framework, in a similar way to Mo, (2001), where countries GDP growth, GDPG, results from increases in labor (the population growth as proxy), PopG; in capital, GCF, Gross capital formation (% of GDP); and technology transfers (inversely proportional to GDP per capita, constant 2010 US$, GDPpc), to which we add the Corruption Perceptions Index ,CPI, and assuming an error term ε, with zero mean and iid. Subscript c is for country and subscript y is for year:

$$GDPG_{c,y} = \beta 0_y + \beta 1_y \, GDPpc_{c,y} + \beta 2_y \, GCF_{c,y} + \beta 3_y \, PopG_{c,y} + \beta 4_y \, CPI_{c,y} + \varepsilon_{c,y} \tag{1}$$

CPI is from Transparency International and all other variables are from World Bank, for the period 1995-2017.

The panel data we build has 2907 complete observations covering 172 countries for 23 years which means there are 26,5% of missing values. Due to the fact that missing values are mainly on small countries, the panel observations covers 92% of the world population.

Motivated by the fact that countries have a very different dimension (a maximum of 1386.4 M people for China in 2017 and a minimum of 0.085 M people for Seychelles in 2006), we will use the population associated with each observation as weight factor. We will not use GDP as weight because that would over-represent developed countries.

Assuming the panel data is in the data frame *d.f*, we use the next R-code to estimate de model represented in the expression (1), see Table 3:

```
#R-code A
    param <- 5 # 5 is the parameter associated with CPI variable
    estimate <- rep(0,23); std <- rep(0,23); popul <- rep(0,23)
    for (i in 1995:2017)
      {d.f2 <- d.f[d.f$year==i,]
       model = lm(GDPG ~ GDPpc+GCF+PopG+CPI, data = d.f2, weight = Pop)
       estimate[i-1994]=summary(model)$coefficients[variable,1]
       std[i-1994]=summary(model)$coefficients[param,2]
       popul[i-1994]=sum(d.f2$Pop)
       print(c(estimate[i-1994],std[i-1994]))
      }
```

From Table 3 we see that, in statistical terms, the impact of corruption on growth oscillates over time. It is negative in 14 years and significant in 7 of those years (1998, 2009, 2010, 2013, 2014, 2016 and 2017) and negative in 9 years and significant in 2 of those years (2001 and 2004) that may result from the CPI being a random variable.

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Estimate	0,011	0,004	0,026	**0,191**	0,033	-0,014	**-0,055**	0,049
t-stat.	0,4	0,1	0,5	3,1	1,0	-0,5	-2,2	1,4
Signif.	n.s	n.s	n.s	1%	n.s	n.s	5%	n.s
Observations	47	46	51	81	96	87	88	99
Population	76,7%	75,3%	77,1%	84,2%	85,7%	84,0%	86,4%	88,3%
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Estimate	-0,019	**-0,127**	-0,030	-0,019	-0,012	-0,032	**0,093**	**0,071**
t-stat.	-0,4	-1,8	-0,9	-0,5	-0,3	-0,9	2,2	2,6
Signif.	n.s	10%	n.s	n.s	n.s	n.s	5%	5%
Observations	128	140	150	154	163	165	164	165
Population	93,5%	95,9%	97,0%	96,9%	97,4%	98,2%	98,1%	98,3%
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**W. Avg**
Estimate	0,021	-0,004	**0,054**	**0,099**	**0,153**	0,048	**0,086**	**0,027**
t-stat.	0,7	-0,1	2,2	4,7	3,6	1,1	3,5	
Signif.	n.s.	n.s.	5%	0,1%	0,1%	n.s.	0,1%	
Observations	166	163	158	155	156	155	130	2907
Population	98,3%	98,2%	98,1%	98,1%	97,7%	97,5%	84,2%	92,0%

Table 3 – Impact of CPI on growth, sectional data (23 years) and weighted average

If some years the impact is negative and others positive, to estimate the long-term impact of corruption on growth we need to compute the average impact for all those 23 years, using each year population as weight:

$$Pop_y = \sum_c (Pop_{c,y}) \quad (2)$$

$$\beta i = \sum_y (\beta i_y Pop_y) \ / \sum_y (Pop_y) \quad (3)$$

From Table 3 it is straightforward to compute the estimate for the long term effect of corruption on growth by using the weighted average but not the statistical properties of the estimator:

```
# R-code B
    sum(estimate*popul)/sum(popul).
```

To compute the statistical properties of the estimators we will use bootstrapping, Efron, (1979) that is a very flexible statistical methodology. The bootstrapping, starting with a sample, first, repeatedly creates new samples by re-sampling randomly from that original sample calculating the estimate for each of these new samples. Then, the statistical properties of the estimator are the properties of the population of estimates.

We computed the statistical properties of the estimators using 100000 re-samplings that guarantee a computation error smaller than 0,001.

We computed Pr(>|t|), for a positive estimate, as the percentage of cases that are smaller than or equal to 0 or greater than or equal to twice the average.

We estimate the model using the next R code (we present a simplified version):

```
# R-code C
  niter=100000
  CPI.p<- rep(0,niter) # we include other parameters in the code that we omit here
  nobs <- nrow(d.f)
  for (iter in 1:niter)
     {cases <- sample(1:nobs,nobs,replace=TRUE) # re-sampling from the original sample
       instance <- d.f[cases,]
      model = lm(GDPG ~ GDPpc+GCF+CPI+PopG, data = instance, weight = Pop)
      CPI.p[iter]<- CPI.p[iter]+summary(model1)$coefficients[5,1]*popul[i-1994]
     }
  CPI.p<- CPI.p/sum(popul)
  print(c(mean(CPI.p),
      sd(CPI.p),mean(CPI.p)/ sd(CPI.p),
      length(CPI.p[CPI.p<0|CPI.p>2*mean(CPI.p)])/n.iter))
#Results in table 4
```

Variables	Estimate	t value	Pr(>|t|)*	Sign.	Variance
(Intercept)	-0.478	-0.8	43%	n.s.	--
GDPpc	-0.086	-6.6	0.0%	0.1%	9.8%
GCF	0.176	9.4	0.0%	0.1%	19.6%
Pop growth	0.508	4.5	0.0%	0,1%	1.2%
CPI	**0.025**	**2.2**	**2.7%**	**5%**	**1.1%**

Table 4 - Estimators using WLS / weighted averages of 23 sectional estimators, R^2 = 30.9%
* For positive average, smaller than or equal to 0 or greater than or equal to twice the average.

Another research question is whether in the least developed countries, where the legislative framework is more defective, corruption helps economic growth by “greasing the wheels” (*e.g.*, Leff, 1964). To evaluate this hypothesis, we measure the difference between the impact of CPI on growth in developed and in underdeveloped countries. To support this hypothesis, the difference, *Dif*, must be significant and positive:

$$Dif = \beta 4_{higher\ GDPpc} - \beta 4_{lower\ GDPpc} \quad (4)$$

To compute *Dif*, we used bootstrapping in a similar way as used in “# R-code C” but creating two samples with identical number of observations, sample 1 with countries with smaller

GDP *per capita* and sample 2 with countries with higher GDP *per capita* (30000 re-samplings guarantees an standard error smaller than 0.001). We observe that *Dif* is negative and non-significant not supporting the hypothesis that in the least developed countries corruption helps growth (see, Table 5).

Variables	Estimate	St. dev.	t value	Pr(>|t|)	Sign.
Dif	-0,017	0,0205	-0.8	41%	n.s.

Table 5 – Estimator of the difference of the impact of CPI on economic growth, high/low GDP pc, using bootstrapping.

3. Conclusion

Using an extended panel data from World Bank and International Transparency, we observe that corruption decreases significantly economic growth, 0.025 percentage points for each point of increase in the CPI indicator with a significance level of 5%. Our result is very similar to the literature, namely, the results of Aidt (2009) that finds, using average values for the period 1970-2000, the value of 0.027 (estimate is 0,27 due to fact that CPI is in the scale 1-10 while our scale is 1-100) significant at a 5% level and the results of Mo (2001) that finds an estimate of 0,028 (average of estimates of table 2, namely, 0.54542, 0.391395, 0.361571, 0.16416, 0.145855 and 0.06459 with CPI in the scale 1-10).

Although the significant negative impact of corruption on growth, on quantitative terms, the estimate indicates that the impact is feeble due to two reasons. First, the level of corruption of a country is very persistent thought time, with an auto-correlation coefficient CPI for five years lag of 0.966(it seems very difficult to a country to decrease its level of corruption). Second, if it would be possible a country to migrate from the most corrupt group of countries (CPI of 21 points) to the least corrupt group of countries (CPI of 55 points) without any cost, growth rate would increase by just 0,85 percentage points on an average GDP growth rate for the period of analysis of 5.6%/year (a 15% relative increase). Due to these two reasons, we observe in the data that the variability of the CPI only explains 1.1% of the variance of the growth rate (see, Table 2).

We also evaluate if, in less developed countries, corruption has a positive impact on growth as conjectured by Leff (1964). We conclude, as Aidt (2009) did, that even in the less developed countries (also more corrupt and with less efficient legal framework), the impact of corruption is not significantly different from that observed in the more developed countries.

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