Influence of corruption on economic growth rate and foreign investments

Boris Podobnik [a,b,c], Jia Shao [c], Djuro Njavro [b],
Plamen Ch. Ivanov [c,d], H. Eugene Stanley [c]

[a] *Department of Physics, Faculty of Civil Engineering, University of Rijeka, Rijeka, Croatia*

[b] *Zagreb School of Economics and Management, Zagreb, Croatia*

[c] *Center for Polymer Studies and Department of Physics, Boston University, Boston, MA 02215*

[d] *Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria*

Abstract

In order to investigate whether government regulations against corruption can affect the economic growth of a country, we analyze the dependence between Gross Domestic Product (GDP) per capita growth rates and changes in the Corruption Perceptions Index (CPI). For the period 1999-2004 on average for all countries in the world, we find that an increase of CPI by one unit leads to an increase of the annual GDP per capita by 1.7 %. By regressing only European transition countries, we find that ΔCPI $= 1$ generates increase of the annual GDP per capita by 2.4 %. We also analyze the relation between foreign direct investments received by different countries and CPI, and we find a statistically significant power-law functional dependence between foreign direct investment per capita and the country corruption level measured by the CPI. We introduce a new measure to quantify the relative corruption between countries based on their respective wealth as measured by GDP per capita.

Corruption, defined as abuse of public power for private benefit, is a global phenomenon that affects almost all aspects of social and economic life. Examples of corruption include the sale of government property by public officials, bribery, embezzlement of public funds, patronage and nepotism. The World Bank estimates that over 1000 billion US dollars annually are lost due to corruption, representing 5% of the world GDP. The African Union estimates that due to corruption, the African continent loses 25% of GDP.

Previous studies have mainly reported a negative association between corruption level and country wealth [1–4], i.e., on average richer countries are less corrupt. There is ongoing debate concerning the relation between corruption and economic growth [5]. Some earlier studies suggested that corruption may even help the most efficient firms bypass bureaucratic obstacles and rigid laws [6], while recent papers do not find a significant negative association between growth and corruption [1,2]. The majority of studies have found an insignificant negative association between the corruption level and foreign investments [2,7,8], without reporting a specific functional dependence.

In order to find a quantitative relation between corruption level and economic factors such as GDP growth rate and foreign direct investments, we analyze the Corruption Perceptions Index (CPI) [9] introduced by Transparency International, a global civil organization supported by government agencies, developmental organizations, foundations, public institutions, the private sector, and individuals. The CPI is a composite index ranging from 0 to 10, where 0 denotes the highest level of corrupt and 10 corresponds to the lowest corruption level. For GDP per capita we use annual nominal GDP per capita in current prices in US dollars [10], and GDP per capita in constant dollars [11].

The CPI is an absolute measure of corruption which does not depend on country wealth. However, besides in absolute terms of corruption level countries may be also compared in relative terms where corruption level is compared depending on the countries' wealth as measured by the GDP per capita.

In Table I, we show the first ten least corrupt countries as ranked by Transparency International according to the CPI values obtained in 2006 as well as some other countries. Besides some Western European countries, among the least corrupt ten countries are New Zealand, Singapore, and Australia. Chile and Botswana are the least corrupt countries in South America and Africa, whereas Singapore is the least corrupt Asian country. Table I provides information about corruption levels throughout the World in absolute terms, where each country, whether rich or poor, is given only its CPI value.

In the modern economy, globalization leads to economic competition and comparison between countries, so we compare the corruption levels for different groups of countries in the world. Normalizing the CPI value for year 2006 on the population in each country [12], we find a normalized CPI value for the world to be 3.7, for the countries in Europe we find 5.4, for Asia and Latin America we find 3.3, and for Africa 2.7.

In an earlier study some of us have reported a power-law functional dependence between GDP per capita and CPI for all countries in the world [4]:

$$\mathrm{CPI} \propto (\mathrm{GDP}_{pc})^{\mu} \tag{1}$$

Table 1

Rank of countries (left colomn) by Transparency International for year 2006 with CPI values (right colomn) for each country.

1	Finland, Iceland, New Zealand	**9.6**
4	Denmark	**9.5**
5	Singapore	**9.4**
6	Sweden	**9.2**
7	Switzerland	**9.1**
8	Norway	**8.8**
9	Australia, Netherlands	**8.7**
11	United Kingdom	**8.6**
16	Germany	**8.0**
17	Japan	**7.6**
18	France, Ireland	**7.4**
20	Belgium, Chile, USA	**7.3**
37	Botswana	**5.6**
40	Italy	**5.0**
70	China, India, Mexico, Brazil, Ghana, Egypt, Peru, S.Arabia, Senegal	**3.3**
121	Russia	**2.5**

with scaling exponent $\mu \approx 0.23$ [see Fig. 1]. This functional dependence spans multiple scales of wealth and remains stable over different time periods. The positive value of exponent μ indicates that richer countries are less corrupt. This power-law dependence provides information about the expected level of corruption for a given level of country wealth — e.g., a country above (or below) the fitting line is less (or more) corrupt than expected for its level of wealth. We may say that for a country above the fitting line the level of corruption is less than the expected level for the given country wealth.

This previous finding indicates that in order to compare the corruption level between two countries, countries may be compared not only in terms of absolute CPI values but also in terms of relative country wealth. To that account, we introduce a new measure of relative corruption which we call *Honesty per Dollar* (HpD):

$$\text{HpD} = \log(\text{CPI}) - \mu \log(\text{GDP}_{\text{pc}}) - c, \tag{2}$$

equal to the difference between actual CPI and the value expected from the power-law fitting line.
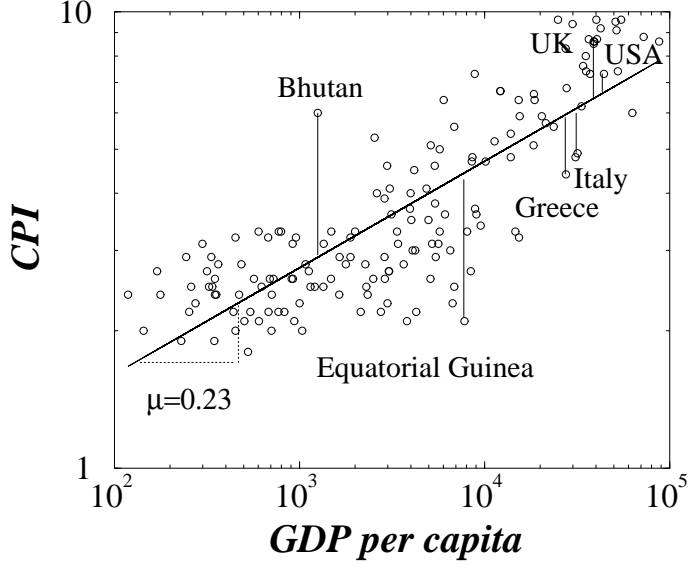
Figure 1: Corruption level measured by Corruption Perceptions Index (CPI) versus country wealth measured by GDP per capita calculated for 2006. We find the functional dependence can be fit by a power law with positive exponent. The power law fit in log-log plot has an obvious statistical explanation, representing the expected level of CPI for a country with given GDP per capita. The countries that are above the line are less corrupt than expected. We define a new index we call Honesty per Dollar (HpD) to measure relative performance of a country when CPI and GDP per capita are simultaneously considered. Besides the USA, UK, Greece, and Italy, we show the countries with the extreme HpD values, Bhutan and Equatorial Guinea (oil exporter).

We assume that all countries, with similar GDP per capita and laying on the power-law fitting line in Fig. 1, have comparable levels of corruption when (HpD = 0). Generally, the larger value for HpD, the better the performance of a country. For 2006 based on regression obtained for the entire world, we calculate the values of the index for some countries: HpD(UK) = 0.29, HpD(USA) = 0.1, HpD(Italy) = −0.23, HpD(Greece) = −0.3. The negative values of HpD indices for Italy and Greece, indicate that these two countries are relatively more corrupt than expected for their corresponding level of wealth (GDP per capita).

One of the reasons for a country to reduce corruption is to attract more foreign investments, and thus to additionally increase the GDP. This is because corruption generally increases start-up costs for new businesses. If investors can choose between two countries with different levels of corruption, they may choose not to start their business in a more corrupt country since the profit in that country will be reduced. In previous study we have analyzed how the corruption level relates to foreign direct investments received by different

countries from the United States [4]. For each continent we have found that the functional dependence between the U.S. direct investments per capita, I, and the corruption levels across countries exhibits scale-invariant behavior characterized by a power law $CPI \sim I^{\lambda}$. Since $\lambda > 0$ for each continent, less corrupt countries have received on average more U.S. investment per capita.
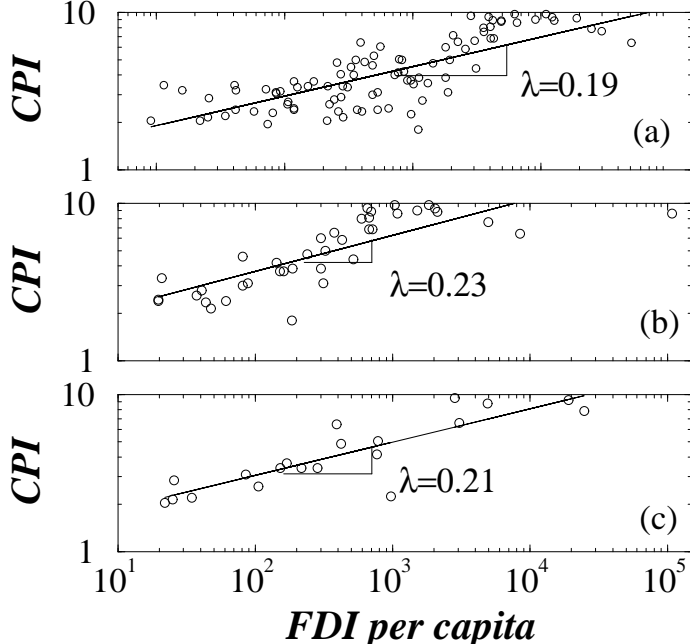

Figure 2: Less corrupt countries receive more foreign investments. For the period 1999-2004, we show average foreign direct investments (FDI) per capita, denoted by I, received by (a) World, (b) European, and (c) Asian countries from all foreign countries versus corruption level measured by CPI. We find the statistically significant power-law dependence between I and CPI, $CPI \sim I^{\lambda}$ with scaling exponents: for the World $\lambda = 0.19$ ($\Delta = 0.016$), Europe $\lambda = 0.23$ ($\Delta = 0.029$), Asia $\lambda = 0.21$ ($\Delta = 0.029$). In brackets we put the standard errors of the exponents. In the study we exclude Indonesia as a country with total negative value for FDI and Cameroon.

Here, for each country in the world we analyze the foreign direct investments (FDI) received from all foreign countries, not only from the US. For each country we sum up the foreign direct investments over the period 1999-2004, and we calculate the average FDI per year per capita. In Fig 2 we show that the functional dependence between the average foreign direct investment per capita, I, and the corruption level measured by CPI exhibits power-law behavior CPI $\sim I^{\lambda}$ with a statistically significant scaling exponent $\lambda = 0.19$ and a standard error $\Delta = 0.016$ [13]. As for the case of the foreign direct investments originating from the US, we find that less corrupt countries on average receive more foreign investments per capita than more corrupt countries. We repeat the whole analysis but this time for different continents. Again we obtain the power-law dependence CPI $\sim I^{\lambda}$ with scaling exponents: for Europe $\lambda = 0.23$ ($\Delta = 0.029$), Asia $\lambda = 0.21$ ($\Delta = 0.029$), Latin America

$\lambda = 0.23$ ($\Delta = 0.085$) and Africa $\lambda = 0.18$ ($\Delta = 0.059$). In the parenthesis we put the standard errors from which we conclude that for each continent the power-law exponent is statistically significant at the 5% level. Note that the scaling exponent we obtain for Europe is larger than the scaling exponent $\lambda = 0.14$ obtained for the US foreign direct investments in Ref. [4].

We investigate the relation between change in CPI and economic growth as measured by growth in the GDP per capita. For the period 1999-2004 and world countries ranked by Transparency International, we run regression fit between the change in the logarithm of the GDP per capita in constant dollars as dependent variable and the change in CPI for this period as the explanatory variable. In Fig. 3(a) we show GDP per capita growth rates versus change in CPI that can be fit by a linear regression with slope $\tau \approx 0.09$. We find that an increase in CPI by one unit leads on average to a 1.7% increase in GDP per capita.

We perform the same analysis for 39 European countries ranked by Transparency International for the period 1999 to 2004 and we obtain statistically insignificant dependence between GDP per capita growth rate and difference of CPI (exponent $\tau = 0.036$ and standard error $\Delta = 0.042$). Then we repeat the same analysis for 21 European developing (transition) countries. In Fig 3(b) for the period 1999-2004 we show the GDP per capita growth rate in constant dollars vs. difference of CPI. We find a functional dependence that can be approximated by a straight line, where the exponent 0.12 (standard error $\Delta = 0.049$) is statistically significant at the 5% level. From the exponent obtained for 5 years period, the increase of CPI by one unit is followed by additional annual increase of GDP per capita of approximately 2.4%. Plot of the GDP per capita growth rate in constant dollars vs. difference in CPI with similar statistically significant exponent 0.11 with error $\Delta = 0.044$, we find by analyzing all new EU members [see Fig. 3(b)].

6
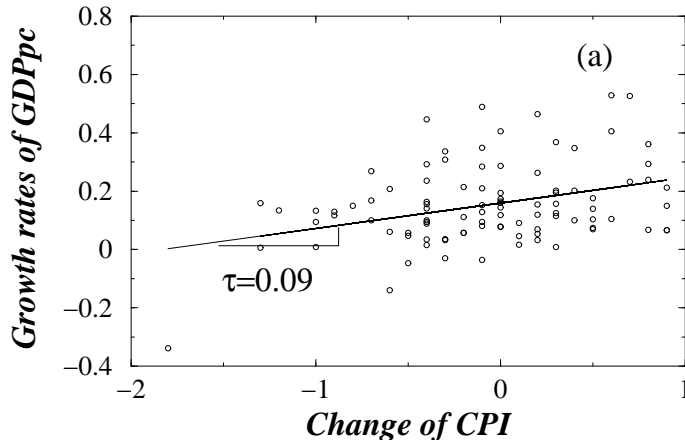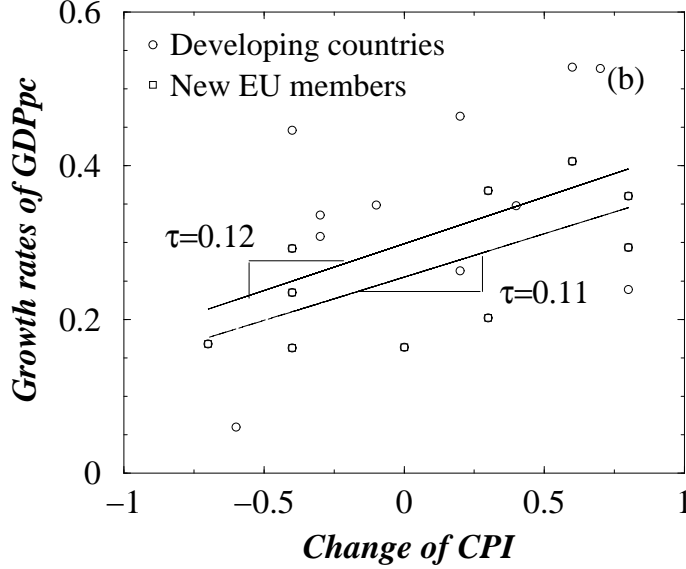
Figure 3 Countries improving more corruption level generates larger GDP per capita growth rate. For the period 1999-2004, we plot growth rate of GDP per capita in constant dollars versus difference of CPI. We analyze (a) World countries except Belgium and Uruguay and (b) 21 European transition countries. For each case we find a functional dependence that can be approximated by a straight line. For case (b) by using linear regression we obtain exponent $\tau = 0.12$ (five years period) with standard error $\Delta = 0.049$. Thus, we find that – on yearly basis — increase of CPI by one is followed on average by increase of GDP per capita equal to $\approx 2.4\%$. Separately, for ten new EU members we obtain that the functional dependence between GDP per capita growth rates and change of CPI can be fit by linear regression with statistically significant exponent $\tau = 0.11$ and standard error $\Delta = 0.044$. Note that if Belgium and Uruguay are included in (a), the estimated exponent in this regression is 0.052 where $\Delta = 0.022$).

In summary, we have observed a statistically significant power-law functional dependence between CPI and foreign direct investment per capita. This power-law dependence spans broad range of scales in foreign direct investment (from hundreds to tens of thousands of dollars). We also find a statistically significant dependence between changes in CPI and GDP per capita growth rate, indicating that reducing the corruption level leads to significant growth in the wealth of country.

References

[1]   J. Svensson, *J. Economic Perspectives* **19**, 19 (2005).

[2]   P. Mauro, *Quarterly J. Economics* **110**, 681 (1995).

[3] V. Tanzi and H. R. Davoodi, *Corruption, Growth, and Public Finance* Working Paper of the International Monetary Fund, Fiscal Affairs Department (2000).

[4] J. Shao, P.Ch. Ivanov, B. Podobnik, and H. E. Stanley, *Eur. Phys. J.* **56**, 157 (2007).

[5] J. G. Lambsdorf, Corruption in Empirical Research - A review, Transparency International Working Paper, (1999).

[6] N. H. Leff, *American Behavioral Scientists* **82**, 337 (1964).

[7] D. Wheeler and A. Mody, *J. International Economics* **33**, 57 (1992).

[8] S. J. Wei, *Rev. Economics & Statistics* **82**, 1 (2000).

[9] The Corruption Perceptions Index (CPI) is published by Transparency International `www.transparency.org`

[10] GDP per capita as current prices in US dollars are provided by the International Monetary Fund, WORLD ECONOMIC OUTLOOK Database, September 2006, `www.imf.org/external/pubs/ft/weo/2006`

[11] Foreign Direct Investments data and GDP per capita as constant prices in US dollars are provided by `www.earthtrends.wri.com`.

[12] Population data are provided by `www.earthtrends.wri.com`.

[13] To test at the 0.05 sugnificance level if exponent λ obtained from the regression line is statistically significant, we use t-ratio (t-value) defined as $t = \lambda/\sigma$, where σ represents the standard deviation of the coefficient λ. If t lies outside the interval $-t_{0.975}$ to $-t_{0.975}$, where $t_{0.975}$ is a critical value, then λ is statistically significant ($\lambda \neq 0$).