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Influence of corruption on economic growth rate and foreign investment

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Abstract. We analyze the dependence of the Gross Domestic Product (GDP) per capita growth rates on changes in the Corruption Perceptions Index (CPI). For the period 1999–2004 for all countries in the world, we find on average that an increase of CPI by one unit leads to an increase of the annual GDP per capita growth rate by 1.7%. By regressing only the European countries with transition economies, we find that an increase of CPI by one unit generates an increase of the annual GDP per capita growth rate 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.

PACS. 89.90.+n Other topics in areas of applied and interdisciplinary physics

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 10^9 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 its GDP [1].

Previous studies have mainly reported a negative association between corruption level and country wealth [2–5], i.e., on average richer countries are less corrupt. There is ongoing debate concerning the relation between corruption and economic growth [6]. Some earlier studies suggest that corruption may even help the most efficient firms bypass bureaucratic obstacles and rigid laws [7], while recent papers do not find a significant negative association between economic growth and the level of corruption [2,3]. The majority of studies have found an insignificant negative association between the corruption level and foreign investments [3,8,9], 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) [10] 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 corruption and 10 denotes the lowest. For GDP per capita we use annual nominal GDP per capita in current prices in US dollars [11], and GDP per capita in constant dollars [12].

The CPI 2006 index is defined based on data gathered from 12 sources originating from 9 independent institutions. All sources measure the overall extent of corruption, where evaluation of the extent of corruption in different countries is done by experts, residents and non-residents. The ranks, and not the scores of countries, are the only information provided from each source. The CPI 2006 combines assessments for the past two years only. Each of the sources uses its own evaluation system, and for that reason the data are standardized before a single mean value for the CPI is determined for each country. This standardization is carried out in two steps, using two statistical methods: matching percentiles and beta-transformation [10].

Table 1 shows the first ten least corrupt countries as ranked by Transparency International according to the

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Table 1. Rank of countries (left column) by Transparency International for year 2006 with CPI values (right column) 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, Senegal Ghana, Egypt, Peru, S.Arabia,	**3.3**
121	Russia	**2.5**

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 1 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 [13], 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.

An earlier study reported a power-law functional dependence between GDP per capita, GDP_{pc}, and CPI for all countries [5]:

$$CPI = N\ (GDP_{pc})^{\mu} \tag{1}$$

with scaling exponent $\mu \approx 0.23$ (see Fig. 1), and constant $N = 0.548$. 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 [5].

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 this

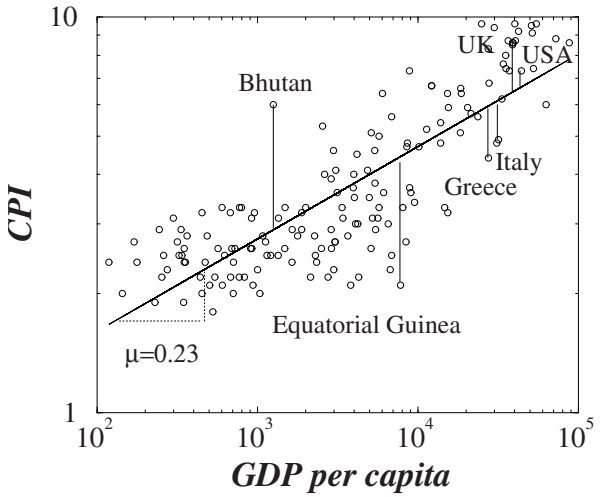

Fig. 1. Corruption level measured by Corruption Perceptions Index (CPI) versus country wealth measured by GDP per capita calculated for 2006 (in US dollars). We find the functional dependence can be fit by a power law 0.56 $(GDP_{pc})^{0.23}$ with positive exponent. The power law fit in log-log plot represents 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, Honesty per Dollar (H_{pd}) 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 H_{pd} values, Bhutan and Equatorial Guinea (oil exporter).

end, we introduce a new measure of relative corruption which we call *Honesty per Dollar* (H_{pd}):

$$H_{pd} = \ln(CPI) - \mu \ln(GDP_{pc}) - \ln N, \tag{2}$$

equal to the difference between the actual CPI value and the value of CPI expected from the power-law fitting line (Fig. 1), where N is defined in equation (1).

We assume that all countries, with similar GDP per capita and falling on the power-law fitting line in Figure 1, have comparable levels of corruption when ($H_{pd} = 0$). Generally, the larger the value for H_{pd}, the better the performance of a country. For 2006 based on regression of the data for the entire world, we can calculate the values of the H_{pd} index for individual countries: $H_{pd}(UK) = 0.29$, $H_{pd}(USA) = 0.1$, $H_{pd}(Italy) = -0.23$, $H_{pd}(Greece) = -0.3$. The negative values of H_{pd} index 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 its 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 the previous study we have analyzed how the corruption level relates to foreign

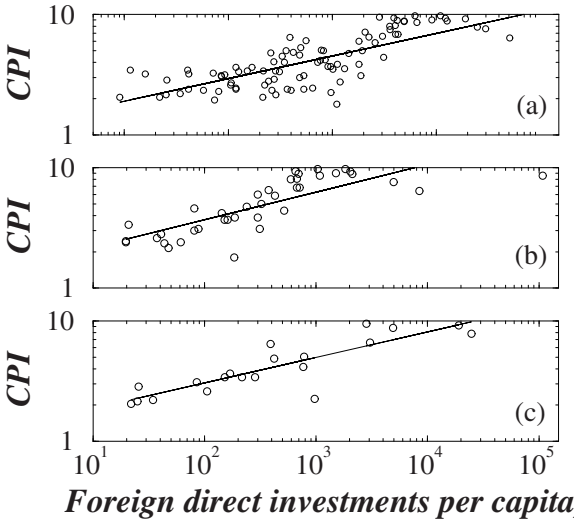

Fig. 2. Less corrupt countries receive more foreign investments. For the period 1999-2004, we show average foreign direct investments (FDI) per capita (in U.S. dollars) originating from all foreign countries, denoted by I, received by (a) World, (b) European, and (c) Asian countries versus corruption level measured by CPI. We find a 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 the paranthesis we show the standard errors of the exponents. In the study we exclude Indonesia and Cameroon as countries with total negative value for FDI.

direct investments received by different countries from the United States [5]. For each continent we have found that the functional dependence between the US direct investments per capita, I, and the corruption levels across countries exhibits scale-invariant behavior characterized by a power law

$$CPI \sim I^{\lambda}. \quad (3)$$

Since $\lambda > 0$ for each continent, less corrupt countries have received on average more US investment per capita.

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 Figure 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 $\Delta = 0.016$ [14]. As for the case of the foreign direct investments originating from the US only [5], we find that less corrupt countries on average receive more foreign investments per capita than more corrupt countries.

We next repeat our analysis for different continents. Again we obtain a power-law dependence $CPI \sim I^{\lambda}$ with scaling exponents for Europe $\lambda = 0.23$ ($\Delta = 0.029$), for Asia $\lambda = 0.21$ ($\Delta = 0.029$), for Latin America $\lambda = 0.23$ ($\Delta = 0.085$) and for Africa $\lambda = 0.18$ ($\Delta = 0.059$).

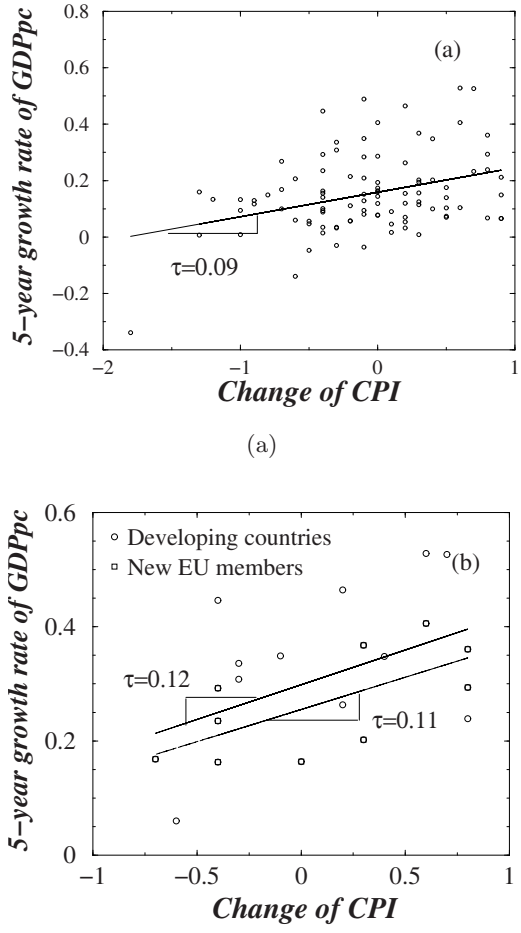

Fig. 3. Countries improving more corruption level generates larger GDP per capita growth rate. For the period 1999–2004, we plot growth rate of GDP per capita in constant dollars, defined as $\ln(GDP_{pc}(2004)) - \ln(GDP_{pc}(1999))$ versus difference of CPI. We analyze (a) world countries (except Belgium 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 (a), by using linear regression we obtain exponent $\tau = 0.09$ (five year period) with standard error $\Delta = 0.024$. For case (b), we obtain exponent $\tau = 0.12$ (five years period) with $\Delta = 0.049$. Thus, for (b) we find that — on yearly basis — increase of CPI by one is followed on average by increase of GDP per capita growth rate equal to ≈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 (outliers) are included in (a), the estimated exponent in this regression is 0.052, where $\Delta = 0.022$.

The parameters obtained for each continent are statistically significant at the 5% level. Note that the scaling exponent $\lambda = 0.23$ we obtain for Europe when considering investments from all foreign countries is larger than the scaling exponent $\lambda = 0.14$ obtained for Europe when considering foreign investments only from the US reported in Ref. [5].

Finally, we investigate the relation between change in CPI and economic growth as measured by growth in the GDP per capita, defined as $\ln(GDP_{pc}(t)) - \ln(GDP_{pc}(t'))$, where t and t' are two different years. For the period 1999–2004 and countries ranked by Transparency International, we run regression fit between the growth rate of the GDP per capita in constant dollars as dependent variable and the change in CPI for this period as the explanatory variable. In Figure 3a we show GDP per capita growth rates versus change in CPI that can be fit by a linear regression with a 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 growth rate.

We perform the same analysis for 39 European countries ranked by Transparency International for the period 1999–2004 and we obtain a statistically *insignificant* dependence of GDP per capita growth rate on changes in CPI (exponent $\tau = 0.036$ and standard error $\Delta = 0.042$). Then we repeat the same analysis for 21 European countries with transition economies. In Figure 3b for the period 1999–2004 we show the GDP per capita growth rate in constant dollars versus change in CPI. We find a functional dependence that can be approximated by a straight line, where the slope 0.12 (standard error $\Delta = 0.049$) is statistically significant at the 5% level. This result shows that an increase of CPI by one unit is followed by additional annual increase of GDP per capita growth rate of approximately 2.4%. For all EU members, we find that the GDP per capita growth rate in constant dollars versus change of CPI is characterized by a similar statistically significant exponent $\tau = 0.11$ with error $\Delta = 0.044$ (see Fig. 3b).

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 a 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, consistent with the interesting possibility that reducing the corruption level leads to significant growth in the wealth of country.

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12. Foreign Direct Investments data and GDP per capita as constant prices in US dollars are provided by `www.earthtrends.wri.com`
13. Population data are provided by `www.earthtrends.wri.com`
14. To test at the 0.05 significance 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 ($\lambda \neq 0$)