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*Corruption as a form of extreme individualism: An economic explanation based on geography and climate conditions*

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# Corruption as a form of extreme individualism:

# An economic explanation based on geography and climate conditions

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**Abstract**

We present a simple model explaining corruption on geography and climate conditions. We test the model's validity in a cross-section of 115 countries. Controlling for all other corruption's determinants we find evidence supporting the model's predictions. Corruption increases with temperature and declines with precipitation and non-cultivatable land. Corruption also declines with per capita GDP, democracy, median age and British colonial heritage; and increases with natural resources, bureaucracy and communist past. Finally, corruption declines with the ratio of internet users to total population. This new finding is interpreted as capturing the beneficial interaction of economic development, human capital/education and independent news.

**Keywords:** individualism; fairness; corruption; geography and climate conditions

**JEL codes:** D73, H11.

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## 1.  INTRODUCTION

Recent years have seen a surge of economic research on corruption. Interest on this topic is well-justified, as corruption is thought to cause significant economic and social costs including lower income levels and growth, higher income inequality and increased distortions in the economy's public and private sector.[1] The costs of corruption are one of two branches in this fast-expanding literature. The second, on which this paper focuses, is corruption's causes. Previous research, reviewed in section 2 below, conditions corruption on a variety of economic, political and social/cultural variables. One variable which is conspicuously absent is geographical and climate conditions (GCCs).[2] This omission is rather surprising given that GCCs are fundamental exogenous factors affecting all human activities and have been used to explain other important economic variables such as economic growth (see e.g. Mauro 1995, Sachs 2001 and Dell et al, 2009).

This paper offers a new, rational economic explanation of corruption based on GCCs. Our analysis relies on a central assumption going back to Adam Smith's (1759) *Theory of Moral Sentiments* supported by significant volume of modern experimental evidence (see Camerer and Fehr, 2006). This is that people subscribe to generally accepted norms of fairness, classify the actions of others on a generally accepted fairness scale, and are prepared to extend altruistic rewards/punishments to those abiding/not-abiding to the commonly-accepted fairness norms. Furthermore, fairness norms do not differ significantly across societies, as suggested by world-wide

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[1] The main channels through which corruption is associated with these negative outcomes include misallocation of public funds; public investment of lower quality/productivity; inefficient regulation, lower volumes of private investment, foreign direct investment and international trade; increased cost of servicing public debt; reduced valuation of equities, sub-optimal formation of human capital; increased shadow economy, tax avoidance and a tax system placing disproportionately high weights on indirect taxes and seignorage revenue. For a detailed survey see Lambsdorff, (2006).

[2] Geography is occasionally mentioned as a determinant of corruption on the basis of natural resources availability, proximity to major trading centres and corruption among neighbouring countries. As explained below, however, these factors are essentially economic determinants of corruption; they do not explain corruption on the effects of geography in human behaviour per se.

repetitions of experiments such as the "ultimatum" game and evidence of considerable agreement across cultures with respect to what constitutes corrupt behaviour (see Camerer and Fehr, 2006, Azfar et al, 2001).

In our analysis corruption is defined as an extreme form of individualism, which is in turn defined as actions of self-rewarding agents aiming exclusively towards improvement of their own personal welfare. We consider individualism to constitute acceptable social behaviour as long as self-improvement is pursued through means complying with the generally accepted fairness norms. We assume that compliance with the fairness norms requires a minimum of civic engagement, reflected in the share of one's personal resources dedicated to the pursuit of wholly or partially collective rather than exclusively self-rewarding objectives. As a result, in our analysis the generally accepted scale of fairness coincides with a scale of individualism measuring the share of one's resources dedicated to pursuing strictly self-rewarding objectives. This renders corruption, defined as actions not complying with the common fairness norms, a form of extreme individualism, i.e. a state where the share of one's personal resources dedicated to strictly self-rewarding actions exceeds a critical threshold up to which individualism is regarded to be legitimate. With heterogeneous agents, each person's degree of individualism is a random variable following a certain (e.g. normal) probability distribution. Given people's inherent sense of fairness, we assume that this distribution's mean ($\mu$) is always below corruption's threshold ($k$), i.e. the representative agent acts fairly in all societies (see Figure 1). The average level of individualism, however, may vary across societies. All else equal, a society with a relatively high average level of individualism ($\mu_I$) will exhibit a higher frequency of extreme individualism, i.e. more observations in the range of corruption, compared to a co-operative society presenting a relatively low average value of individualism ($\mu_C$, see

Figure 2). In that case, the factors explaining the frequency of extreme observations, reflecting the aggregate level of corruption, will be the same factors determining the mean of the distribution of individualism.

This brings us to the central point of our paper: We argue that the average level of individualism, and hence the aggregate level of corruption, are determined by rational incentives created by an exogenous fundamental factor, namely GCCs. To show this, we use a simple model of utility maximization where the representative agent derives utility from consumption and leisure. Output, which in our model equals consumption, is determined by labour effort and labour productivity. The representative agent operates under a survival constraint imposing a minimum, for survival, level of consumption. To meet this constraint the agent can either work individually or in co-operation with another agent. The productivity of individual labour is exogenously determined by stochastic GCCs. In making her choice, the agent faces a trade-off. Co-operative work increases labour productivity beyond the level determined by GCCs due to positive synergies. From that point of view, the agent has an incentive to work co-operatively. On the other hand, the disutility of co-operative labour is higher than that of individual labour, due to co-ordination costs present in joint work. From that point of view, the agent has an incentive to work individually. As favourable GCCs increase the productivity of individual labour, the latter can meet the survival constraint easier under favourable rather than unfavourable GCCs. Therefore, more favourable GCCs provide incentives for more individual work, resulting in a higher level of average individualism and higher aggregate corruption. To the best of our knowledge our paper is the first in the economic literature to use GCCs as a structural determinant of corruption. The insight, on which it is based, however, is not new. Indeed, the link between

individualism and GCCs exists in the very first piece of written history, the works of Herodotus.[3]

Our explanation of corruption seems, at first sight, more relevant to ancient-rural rather than modern-industrial economies. Is it possible that corruption is such a long-memory process for its level in the very old past to bear a present-day legacy? The answer is, possibly yes. Experimental evidence discussed by Camerer and Fehr (2006) suggests that as the ratio of excessively individualistic agents to total population increases, the ability of fair agents to impose outcomes consistent with the generally accepted fairness norms declines, inducing them to adopt non-fair behaviour. Therefore, a critical mass of excessively individualistic agents may have an amplifying effect on corruption as it increases the average value of observed individualism beyond the level consistent with the preferences of the representative agent. Thus, GCCs may have determined in the very long past an initial equilibrium of high corruption from which

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[3] Writing in the fifth century B.C., in Book Two of his *Histories* (Euterpe), Herodotus, comparing ancient Egypt with ancient Greece mentions: "When the Egyptians…who live in the Delta [of the Nile]…found out that the whole of Greece relies on rainfall rather than its rivers, as Egypt does, to irrigate the land, they commented that the Greeks would one day have their high hopes dashed and would suffer the torments of *starvation*. What they were getting at was that if the God decides not to rain and maintains a state of drought instead, the Greeks will die of hunger, because Zeus is their only source of water…At the moment, of course, they [the Egyptians living in Delta of the Nile] gather their crops with *less effort* than anyone else in the world, including the rest of Egypt. They do not work at breaking the land up into furrows with a plough, they do not have to wield hoes or carry out any of the other crop-farming tasks which everyone else does. Instead, the river rises of its own accord and irrigates the fields, and when the water has receded again, *each of them* sows seed *in his own field* and sends pigs into it to tread the seed down. Once this has been done, he only has to wait for the harvest-time, and then he has his pigs thresh the grain. And that is how he brings in his crops". He continues: "I was particularly eager to find out why the Nile starts coming down in a flood at the summer solstice…but remains low for the whole winter…My desire to know about these matters led me to make enquiries". He proceeds to discuss three theories regarding the flow of the Nile advocated by Greek thinkers of the time, all of which were based on climate conditions. Having dismissed all three as implausible, he offers his own explanation also based on climate conditions involving the position of sun, rain, moisture and winds. To summarize, Herodotus describes what a modern economist would view as different steady-state allocations, with differences between ancient Greece and Egypt defined in terms of starvation and labour effort (concepts that relate directly to the arguments of a modern utility function, i.e. consumption and leisure respectively) as well as individualism, with Herodotus indicating that production in Egypt is organised on more individualistic lines than in Greece. Notice that the precise choice of words in the ancient Greek text for the phrase "*each of them...in his own field*" (ἕκαστος τὴν ἑωυτοῦ ἄρουραν) is such as to emphasise the element of individuality involved in the activities described. Herodotus finds these differences important enough to merit detailed inquiries, after which he comes up with explanations based on climate conditions. What he argues, in effect, is that favourable GCCs increase land productivity causing a more individualistic structure of production in Egypt relative to Greece. Therefore, Herodotus was the first to imply that geography and climate are structural variables explaining individualism and, by extension, corruption.

society cannot depart without developing credible/effective mechanisms of imposing fair behaviour. The more a society remains in this initial equilibrium the more difficult it becomes to develop such mechanisms, as culture adapts to corruption's presence and the costs for individuals willing to adopt fair behaviour increases. Corruption may then display very long-run memory. Exactly how long is an empirical question. If GCCs are statistically significant in explaining corruption after all other possible determinants are included in the analysis, then the answer is very long indeed.

This is precisely the empirical approach followed in this paper. We test the link between corruption and GGCs using data from a cross-section of 115 countries. Following the majority of existing studies, we measure corruption using the Corruption Perception Index published by Transparency International (TI-CPI) and, for robustness, the Control of Corruption Index compiled by the World Bank (WB-CCI). Controlling for all other possible determinants of corruption suggested in the literature, we find that corruption is indeed endogenous to GCCs. In particular, corruption increases with temperature and declines with precipitation and the ratio of non-cultivatable land to total area. We also find that corruption declines with per capita GDP and genuine, as opposed to "half-hearted", democracy, and median age; and increases with natural resources and bureaucracy/regulation. British colonial heritage reduces corruption whereas a communist past increases it. Finally, we find that corruption declines with the ratio of internet users to a country's population. This new finding, not reported in previous literature, is intuitively plausible as it is interpreted to capture the beneficial interaction of economic development, education and independent news/information.

The remainder of this paper is structured as follows. Section 2 reviews the literature on the causes of corruption. Section 3 presents a simple theoretical model

explaining corruption on GCCs. Section 4 presents our empirical analysis. Finally, section 5 summarises and offers concluding remarks.


## 2.  THE CAUSES OF CORRUPTION: A BRIEF REVIEW

Research on the causes of corruption is inter-disciplinary with economics, politics and sociology all making significant contributions. Before reviewing them, two generic issues relating to their empirical testing must be noted. The first is the scarcity of data on actual levels of corruption. As a result, most empirical studies are based on indexes of perceived corruption, compiled using surveys of residents' and foreign experts' subjective assessments. Unavoidably this raises a question of measurement errors. Reassuringly, however, indexes compiled by different organisations are highly correlated, as are those using the views of local and foreign residents. This increases the credibility of perception indexes as valid approximations of actual corruption.

The second issue refers to endogeneity. Many causes of corruption are themselves caused by corruption and are highly correlated between them. Theoretically, this problem can be addressed using valid instruments. In practise, however, it is almost impossible to find variables correlated with corruption's determinants but not correlated with corruption or among them. As a result, modelling corruption on variables potentially determined by corruption carries the risk of endogeneity bias. On the other hand, excluding such variables could result in omitted variables' bias. With the literature's emphasis being on qualitative rather than quantitative inference, the former is generally regarded as a risk preferable to the latter; in which case positive findings are regarded as more robust than negative ones (see Treisman, 2000).

## 2.1. Economic determinants of corruption

Economic determinants of corruption fall into two categories: economic development and rent-seeking opportunities available to government officials. Starting with the former, the link between economic development and corruption is clearly a two-way one as corruption is unambiguously regarded to be detrimental to growth (see Mauro, 1995). But income levels also affects corruption, as richer countries can afford good-quality institutions; higher officials' wages tilting their cost-benefit analysis against corruption; and a better education system reducing tolerance against corruption (see Treisman, 2000 and Acemoglu and Verdier, 2000). Empirical studies have consistently shown per-capita GDP to be the variable most strongly associated with corruption. As such, it is the control variable against which all other possible causes of corruption are typically tested.

Rent-seeking opportunities are linked to corruption through a number of channels. The first is *government intervention* in economic life. Empirical evidence, however, on this link's strength is rather mixed. La Palompara (1994) and Gerring and Thacker (2005) do not find a significant association while Elliot (1997), Treisman (2000) and Montinola and Jackman (2002) do so.[4] The evidence is more robust on the role of *regulation, bureaucracy* and *competition*. Broadman and Recanatini (1999), Djankov et al (2002) and Svensson (2005) find that excessive regulation placing barriers to market entry lead to higher corruption, while Gerring and Thacker (2005) find that good-quality regulation is associated with lower corruption. Goldsmith (1999) and Paldam (2002) emphasise openness in public procurements, arguing that higher competition drives prices down reducing the scope for rent-seeking behaviour. Ades and Di Tella (1997, 1999) support this view, also finding that economic openness has a

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[4] An argument reconciling these conflicting findings has been provided by La Porta et al (1999) who have argued that particular government sector activities (e.g. redistributive activities) may be more vulnerable to corruption than others (e.g. education).

negative effect on corruption. Treisman (2000) present similar findings, corroborated by Sachs and Werner (1995), Leite and Weidmann (1999) and Wei (2000).[5] Finally, corruption is linked to the availability of natural resources, whose profitable exploitation creates rent-seeking opportunities (see Leite and Weidmann (1999), Ades and Di Tella (1999), Gylfason (2001) and Montinola and Jackman (2002)).

## 2.1. Political determinants of corruption

Political determinants of corruption can broadly be classified in three categories: exposure to democracy; constitutional arrangements; and colonial/legal heritage. *Democracy* is thought to reduce corruption by protecting individuals from officials' abuses and club-practices. Furthermore, as elections promote competition for political mandates, democracy increases corruption's price for politicians and their appointees. A similar argument is provided by Brunetti and Weder (2003) who suggest that by increasing scrutiny on individuals in positions of power, free access to independent news reduces corruption. Empirical studies including Chowdhury (2004) and Bohara et al (2004)) find exposure to democracy to be negatively associated with corruption. On the other hand, Goldsmith (1999), Treisman (2000), Paldam (2001) and Persson et al (2003) find that once other variables are controlled for, this relation breaks down. Treisman (2000) and Gerring and Thacker (2004, 2005) find that rather than current exposure to democracy, corruption is explained by democratic tradition. Reconciling the above, Montinola and Jackman (2002) argue that moderate levels of democracy do not reduce corruption, they may even increase it; but when a critical threshold of democratic freedoms is reached, corruption indeed declines. Sung (2004) supports this view: He

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[5] Wei (2000) divides openness into a natural component, determined by population and remoteness from world's financial centres, and a residual component, explained by policy regime and trade policy. He finds that corruption declines with natural openness but does not depend on residual openness. Similar findings are reported by Ades and Di Tella (1999).

finds the best empirical specification for the relationship between corruption and democracy to be non-linear, with measures of democracy entering in the third power.

Constitutional determinants of corruption include parliament's power versus the executive, decentralisation/federalism, and electoral laws/voting systems. Panizza (2001), Lederman et al (2001) and Gerring and Thacker (2004) suggest that by limiting the executive's scope for rent-seeking behaviour, powerful parliaments reduce corruption. The link between corruption and *decentralisation* is disputed. Fisman and Gatti (2002) argue that by facilitating the monitoring of politicians at the local level, decentralisation reduces corruption. They also report positive correlation between corruption and a country's population, which they interpret as further evidence that smaller units of government reduce corruption (see also Damania et al, 2004). The alternative view is that local governments are weaker and therefore more corruption-prone than central ones. This is particularly relevant for countries where the federal structure reflects ethnological/linguistic fragmentation leading to multiple affiliations and mixed loyalties. Furthermore, ethnically divided societies tend to under-provide public goods, causing increased incentives for corruption (see, Mauro 1995 and Alesina et al, 2003). All in all, empirical evidence on the link between decentralisation and corruption is mixed, with results largely determined by sample selection and decentralisation's measurement.

A similar ambiguity applies to the role of *electoral laws and voting system*s. Persson et al (2003) argue that smaller voting districts increase corruption by restricting entry to new candidates and reducing political competition. They also find that corruption is higher in countries whose parliaments are elected from set party-lists rather than individually-elected candidates. As the second effect is found to be stronger than the first, their analysis implies that voting systems with proportional representation,

even in large districts, result into higher corruption than systems based on majority rule. Further support to this conclusion is provided by Kunicova and Rose-Ackerman (2005). By contrast Panizza (2001) suggests that the effect of electoral laws is particular to each country, depending on the extent to which controls on political parties are undermined by excessive influence of individual politicians.

Finally, corruption has been linked to the legal heritage of a country's colonial past. Glaeser and Shleifer (2002) argue that legal systems based on British-based common law are better-equipped to tackle corruption than those based on code law for three reasons. First, common law is historically rooted to the British aristocracy's effort to protect their property rights against abuses on behalf of the Crown. As such, it offers better protection to individuals against officials' coercion and power abuse. Second, common law systems provide the judiciary with higher independence, which reduces corruption (see La Porta et al, 1999). This is in contrast with other legal traditions, such as communist ones, where lack of judicial independence promotes corruption (see Gerring and Thacker, 2005). Finally, by emphasising the procedural aspects of applying the law, the British law system enhances the ability of subordinates and judges to challenge judicial hierarchies and politicians. Among others, Treisman (2000) and Swamy et al (2001) provides empirical evidence that ex-British colonies present lower corruption than colonies of other countries or countries that have never been colonised.

## 3.1. Social and cultural determinants of corruption

The third set of corruption's determinants refers to social and cultural factors, the main of which are trust, values, religion, acceptance of hierarchies and gender. *Trust* among society's members reduces corruption by allowing bureaucrats to co-operate better with each other and private citizens. Evidence supporting this hypothesis has been

provided by La Porta et al (1997), Adsera et al (2000), Uslaner (2004) and Bjornskov and Paldam (2004).[6] *Values* affect corruption through multiple channels. Husted (1999) provides evidence suggesting that corruption increases with the extent to which the quest for material success dominates over concerns for quality of life; and the extent to which society members feel threatened by uncertainty. Sandholtz and Taagepera (2005) emphasize the role of "traditionalism": They find societies cultivating values of secular-rational-impersonal attitudes to be less corrupt than societies dominated by traditional, religious and family values. Similar findings are reported by Lipset and Lenz (2000) who construct a scale of "familism" and find it to be significant in explaining corruption, even after controlling for per capita income.

*Religion* features in many studies modelling corruption, as it is considered important for the creation or prevention of hierarchical structures that restrict civic engagement and promote corruption (see Treisman, 2000). In particular, with protestant creeds being less hierarchical and more independent from the state, protestant societies are often assumed to be less tolerant to corruption. Authors, including La Porta et al (1997, 1999), Treisman (2000), Lipset and Lenz (2000), Gerring and Thacker (2005) and Paldam (2001) provide empirical evidence supporting this view. The detrimental effects of hierarchy have also been studied by Husted (1999) in a non-religious context. He models corruption on a variable defined as "power distance" measuring the extent to which the less powerful members of institutions and organisations expect and accept that power is distributed unequally. He finds this variable to be statistically significant in explaining corruption, and robust to the inclusion of other variables.

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[6] Anderson and Tverdova (2003) focus on another type of trust, namely the one among corruption partners. They argue that this is critical for corruption's persistence, as corrupt deals cannot be legally enforced. Corruption is indeed found to be higher in countries where partners are confident that corruption deals will be honoured and favours will be reciprocated. Lambsdorff (2002) supports this view. An interesting insight drawn from this research is that to fight corruption effectively it is important to destroy trust among corruption's partners.

Finally, another suggested determinant of corruption is gender, with females assumed to be less prone to corruption. Swamy et al (2001), Dollar et al (2001) and Sung and Chu (2003) provide evidence showing that increased female participation in labour force and parliament is associated with lower corruption. This finding, however, is subject to the critique of reverse causality, as low levels of corruption may place restrictions in male-dominated networks, resulting in higher participation of females. Furthermore, female participation in the labour market or political competition may be a proxy for other variables, such as democracy and the rule of law, protecting women's rights and promoting meritocracy.

## 3. A SIMPLE MODEL OF INDIVIDUALISM AND CORRUPTION BASED ON GEOGRAPHY AND CLIMATE CONDITIONS

Consider an economy of identical agents deriving utility from consuming a composite good and disutility from labour effort, which is the only production factor. The representative agent's utility function is given by:

$$U = \ln C - \kappa \ell \tag{1}$$

where $C$ denotes consumption, $\ell$ hours worked and $\kappa > 0$.

Assume that the composite good can be produced in two ways, either by individual or co-operative labour. Total labour effort is the sum of the two:

$$\ell = \ell_1 + \ell_2 \tag{2}$$

where the subscripts 1 and 2 respectively refer to individual and co-operative variables. Assume now that the disutility of labour is not homogeneous across types of labour. Co-operative labour involves a co-ordination cost which, all else equal, reduces leisure and welfare. In that case, the agent's utility function becomes:

$$U = \ln C - \kappa_1 \ell_1 - \kappa_2 \ell_2 \tag{3}$$

where $\kappa_2 \succ \kappa_1$

Co-operative labour is more productive than individual labour due to synergies accruing from co-operation. This results in separate individual and co-operative production functions, respectively described by (4) and (5) below:

$$Y_1 = A_1 \, \ell_1^a \tag{4}$$

$$Y_2 = A_2 \, \ell_2^a \tag{5}$$

In equations (4) and (5) $0<a<1$, implying declining marginal product of labour, and $A_1$ and $A_2$ are exogenous productivity parameters with $A_2 > A_1 > 0$.

Assuming that all output is consumed, the sum of an agent's individual and co-operative production equals the agent's total consumption, i.e.

$$C = Y_1 + Y_2 = A_1 \, \ell_1^a + A_2 \, \ell_2^a \tag{6}$$

Replacing equation (6) in (3) the representative agent's utility function becomes:

$$U = \ln (A_1 \, \ell_1^a + A_2 \, \ell_2^a) \, - \kappa_1 \, \ell_1 - \kappa_2 \, \ell_2 \tag{7}$$

Finally, assume that the representative agent operates under a survival constraint imposing a minimum level of consumption $M$:

$$C = Y_1 + Y_2 = A_1 \, \ell_1^a + A_2 \, \ell_2^a \geq M \tag{8}$$

The agent maximizes the utility function given by equation (7) with respect to $\ell_1$ and $\ell_2$ subject to the survival constraint given in equation (8). Taking first order conditions and solving the resulting system of equations yields the following ratio of individual to co-operative labour:

$$R = \frac{\ell_1}{\ell_2} = \left( \frac{\kappa_1 A_2}{\kappa_2 A_1} \right)^{\left[ \frac{1}{a-1} \right]} \tag{9}$$

From equation (9) we obtain $\frac{\partial R}{\partial A_1} \succ 0$, $\frac{\partial R}{\partial \kappa_2} \succ 0$, $\frac{\partial R}{\partial A_2} \prec 0$ and $\frac{\partial R}{\partial \kappa_2} \prec 0$, i.e. the ratio of

individual to co-operative labour ($R$) increases with the productivity of individual labour

($A_1$) and disutility of co-operative labour ($\kappa_2$); and declines with the productivity of co-

operative labour ($A_2$) and disutility of individual labour ($\kappa_1$).[7], [8]

Equation (9) provides a measure of individualism consistent with our definition

in the introduction section, i.e. share of personal resources dedicated to pursuing

exclusively self-rewarding objectives. Assume now that the productivity of individual

labour $A_1$ is determined by exogenous GCCs. Agents working under favourable GCCs,

implying a high value for $A_1$, will display a relatively high level of individualism, as

high-productivity individual work can meet easier the survival constraint allowing a

larger amount of leisure.[9] By contrast, agents working under unfavourable GCCs,

implying a low value for $A_1$, will have strong incentives to use the synergies present in

co-operative labour to meet the survival constraint. Overall, equation (9) suggests that

the more favourable a country's GCCs are, the higher is the level of the representative

agent's individualism. Introducing stochastic heterogeneity across agents gives rise to a

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[7] It is also easy to show that individual and co-operative labour both increase with the amount of minimum consumption $M$.

[8] These results continue to hold if $A_2$ becomes endogenous to $A_1$ under the plausible assumption that shocks to individual labour productivity have incomplete pass-through to co-operative labour productivity. To show this, assume the former having a mark-up over the latter given by $A_2 = A_1[1 + f(A_1)]$ where $f(A_1) \geq 0$ (i.e. negative synergies cannot occur). Replacing this formula in (9) we obtain:

$$R = \frac{\ell_1}{\ell_2} = \left[ \left( \frac{\kappa_1}{\kappa_2} \right)(1 + f(A_1)) \right]^{\left[ \frac{1}{a-1} \right]}$$

Differentiating with respect to $A_1$ we can easily show that as long as the mark-up of co-operative over individual labour declines with increases in individual productivity, positive shocks in the latter give rise to a higher value for the ratio of individual to co-operative work. In short, if $(df / dA_1) \prec 0$ then $(\partial R / \partial A_1) \succ 0$.

[9] This assumption is intuitively plausible, as any given amount of individual labour would be expected to yield a higher level of output under abundant fertile land and temperate climate (e.g. ancient Mediterranean) rather than sparse cultivatable land and extreme weather conditions (e.g. ancient Scandinavia). If that is so we might view, at least up to a certain extent, the North-to-South immigration waves occurring in ancient Europe as an "arbitrage" phenomenon, with Northern Europeans moving from GCCs of low marginal labour productivity to GCCs of higher marginal labour productivity in the South.

certain (e.g. normal) distribution of individualism whose mean equals the representative

agent's score (Figure 1). In that case, if corruption is defined as extreme individualism,

going beyond a universally accepted critical threshold of legitimate individualism, the

aggregate level of corruption will be given by the frequency of observations falling

beyond corruption's critical threshold (Figure 1). Therefore, more favourable GCCs

causing a higher average level of individualism will also cause a higher level of

corruption (Figure 2). We proceed to test this hypothesis in section 4 below.


## 4. EMPIRICAL ANALYSIS

### 4.1. Data

We use data from a cross-section of 115 countries listed in Table A1 in the

Appendix.[10] We measure corruption using the three-year average of the Corruption

Perception Index published by Transparency International (TI-CPI) for years 2007,

2008 and 2009 and the Control of Corruption Index published by the World Bank (WB-

CCI) for years 2006, 2007 and 2008. Using averages has the advantage of mitigating the

effects of random measurement errors particular to specific years. We explain

corruption on four sets of variables, namely GCCs, and the three variables suggested by

previous literature as possible determinants of corruption, i.e. economic, political and

social/cultural variables. An important characteristic relating to GCCs is that the issue

of endogeneity does not arise: Although GCCs variables may be endogenous to each

other, as a group they are clearly exogenous to every other possible determinant of

corruption. In other words, if any endogeneity exists, causation is clearly running from

the set of GCCs to other variables. Endogeneity may exist among some of the remaining

determinants of corruption. However, as discussed in section 2, with the possible

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[10] With the exception of South Africa, we exclude all sub-Saharan African countries. We do so to ensure
that the particularly unfavourable economic/political circumstances prevailing in many of those countries
(see Sachs, 2001) do not bias our findings in favour of a significant effect of GCCs on corruption.

exception of GDP it is impossible to find valid instruments approximating the affected variables. Therefore, the findings reported below are better seen in the light of Treisman's (2000) remarks suggesting that positive empirical findings are more robust than negative ones.

The full data definitions and sources are reported in Table A2 in the Appendix. We measure climate conditions using average daily sunlight hours, annual average temperature in Celsius degrees, average volume of daily precipitation, annual average number of wet days and average number of days with temperature below freezing point (zero Celsius degrees).[11] Geographical conditions are approximated using total length of coastline (kilometres), maximum elevation point (metres), total country area (squared kilometres), percentage of inland water bodies (rivers, lakes, etc.) in total country area and percentage of non-cultivatable land in total country area. Economic variables include level of per capita (PPP-adjusted) GDP measured in 2007 US Dollars, the ratio of government spending to GDP, economic openness, the Ease of Doing Business Index published by doingbusiness.org as a proxy for bureaucracy/regulation; and natural resources' availability, approximated by volume of proven oil and natural gas reserves. Education spending, used as a proxy for human capital, is calculated as percent in GDP. Political variables include the Political Rights Index published by the Freedom House, as a proxy for the current level of democracy; a dummy variable taking the value of unity for countries with uninterrupted democracy since 1950, as a proxy for long-standing democratic tradition; the Freedom of Press Index published by the Freedom House, measuring restrictions on press; the ratio of internet users to total population, as a proxy for access to independent news and its interaction with economic development and quality of education; the Political Globalisation Index published by the Swiss

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[11] The values of a country's climate variables are approximated by their values in the country's capital city as reported by the BBC weather site. For some countries BBC weather does not report climate conditions for the capital city, in which case we use values reported for the country's largest city.

Economic Institute (KOF), as a proxy for a country's integration to the international community; a dummy variable taking the value of unity for constitutionally federal states; total population as a proxy for the degree of federalism; a dummy variable taking the value of unity for countries applying common law legal systems; and a set of dummies taking the value of unity for different types of colonial/imperial/communist past. Finally, social/cultural variables include urbanisation; income inequality measured by the Gini coefficient; females as percentage of economically active population; median age; the proportion of the largest ethnic/linguistic group as a proxy for the degree of ethnic fragmentation; the Social Globalisation Index published by KOF as a proxy of a country's integration to global cultural interaction; religion dummies, taking the value of unity if more than fifty percent of the population belongs to a specific religious creed; and longitude, latitude (absolute distance from the Equator) and their interaction as proxies for unobserved social/cultural factors.

Table 1 presents correlation coefficients of all possible determinants of corruption against the two measures of corruption. A high TI-CPI and WB-CCI score denotes a lower level of corruption therefore corruption is negatively correlated with positive-signed variables and negatively associated with positive-signed ones. Consistent with previous studies, TI-CPI and WB-CCI are almost perfectly correlated. The statistics reported for GCCs include reasonably sizeable negative values for average sunlight, temperature and maximum elevation point and positive ones for average number of wet days. The set of economic variables includes, unsurprisingly, a high positive score for per capita GDP and an equally high negative score for the easy of doing business index. Scores of moderate size are reported for government share in GDP (negative) and education expenditure (positive). For political variables, we obtain a strikingly high positive coefficient for the proportion of internet users in total

population, indeed the highest score (0.87) among the full set of variables. This is closely followed by significant positive scores for the political rights index (our proxy for the level of democracy) and a highly negative score for restrictions on press. A moderate positive coefficient is reported for common law while among colonial dummies the most sizeable score is the negative coefficient referring to ex-Soviet/communist countries. Finally, among social/cultural variables we obtain a very high positive score for the social globalisation index, followed by sizeable positive scores for median age and urbanisation. Moderately sizeable coefficients are also reported for female participation in labour force (positive) and two religious dummies.

## 4.2. Empirical findings

### 4.2.1. Benchmark models

Following the existing empirical literature on the determinants of corruption we adopt a specific-to-general econometric approach. We start by estimating a model conditioning corruption on GCC variables and build upward adding, in separate estimation rounds, per-capita GDP, other economic variables, political variables and social/cultural determinants of corruption. We first estimate an OLS model explaining the TI-CPI score on GCCs only. The results are presented in Table (2), column (a). Statistically significant variables include temperature (with a negative sign), non-cultivatable land (positive sign), coastline length (positive sign), maximum elevation point (negative sign) and number of days below freezing point (negative sign). Next, we re-estimate the model controlling for per capita GDP. The results are reported in Table (2), column (b). As expected, GDP per head is highly significant with a positive sign. Temperature, coastline and days below zero remain significant. Maximum elevation

point becomes insignificant, replaced by precipitation which enters the model with a positive sign.

We then add the remaining economic variables, including education expenditure, as percent in GDP. From this point onwards, and in order to save space, we only report the findings of the estimated parsimonious models (all the intermediate results are available upon request).[12] The results are reported in Table 2, column (c). Temperature, precipitation, days below zero and coastline length are all statistically significant. Despite their individual insignificance, non-cultivatable land and water bodies are also jointly significant and hence maintained. As far as economic variables are concerned, in addition to GDP significant variables are the Ease of Doing Business Index (negative sign), natural gas reserves (negative sign) and education spending (positive sign). Next we introduce political variables. The results are reported in Table 2, column (d). We obtain three new significant variables. First, the Political Rights Index measuring democratic freedoms. Consistent with previous findings in the literature, this enters the model in its second and third power, with negative and positive sign respectively. Second two colonial dummies, namely ex-British colonies with a positive sign and ex-Soviet republics/communist states with a negative sign. Third, the percentage of internet users in total population. Last we add cultural/social variables. The estimated parsimonious model is reported in Table 2, column (e). This represents our final and preferred specification. From this last set of variables only mean age and the interaction of longitude with the absolute value of latitude are significant, with a positive and negative sign respectively. The remaining variables remain unaffected.

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[12] The parsimonious model is obtained using a general-to-specific approach: Starting from a model including all variables, we exclude the least significant variable and re-estimate the model. We continue to exclude individual insignificant variables until we are left with a set of variables that are either significant on their own, or jointly as a group.

### 4.2.2. Robustness tests

We test the robustness of our empirical findings in a number of ways. First, we added back, on a one-by-one basis, all variables excluded in previous estimation rounds. In all cases the final parsimonious specification reported in Table (2), column (e) did not change (results available upon request). Second, we repeated our OLS estimations using as dependant variable the three-year average of the Control for Corruption Index published by the World Bank (WB-CCI) for years 2006, 2007 and 2008. The results of the final parsimonious model are reported in Table 3, column (a).[13] These are almost identical to those obtained using the TI-CPI, the only exception being that natural gas resources are now marginally insignificant.[14] Third, we use a two-stage least squares modelling approach, where in the first stage we instrument per capita GDP using GCC variables and geographical co-ordinates.[15] The results of the final parsimonious specifications modelling the TI-CPI and WB-CCI are presented in Table 3, columns (b) and (c) respectively. With minor differences, these are very similar to those obtained using OLS. Although temperature and GDP appear statistically significant at the 10% level only, in both equations they are jointly significant at the six percent level. Note also that the two-stage equation modelling the TI-CPI replaces natural gas reserves with oil reserves. Although this variable is marginally insignificant at the 10% level, it is jointly significant with temperature and GDP at the 5% level. For the two-stage LS equation modelling the WB-CPI neither natural gas nor oil reserves were close to being significant at the 10% level, hence they are excluded.

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[13] The results of all intermediate estimations are available upon request.

[14] The difference in the size of the reported coefficients compared to the equations modelling the TI-CPI is explained by the difference in the units of measurement. The TI-CPI classifies countries using an index taking values between 1 and 10. The WB-CCI takes values between -2.5 and 2.5. In both cases, a higher score denotes less corruption.

[15] The exact set of instruments in the equation modelling GDP are longitude, the interaction of longitude with absolute latitude (distance from the Equator), non-cultivatable land, coastline and maximum elevation point.

Finally, we use weighted least squares (WLS) to estimate models where the dependent variable is the WB-CCI reported for year 2008 and weights are the inverse of the reported scores' standard deviation.[16] This estimation methodology has the advantage of placing higher emphasis on the more reliable, lower-variance observations as opposed to the less reliable, higher-variance ones. The results are reported in Table 3, column (d). Compared to our final OLS specification reported in Table 2, column (e), the WLS findings remain qualitatively unchanged.

### 4.2.3. Discussion

Our main empirical finding is that GCCs in the form of average temperature, precipitation and non-cultivatable land are significant in explaining corruption, even after controlling for all other possible determinants of corruption suggested by previous literature. Corruption increases with cultivatable land, which is consistent with the predictions of our theoretical model in section 3. Corruption also increases with temperature and declines with precipitation. These findings are also consistent with the intuition underlying our theoretical background: Benign temperatures enhance the chances of human survival while high precipitation, particularly under low temperatures, poses challenges increasing incentives for co-operation.[17]

Regarding other determinants of corruption, our findings are consistent with those reported by previous studies. We find corruption to decline with per-capita income and to increase with the rent-seeking opportunities created by bureaucracy/excessive regulation and natural resources. The link between corruption

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[16] We could not estimate WLS models using the TI-CPI as dependent variable, as the Transparency International website does not report standard deviations for the reported values of the TI-CPI index.

[17] It might be plausibly argued that high precipitation under benign temperatures increases land fertility thus providing lower incentives for co-operation increasing individualism and corruption. This effect is captured in our model by the proportion of non-cultivatable land which can be seen as capturing the interaction between temperature and precipitation in each of our sample countries.

and democratic freedoms is confirmed to be non-linear, suggesting that for corruption to decline a critical threshold of freedoms has to be reached. Furthermore, corruption is lower in countries with a British colonial past and increases in countries with a Soviet/communist political legacy. Last, but not least, we provide a new, previously unreported, empirical finding, according to which corruption declines with the percentage of internet users to a country's total population. This finding may be interpreted as capturing the beneficial interaction of three variables reducing corruption, namely economic development, human capital/education and access to independent news. This explains the absence of education and the freedom of press index from our final specifications and renders our findings consistent with those of previous studies.

Finally, an interesting aspect of our empirical findings is the lack of social/cultural variables from our final specifications, with the exception of mean age. Given the unambiguous exogeneity of GCCs to any other potential determinant of corruption, this raises the prospect of an intriguing possibility, namely that cultural norms themselves are heavily influenced on GCCs. If this is the case indeed, previous studies explaining corruption on social/cultural variables are not necessarily picking up a structural effect of those variables on corruption but, indirectly, the effect of GCCs through variables that are ultimately endogenous to climate. This is consistent with the predictions of our theoretical analysis in section 2, where unfavourable GCCs increase the pay-off schedules of co-operative strategies, reflected in social variables, relative to individualistic strategies. Higher pay-offs provided by co-operative strategies under unfavourable GCCs provide rational agents incentives to develop social organisations yielding positive externalities benefiting rational, self-rewarding individuals. This is reflected, for example, in higher urbanisation and female participation in production as well as the development of trust technologies expressed in fair-play values, labour

division based on individual's comparative advantage (a pre-requisite of meritocracy), mutual-trust and law-abiding behaviour, all of which are associated with less corruption. Furthermore, higher individual rewards offered by co-operative strategies under unfavourable GCCs increase the credibility of individuals' commitment to them. Increased credibility reinforces in turn the culture of mutual trust among agents, thus facilitating the perpetuation of co-operative strategies.

## 5. SUMMARY AND CONCLUDING REMARKS

This paper presents a new explanation of corruption based on geography and climate conditions (GCCs). We define corruption as an extreme form of individualism, defined as actions of self-rewarding agents aiming exclusively towards improvement of their personal welfare. Individualism is socially acceptable as long as self-improvement is pursued through means complying with generally accepted fairness norms, the existence of which has been established by previous literature. In our analysis meeting the common fairness norms requires a minimum of civic engagement, reflected by the share of one's personal resources dedicated to wholly or partially collective, as opposed to exclusively self-rewarding, objectives. Corruption is defined as a state where the degree of one's individualism exceeds a critical threshold up to which individualism is generally regarded to be legitimate. Each person's degree of individualism is a random variable following a certain (e.g. normal) probability distribution. We assume that this distribution's mean is always below corruption's threshold, i.e. the representative agent acts fairly in all societies. The average level of individualism, however, may vary across societies. A society with a relatively high average level of individualism will exhibit a higher frequency of extreme individualism, compared to a society with a relatively low average value of individualism. In that case, the factors explaining corruption will be

the factors determining the mean of the distribution of individualism. The central point of our paper is that this mean is originally determined by exogenous GCCs.

To show this, we use a simple model where the representative agent derives utility from consumption and leisure. The agent operates under a survival constraint imposing a minimum level of consumption. To meet this survival constraint the agent can either work individually or in co-operation with another agent. The productivity of individual labour is exogenous, determined by stochastic GCCs. Co-operative work increases labour productivity beyond the level determined by GCCs due to synergies in joint work. From that point of view, the agent has an incentive to work co-operatively. On the other hand, the disutility of co-operative labour is higher than that of individual labour, due to co-ordination costs present in joint work. Hence, the agent has an incentive to work individually. As favourable GCCs increase the productivity of individual labour, agents can meet the survival constraint easier under favourable rather than unfavourable GCCs. Therefore, more favourable GCCs provide incentives for more individual work, resulting in a higher level of average individualism. This causes a higher frequency of extreme individualism i.e. higher corruption. GCCs be seen to determine an initial equilibrium whose present-day legacy can be tested controlling for other possible corruption causes.

We test the empirical validity of our model using data from a cross-section of 115 countries. Controlling for all other determinants of corruption suggested in previous literature we confirm the model's main predictions: We find that corruption increases with temperature and declines with precipitation and the share of non-cultivatable land in a country's total area. We also find that corruption declines with per capita GDP and genuine, as opposed to "half-hearted", democracy; and increases with natural resources and bureaucracy/regulation. British colonial heritage reduces corruption whereas a

communist past increases it. A country's median inhabitant's age has a negative effect on corruption. Finally, we find that corruption declines with the ratio of internet users to a country's population. This new finding, not reported in previous literature, is interpreted as capturing the beneficial interaction of economic development, human capital/education and access to independent news.

At first sight our empirical findings may be seen as conveying pessimistic implications: If stochastic GCC determine an initial equilibrium involving a high level of corruption society may subsequently adapt to it thus reinforcing and perpetuating it. Yet, the international experience presented in this paper clearly demonstrates that this need not be so. Countries with GCCs rendering them naturally prone to high levels of corruption may tackle corruption successfully if they develop effective institutions providing credible rewards for agents adopting fair behaviours and sanctions for agents adopting corrupt ones. To achieve this objective two conditions are imperative: transparency and belief in the rule of law. These in turn require, as confirmed by our empirical findings, a high level of individual political freedoms, freedom of information and advanced systems of education and legal administration. All these variables, as well as economic development, are endogenous to public choices reflected in government policy and quality of state institutions. Hence the implications of our findings are mainly optimistic: As long as there is a will to do so, corruption can be substantially reduced, even within environments where natural conditions and past practices have deeply entrenched it.

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**Figure 1: Distribution of individualism and corruption as a form of extreme individualism**
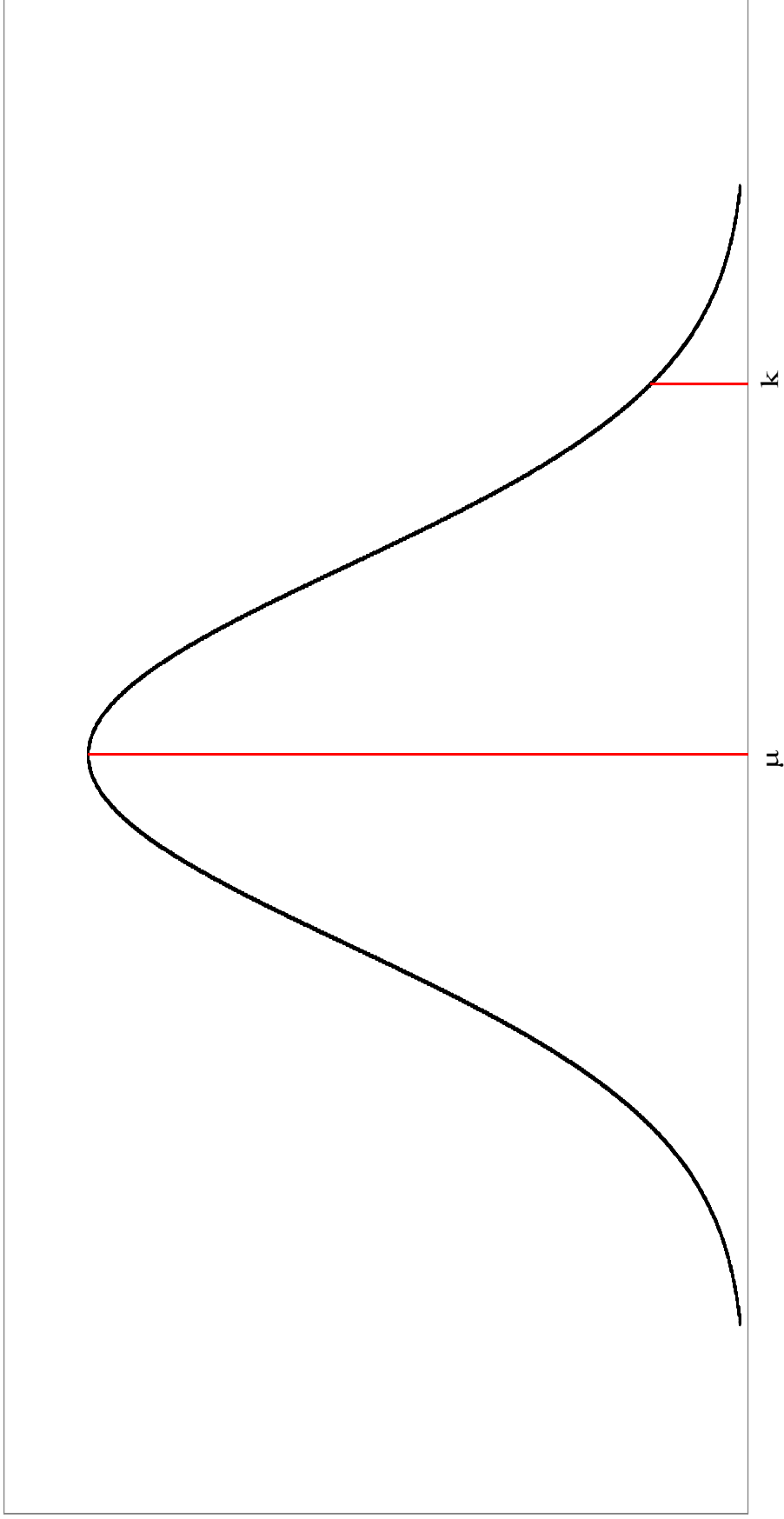


*Notes*: Individualism is defined as the proportion of an agent's resources dedicated to exclusively self-rewarding actions. The distribution of corruption has a mean value equal to $\mu$. Corruption is defined as a proportion of self-rewarding actions exceeding the critical threshold of legitimate individualism described by k. The aggregate level of corruption is given by the area under the curve on the right-hand side of k.

**Figure 2: Individualism and corruption in individualistic versus co-operative societies**
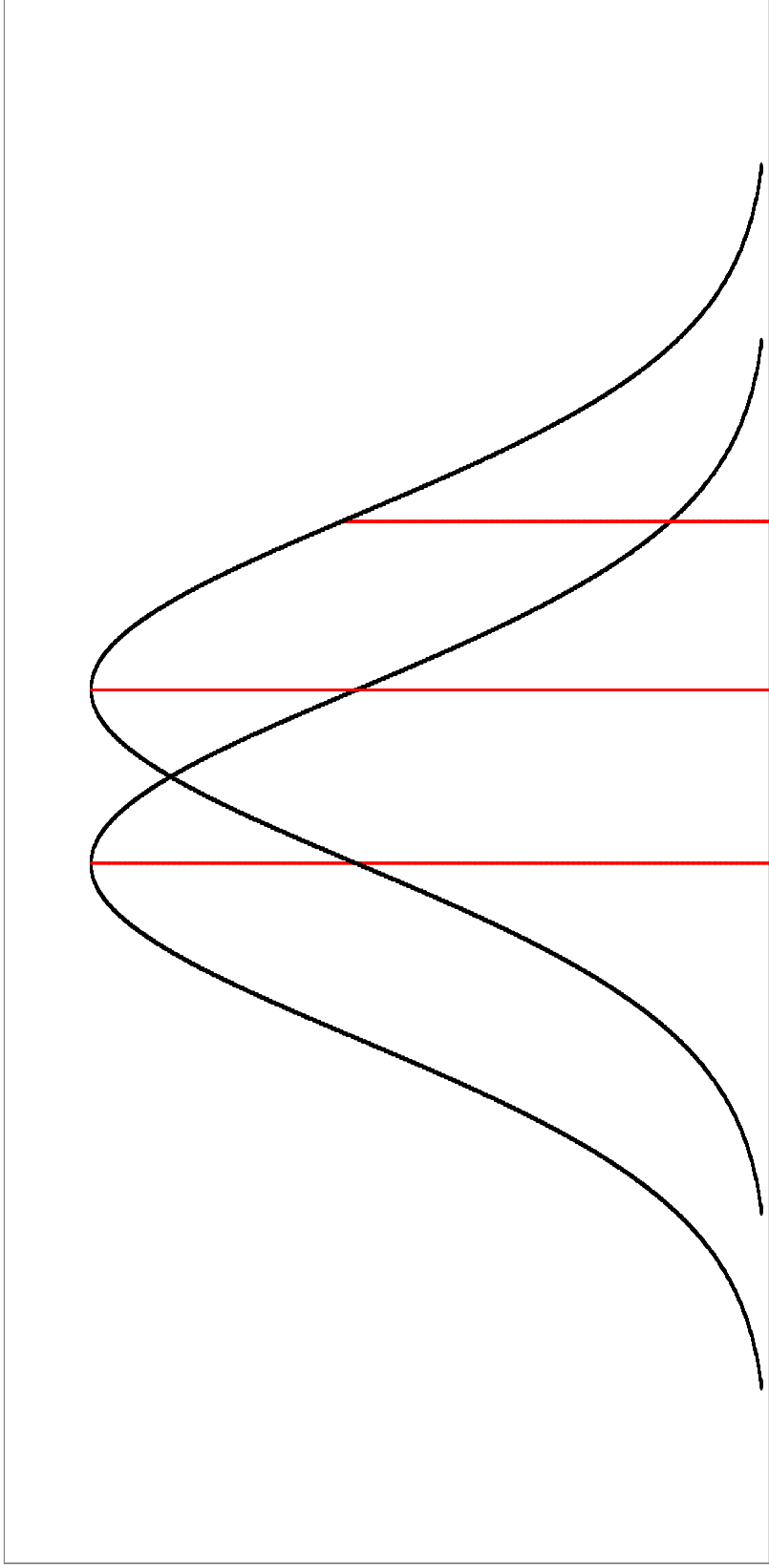


*Notes*: Individualism is defined as the proportion of an agent's resources dedicated to exclusively self-rewarding actions. Corruption is defined as a proportion of self-rewarding actions exceeding the critical threshold of legitimate individualism described by k (the area under the curve on the right-hand side of k). In all societies the average level of individualism is assumed to be below corruption's critical threshold. Relatively individualistic societies exhibit higher average score of individualism compared to relatively co-operative societies ($\mu_I > \mu_C$). Given a common critical threshold of legitimate individualism (k), individualistic societies will exhibit a higher frequency of corruption.

**Table 1: Correlation coefficient against indexes of perceived corruption**

|                                                              | TI – CPI | WB – CCI |
|--------------------------------------------------------------|----------|----------|
| Transparency International CPI                                | 1.00     | 0.99     |
| World Bank CCI                                                | 0.99     | 1.00     |
|                                                              |          |          |
| *Climate variables*                                          |          |          |
| Sunlight                                                     | -0.34    | -0.32    |
| Temperature                                                  | -0.35    | -0.34    |
| Precipitation                                               | 0.07     | 0.03     |
| Wet days                                                    | 0.37     | 0.36     |
| Days below 0 C                                              | 0.21     | 0.20     |
|                                                              |          |          |
| *Geography variables*                                        |          |          |
| Coastline                                                   | 0.20     | 0.19     |
| Maximum elevation point                                     | -0.34    | -0.34    |
| Total area                                                  | 0.00     | -0.01    |
| Inland water bodies  (% in total area)                      | 0.13     | 0.11     |
| Non-cultivatable land  (% in total area)                    | 0.07     | 0.08     |
|                                                              |          |          |
| *Economic variables*                                         |          |          |
| Per capita GDP                                              | 0.76     | 0.78     |
| Government share in GDP                                     | -0.37    | -0.36    |
| Economic openness                                          | 0.22     | 0.21     |
| Ease of Doing Business (higher values = more bureaucracy)  | -0.74    | -0.74    |
| Oil reserves                                               | -0.06    | -0.04    |
| Natural gas reserves                                       | -0.13    | -0.11    |
|                                                              |          |          |
| Education expenditure  (% in GDP)                           | 0.34     | 0.37     |

*Notes:* The values of a country's climate variables are approximated by the values in the country's capital city reported by the BBC weather site. For some countries BBC weather does not report climate conditions for the capital city, in which case we use the values reported for the country's largest city.

**Table 1 (cont'd): Correlation coefficient against indexes of perceived corruption**

|  | TI – CPI | WB – CCI |
|---|---|---|
| *Political variables* |  |  |
| Political Rights Index | 0.63 | 0.64 |
| Uninterrupted democracy | 0.66 | 0.65 |
| Freedom of Press |  |  |
| (higher values = more restrictions) | -0.72 | -0.72 |
| Internet users (% of total population) | 0.87 | 0.86 |
| Political globalization index | 0.42 | 0.42 |
| Federal state | 0.08 | 0.08 |
| Total population | -0.09 | -0.10 |
| Common law | 0.31 | 0.31 |
| British colony | 0.18 | 0.18 |
| French colony | -0.23 | -0.24 |
| Ottoman province | -0.19 | -0.18 |
| Soviet Republic or communist state | -0.29 | -0.30 |
| Austrian-Hungarian province | -0.01 | -0.01 |
| Spanish colony | -0.17 | -0.17 |
| Portuguese colony | 0.02 | 0.04 |
| Dutch colony | -0.01 | 0.00 |
| USA-administered | 0.05 | 0.03 |
|  |  |  |
| *Social variables* |  |  |
| Urbanisation | 0.59 | 0.60 |
| Income inequality (Gini coefficient) | -.0.37 | -0.38 |
| Females as % in economically active population | 0.32 | 0.31 |
| Median age | 0.67 | 0.68 |
| Ethnic fragmentation |  |  |
| (higher values = higher homogeneity) | 0.11 | 0.09 |
| Social globalisation index | 0.82 | 0.83 |
| Protestant | 0.39 | 0.40 |
| Catholic | 0.02 | 0.03 |
| Orthodox | -0.17 | -0.16 |
| Judaism | 0.06 | 0.06 |
| Muslim | -0.35 | -0.34 |
| Hindu | -0.09 | -0.09 |
| Eastern Asia religions | -0.10 | -0.12 |
| Longitude | 0.21 | 0.21 |
| Latitude (distance from Equator, klms) | -0.17 | -0.21 |
| Interaction of longitude/latitude | -0.19 | -0.21 |

**Table 2: Empirical models of corruption, OLS estimates**

| | (a) Geography/climate only | (b) Add GDP | (c) Add economic variables | (d) Add political variables | (e) Add social variables |
|---|---|---|---|---|---|
| Constant | 8.269 *** | 5.154 *** | 4.442 *** | 3.042 ** | 2.215** |
| Sunlight | -0.180 | 0.030 | | | |
| Temperature | -0.222 *** | -0.179 *** | -0.114 *** | -0.043 *** | -0.041*** |
| Precipitation | 0.003 | 0.008* | 0.008 *** | 0.007 *** | 0.007*** |
| Wet days | 0.002 | 0.003 | | | |
| Days below 0 Celsius | -0.020 *** | -0.015 *** | -0.011*** | | |
| Coastline | 0.026 ** | 0.014 * | | | |
| Maximum elevation | -0.0004 *** | -0.0001 | | | |
| Non-cultivatable land | 0.035 *** | 0.010 | 0.010 | 0.012 ** | 0.014** |
| Water bodies | 0.039 | 0.039 | 0.054 | | |
| Total Area | -0.0001 | -0.0001 | 0.0001* | | |
| GDP | | 0.08 *** | 0.070 *** | 0.025 *** | 0.022*** |
| Ease of Doing Business Index | | | -0.014 *** | -0.010 *** | -0.001*** |
| Natural gas reserves | | | -0.086 *** | -0.031 *** | -0.028** |
| Education expenditure | | | 0.175 *** | | |
| Freedom Index squared | | | | -0.003 *** | -0.004*** |
| Freedom Index cube | | | | 0.0001 *** | 0.0001*** |
| Internet users | | | | 0.024 *** | 0.018 *** |
| British colony | | | | 0.630 *** | 0.633*** |
| Soviet/communist state | | | | -0.690 *** | -0.880*** |
| Median age | | | | | 0.042** |
| Longitude * Absolute Latitude | | | | | -0.0001** |
| $R^2$ | 0.42 | 0.71 | 0.82 | 0.91 | 0.92 |

*Notes*: For all reported equations the dependent variable is the Transparency International Corruption Perception Index, average for years 2007-09. The asterisk symbols * , ** and *** respectively denote statistical significance at the 10%, 5% and 1% level respectively. Columns (c), (d) and (e) report parsimonious models, including statistically significant variables only. The results of the intermediate estimations including the full set of political and social/cultural variables are available upon request. In column (d) non-cultivatable land and water are jointly significant and hence maintained in the model.

**Table 3: Empirical models of corruption, robustness tests**

| Dependent variable<br>Method of estimation | (a)<br>WB-CCI<br>OLS | (b)<br>TI-CPI<br>2-stage LS | (c)<br>WB-CPI<br>2-stage LS | (d)<br>WB-CPI<br>WLS |
|---|---|---|---|---|
| Constant | -1.003** | 2.074** | -1.100** | 1.994** |
| Temperature | -0.017** | -0.030* | -0.013 | -0.043** |
| Precipitation | 0.002*** | 0.006*** | 0.002** | 0.006*** |
| Non-cultivatable land | 0.007*** | 0.012** | 0.006** | 0.013** |
| GDP | 0.012*** | 0.017* | 0.009* | 0.023*** |
| Ease of Doing business Index | -0.004*** | -0.001*** | -0.005*** | -0.009*** |
| Natural gas reserves | -0.010 | | | -0.028** |
| Oil reserves | | -0.030 | | |
| Freedom Index squared | -0.002*** | -0.004*** | -0.002*** | -0.004*** |
| Freedom Index cube | 0.00005*** | 0.0001*** | 0.00005*** | 0.0001*** |
| Internet users | 0.008** | 0.024*** | 0.011*** | 0.018*** |
| British colony | 0.260*** | 0.682*** | 0.289*** | 0.730*** |
| Soviet/communist state | -0.417*** | -1.084*** | -0.517*** | -0.899*** |
| Median age | 0.022** | 0.044** | 0.024** | 0.048*** |
| Longitude*Absolute Latitude | -0.00006*** | -0.00008* | -0.00005** | -0.0001** |
| $R^2$ | 0.91 | 0.91 | 0.91 | 0.91 |

*Notes:* WB-CCI and TI-CPI respectively denote the World Bank Control for Corruption Index and the Transparency International Corruption Perception Index. The dependent variable in columns (a) and (c) is the average WB-CCI score for years 2006-08; in column (b) the average TI-CPI score for years 2006-08; in column (d) the WB-CCI score for year 2008. The asterisk symbols *, ** and *** respectively denote statistical significance at the 10%, 5% and 1% level respectively. All columns report parsimonious models, including statistically significant variables only. The results of intermediate estimations are available upon request. The weights used for the WLS estimation in column (d) are the inverse values of the standard deviations of the WB-CCI scores reported for year 2008. Note that the 2-stage LS equation modelling the TI-CPI reported in column (b) replaces natural gas reserves with oil reserves. Although this variable is marginally insignificant at the 10% level, it is jointly significance with temperature and GDP at the 5% level and hence maintained in the model.

**Table A1: List of sample countries ranked by Transparency International Corruption Perception Index (average for years 2007, 2008 and 2009)**

| Ranking | Country | TI-CPI | Ranking | Country | TI-CPI |
|---|---|---|---|---|---|
| 1 | New Zealand | 9.4 | 31 | United Arab Emirates | 6.0 |
| 2 | Denmark | 9.3 | 32 | Dominica | 5.8 |
|  | Sweden | 9.3 |  | Puerto Rico | 5.8 |
| 4 | Singapore | 9.2 | 34 | Taiwan | 5.7 |
| 5 | Finland | 9.1 | 35 | Malta | 5.6 |
| 6 | Switzerland | 9.0 | 36 | South Korea | 5.4 |
| 7 | Iceland | 8.9 | 37 | Bahrain | 5.2 |
|  | Netherlands | 8.9 |  | Hungary | 5.2 |
| 9 | Australia | 8.7 |  | Oman | 5.2 |
|  | Canada | 8.7 | 40 | Costa Rica | 5.1 |
| 11 | Norway | 8.4 |  | Czech Republic | 5.1 |
| 12 | Luxembourg | 8.3 | 42 | Jordan | 4.9 |
| 13 | Hong-Kong | 8.2 |  | Malaysia | 4.9 |
| 14 | Austria | 8.0 |  | South Africa | 4.9 |
| 15 | Germany | 7.9 | 45 | Italy | 4.8 |
|  | UK | 7.9 |  | Latvia | 4.8 |
| 17 | Ireland | 7.7 |  | Slovakia | 4.8 |
| 18 | Japan | 7.5 | 48 | Poland | 4.6 |
| 19 | USA | 7.3 | 49 | Lithuania | 4.5 |
| 20 | Belgium | 7.2 | 50 | Greece | 4.4 |
| 21 | France | 7.0 |  | Turkey | 4.4 |
| 22 | Chile | 6.9 | 52 | Tunisia | 4.3 |
| 23 | Uruguay | 6.8 | 53 | Croatia | 4.2 |
| 24 | Estonia | 6.6 |  | Kuwait | 4.2 |
|  | Slovenia | 6.6 | 55 | Romania | 3.8 |
| 26 | Qatar | 6.5 |  | Bulgaria | 3.8 |
| 27 | Spain | 6.4 |  | Colombia | 3.8 |
| 28 | Cyprus | 6.1 |  | Georgia | 3.8 |
|  | Israel | 6.1 |  | El Salvador | 3.8 |
|  | Portugal | 6.1 | 60 | Saudi Arabia | 3.7 |

Notes: Scores out of 10. Higher values imply a higher level of transparency and a lower value of corruption

**Table A1 (cont'd) List of sample countries ranked by Transparency International Corruption Perception Index (average for years 2007, 2008 and 2009)**

| Ranking | Country | TI-CPI | Ranking | Country | TI-CPI |
|---|---|---|---|---|---|
| 61 | FYRO Macedonia | 3.6 | 89 | Libya | 2.5 |
| | Brazil | 3.6 | | Ukraine | 2.5 |
| | China | 3.6 | | Honduras | 2.5 |
| | Peru | 3.6 | | Nicaragua | 2.5 |
| | Suriname | 3.6 | | Nepal | 2.5 |
| 66 | Mexico | 3.5 | 94 | Philippines | 2.4 |
| | Montenegro | 3.5 | | Syria | 2.4 |
| 68 | Serbia | 3.4 | | Pakistan | 2.4 |
| | India | 3.4 | 97 | Kazakhstan | 2.3 |
| | Thailand | 3.4 | | Paraguay | 2.3 |
| | Morocco | 3.4 | | Yemen | 2.3 |
| 72 | Panama | 3.3 | 100 | Russia | 2.2 |
| 73 | Sri Lanka | 3.2 | | Iran | 2.2 |
| | Bosnia | 3.2 | | Belarus | 2.2 |
| | Albania | 3.2 | | Bangladesh | 2.2 |
| 76 | Guatemala | 3.1 | 104 | Azerbaijan | 2.1 |
| | Jamaica | 3.1 | | Equator | 2.1 |
| 78 | Algeria | 3.0 | | Tajikistan | 2.1 |
| | Moldova | 3.0 | 107 | Laos | 2.0 |
| | Dominican Republic | 3.0 | 108 | Cambodia | 1.9 |
| 81 | Argentina | 2.9 | | Kyrgyzstan | 1.9 |
| | Armenia | 2.9 | | Turkmenistan | 1.9 |
| | Bolivia | 2.9 | | Venezuela | 1.9 |
| 84 | Egypt | 2.8 | 112 | Uzbekistan | 1.7 |
| | Lebanon | 2.8 | 113 | Haiti | 1.6 |
| 86 | Vietnam | 2.7 | 114 | Afghanistan | 1.5 |
| 87 | Indonesia | 2.6 | 115 | Iraq | 1.4 |
| | Guyana | 2.6 | | | |

Notes: Scores out of 10. Higher values imply a higher level of transparency and a lower value of corruption

**Table A2: Data description, sources and units of measurement**

| Variable | Source | Units of measurement and notes |
|---|---|---|
| **Corruption Indexes** | | |
| Corruption Perception Index | Transparency International | Scale 1 to 10. Higher scores imply less corruption |
| Control of Corruption Index | World Bank | Scale -2.5 to 2.5. Higher scores imply less corruption |
| | | |
| **Climate variables** | | |
| Sunlight | BBC Weather | Daily average, hours |
| Temperature | BBC Weather | Yearly average, Celsius degrees |
| Precipitation | BBC Weather | Daily average, millimetres |
| Wet days | BBC Weather | Yearly average, days with total precipitation higher than 0.25 mm. |
| Days below freezing point ( zero degrees Celsius) | www.weatherbase.com | Yearly average |
| | | |
| **Geography variables** | | |
| Coastline | CIA Factbook | Kilometres |
| Maximum elevation point | CIA Factbook | Meters |
| Total area | CIA Factbook | Squared kilometres |
| Inland water bodies | CIA Factbook | Rivers, lakes and dams. Per cent in total country area |
| Non-cultivatable land | CIA Factbook | Per cent in total country area minus arable areas and permanent crops. |
| | | |
| **Economic Variables** | | |
| Per capita GDP | CIA Factbook | Thousands of US Dollar |
| Government expenditure (% in GDP) | World Penn Tables 6.3 | Per cent in real per-capita GDP |
| Economic openness | World Penn Tables 6.3 | Exports plus imports divided by GDP |
| Ease of Doing Business Index | www.doingbusiness.org | Absolute rankings in a sample of 184 countries. Lower scores imply less bureaucratic burden and higher ease of doing business. |
| Oil, proved reserves | CIA Factbook | Trillions of barrels |
| Natural gas, proved reserves | CIA Factbook | Trillions of cube meters |
| Education expenditure (% in GDP) | CIA Factbook | Per cent in GDP |

**Table A2 (continued): Data description, sources and units of measurement**

| Variable | Source | Notes and units of measurement |
|---|---|---|
| **Political variables** | | |
| Political Rights Index | www.freedomhouse.org | Scale 0-40, average for years 2003-09. Higher scores denote higher political rights |
| Uninterrupted democracy 1950-2009 | | Dummy variable, 1 for uninterrupted democracy, 0 otherwise |
| Freedom of Press | www.freedomhouse.org | Scale 0-100 for year 2008. Higher scores denote more press restrictions, i.e. less press freedom |
| Internet users ( % in total population) | CIA Factbook | Calculated as ratio of internet users to total population |
| Federal state | CIA Factbook | Dummy variable, 1 for federal state, zero otherwise |
| Population | CIA Factbook | Millions |
| Common law system | | Dummy variable, 1 for common law system, zero otherwise |
| Political globalization index (scale 0-100, average 2000-2007) | www.globalization.kof.ethz.ch | Scale 0-100, average for years 2000-07. Higher scores imply a higher degree of political globalisation |
| Colonial/political past: British, French, Ottoman, Soviet Republic/communist state, Austrian-Hungarian, Spanish, Portuguese, Dutch, USA-administered. | | Dummy variables, 1 for respective country, zero otherwise |
| **Social variables** | | |
| Urbanisation | CIA Factbook | Percent of population living in cities |
| Income inequality | CIA Factbook | Gini coefficient |
| Females as percentage of economically active population | LARBORSTA international labour statistics | Average for years 2000-08 |
| Median age | CIA Factbook | |
| Ethnic fragmentation | CIA Factbook | Percentage of largest ethnic group in total population. For countries that no ethnic groups are reported, percentage of largest linguistic group in total population. |
| Social globalisation index | www.globalization.kof.ethz.ch | Scale 0-100, average of years 2000-07. Higher scores imply higher social globalisation |
| Religion dummies (Protestant, Catholic, Orthodox, Judaism, Eastern Asia Religions, Muslim, Hindu) | CIA Factbook | Dummy variables; 1 if 50% or more of population belongs to corresponding religion group, zero otherwise. |