# THREE ESSAYS ON CORRUPTION

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## Abstract

This thesis is a study on corruption from an economics perspective. Corruption is defined as the misuse of power in public office for private gain. Unfortunately, its obscure nature makes it difficult to identify and fight it. The thesis' aim is to increase our understanding of its mechanics and help toward this direction. In particular, it consists of three different studies, which focus on the causes of corruption, its consequences and measurement. The first section investigates whether political leaders are empirically associated with governance, one of its constituent elements being corruption. The results show that leaders do matter for bureaucratic quality and the rule of law, especially in autocratic regimes. Corruption does not seem to be affected by leaders though, which is an outcome probably driven by the data inadequacies and the inherent features of malfeasance. The second part elaborates on corruption as a driving force behind a salient feature of demographic transition. This is the dilemma that parents face whether to improve their children's education or increase the size of their families. Corruption can affect their decision since it impedes the provision of public services important for the development of human capital. The model shows that higher levels of corruption increase fertility, diminish human capital and lower growth. Additionally, the model offers an explanation for the empirical observation of volatile fertility rates. Finally, the last study explores the measurement of malfeasance. Initially, a new dataset is built including measures of perceived corruption along with survey questions. A sample of 10 measures is chosen taking into consideration their nature and reliability. An advanced statistical model is applied to this sample in order to construct a new index of corruption, whose scores are accompanied by their measurement errors as well. The strength of the new index is its ability to combine the knowledge of numerous scholars and analysts who examine corruption. In addition, the model is equipped with tools that make feasible the comparison of the constituent measures' different levels and reliability on the same underlying scale.

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# Introduction

This thesis studies the incidence of corruption from an economics perspective. Corruption, here, is defined as the misconduct in public office for private gain. Examples of such misbehaviour are kickbacks, extortion and nepotism. Probably, the greatest challenge when dealing with this phenomenon is its inherent obscurity, which makes the identification and prosecution of cases of malfeasance a demanding task. Similarly, its research, whether it focuses on the causes, consequences or measurement of corruption, is equally difficult because it requires the use of methodological innovations and the drawing of inferences, which are sound and robust. This thesis aims to help toward this direction by presenting three studies, which try to shed some light on the roots, effects and assessment of corruption respectively.

The first section presents an empirical work, which identifies the influence of political leaders as a potential determinant of governance, one of its prominent features being corruption. The study uses the methodological approach of a recent project on the effects of leaders on growth and evaluates their impact on corruption, bureaucratic quality and the rule of law. The results show that leaders do matter for bureaucratic quality and the rule of law, whose effect is especially pronounced in autocratic regimes. On the contrary, leaders seem to be unable or unwilling to affect corruption, an outcome that is not very surprising given the data limitations and the nature of the concept.

The next section investigates the consequences of wrongdoing in the public sector on the development of human capital, fertility and growth. A theoretical framework is built, which introduces a mechanism where parents' decision to either educate their children or rear more is determined by the level of embezzlement of public funds otherwise devoted to the procurement of public services. The model shows that the increasing prevalence of corruption results in higher levels of fertility, diminishing human capital and lower growth. In addition, the model's mechanism can account for the empirically shown occurrence of fertility fluctuations.

The final part of the thesis elaborates on the quantification of corruption. Initially, a new dataset is constructed, which incorporates extant measures of

perceived corruption as well as survey questions. From this dataset, a small sample of 10 measures is extracted taking into account their nature and reliability. An advanced statistical model is applied to this in order to synthesise a new index of corruption where the point estimates are accompanied by their corresponding measurement errors. The strength of the new scale lies on its ability to combine the efforts and experiences of numerous scholars and analysts to produce corruption indicators. Additionally, the model offers tools to compare the different levels and reliability of the constituent measures on the same underlying latent scale.

# Leaders and Governance

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**Abstract**

The paper uses the approach of Jones and Olken (2005) to examine whether leaders affect institutional quality. In particular, I examine the effect of leadership transitions on a set of measures of governance such as corruption, bureaucratic quality and the rule of law. The findings suggest that leaders' impact is substantial on bureaucratic quality and the rule of law, especially under autocratic regimes. Nevertheless, they seem to be unable or unwilling to affect corruption, a result probably determined by data limitations and the innate qualities of this concept. Consequently, the paper recognises the idiosyncratic forces of influential individuals as a new determinant of institutional quality.

## 1.1 Introduction

The political economy literature has recognised the intimate relationship institutions and economic development share (Mauro (1995); Hall and Jones (1999); Acemoglu *et al.* (2001); Easterly and Levine (2003); Rodrik *et al.* (2004)). A key aspect of institutions is their association with governance and therefore it is instructive to identify its determinants. Corruption – a key feature of governance and institutional quality – alone is the subject of a considerable and constantly growing literature that discusses its causes.[1] Similarly, several factors have been proven to be conducive to the formation of sound systems of governance. In particular, the institutional differentials across the world have been ascribed to ethnic diversity (Mauro (1995)), distance from equator and language (Hall and Jones (1999)), the extractive (versus non-extractive) institutions of European settlers  (Acemoglu *et al.* (2001)), foreign aid dependence (Knack (2001)), natural resources (Easterly and Levine (2003)), generalised morality (Tabellini (2008)) and, recently, culture (Maseland (2013)).

The aim of this paper is to contribute towards this direction by proposing a new factor that could potentially affect institutions; political leaders. Exploiting an existing framework, I argue that changes in leadership cause variations on the level of certain prominent features of governance. This study complements the aforementioned literature and highlights the complexity of understanding the institutional determinants and consequences.

The framework I adopt builds on a relatively recent study on the driving forces of growth. Specifically, Jones and Olken (2005) (JO hereafter) investigate the impact of political leaders on economic development assuming that since growth varies significantly among countries across decades, one causal factor might be leadership transitions. Ultimately, their findings provide support for this hypothesis. It is noteworthy that the potential endogeneity concern with respect to leaders' transitions is effectively treated by employing leaders' *deaths* occurred by *natural* causes whilst in office.

In this study I adopt the methodology of JO to examine the impact of leaders on governance. Particularly, I try to find a statistically significant affect of leaders on the quality of governance, as represented by indicators of corruption, bureaucratic quality and the rule of law. The results indicate that leaders do influence

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[1] Treisman (2007) offers an excellent review in this respect.

bureaucratic quality and the rule of law. Further investigation shows that these effects are particularly pronounced in autocratic regimes. Finally, the results do not provide any sign of a substantial leadership effect on corruption, an outcome probably dictated by the inadequate data and the nature of concept.

Given that the JO framework constitutes the backbone of this study, the next section presents this paper. Section 3 describes the methodology and Section 4 the data of this paper. Section 5 reports the main results and Section 6 studies differences between democratic and autocratic regimes. Finally, Section 7 concludes.

## 1.2   The contribution of Jones and Olken (2005)

As mentioned before, this seminal work attempts to shed some light on the determinants of growth by introducing the changes in leadership as a driving force. The paper traces its motivation to an old debate about the role of individuals and external forces throughout history. Particularly, on the one hand, there is the view that leaders have very little impact on the events in the course of time, in fact, acting upon the options that they are offered by obscure socioeconomic forces, which are out of their control. On the other hand, there is the school that considers most events in history being the outcome of decisions of a handful of influential individuals. Somewhere in the middle between these two extremes, lies the view that leaders' actions can be decisive as long as this is allowed by the contemporary institutional context.

Given this perpetuating controversy, the paper attempts to find statistical evidence of the leaders' role with regard to growth. In this respect, the authors introduce a linear association between growth and leader quality and examine whether the latter's coefficient is different from zero or not with the integration of a parametric Wald test. Later on, they relax the underlying assumptions of the parametric procedure and perform additional (non-parametric) tests independent of the growth structure.

The leadership data is assembled by the authors including all national leaders around the world after World War II for the period 1945-2000, for whom growth data is available from the Penn World Tables. In order to cope with underlying endogeneity issues between transitions and economic performance, they consider

only deaths while in office, either by natural causes or accidents. The final sample consists of 57 leadership transitions.

The results clearly indicate that leaders matter for growth even after several robustness checks. Furthermore, assuming that the leader's influence might be dictated by the institutional context, the sample is divided into "democrats" and "autocrats" according to the distinction of the "polity" variable from the Polity IV dataset.[2] The findings show that autocrats appear more able to affect the growth path of their nations. Additional outcomes suggest that the presence of political parties negates the impact of autocrats while the seizure of power[3] seems to increase their effect. Also, classifying countries according to their income level, it is shown that mainly the actions of autocrats of middle-income regions are decisive with respect to growth.[4] Finally, the study examines potential effects of leaders on indicators of monetary, fiscal, trade and security policy presenting strong evidence only in the case of autocrats when inflation is used as a measure of monetary policy.

## 1.3   Methodology

This section replicates the corresponding section from JO, nevertheless, it is included for reasons of consistency and inclusiveness.[5] Given that the main hypothesis of this paper is focused on the association of governance with leaders the following specification is introduced

$$g_{it} = v_i + \varphi l_{it} + \varepsilon_{it}, \tag{1}$$

where $g_{it}$ is the *change* in governance in country $i$ at time $t$, $v_i$ is a fixed effect of the country $i$ and $\varepsilon_{it}$ is a normally distributed error term with mean 0 and variance $\sigma_{\varepsilon i}^2$.[6] The variable $l_{it}$ denotes the quality of the leader and is fixed through her life. Supposing that leaders are selected following this pattern

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[2] The same classification is introduced here as well, thus further details in this respect will be provided later on.
[3] For instance, gaining power through some type of coup rather than being elected.
[4] There is some weak evidence about the impact of both types of leaders in high-income countries as well.
[5] In addition, I also draw on the working paper version of the paper (Jones and Olken (2004)).
[6] Whenever "governance" is mentioned from now on, it implies the change in certain aspects of governance, unless it is stated differently. For more details on these aspects see the next section.

$$l_{it} = \begin{cases} l_{it-1} & P\left(\delta_0 g_{it} + \delta_1 g_{it-1} + \dots\right) \\ l' & 1\text{-}P\left(\delta_0 g_{it} + \delta_1 g_{it-1} + \dots\right) \end{cases},$$

where $l$ and $l'$ are normally distributed with mean $\mu$, variance $\sigma_l^2$ and $Corr(l,l') = \rho$. Effectively, this expression indicates that the probability of a leadership transition is a function of the quality of governance. Given the past incidence of governance ($\delta_0 g_{it} + \delta_1 g_{it-1} + \dots$), leader quality $l_{it}$ at time $t$ might continue to be the same as before ($l_{it-1}$) or change to $l'$, in which case a leadership transition occurs.

The hypothesis of interest is whether $\varphi = 0$ or not, i.e. whether leaders have an impact on governance or not. If leader transitions were exogenous, then it would be reasonable to consider the joint significance of the leader fixed effects. However, since there are endogeneity concerns, this approach might give significant results even under the null $\varphi = 0$ due to the level of governance being associated with leadership transitions at the time they transpire.

A different approach would be to compare differences in dummies that are true $T$ periods before the leader's death and $T$ periods after the leader's death. Using this method, the end periods of these dummies are exogenously determined with respect to governance.

Particularly, $\overline{PRE_z}$ is defined as the average change in governance $T$ years before leader's death in year $z$ and $\overline{POST_z}$ as the average change in governance $T$ years after the leader's death. The dummies then are distributed according to

$$\overline{PRE_z} \sim N\left(v_i + \varphi l, \frac{\sigma_{\varepsilon i}^2}{T}\right)$$
$$\overline{POST_z} \sim N\left(v_i + \varphi l', \frac{\sigma_{\varepsilon i}^2}{T}\right),$$

where $\sigma_{\varepsilon i}^2 / T$ is the sampling variance. Given that $l$ and $l'$ are distributed normally, with mean $\mu$, variance $\sigma_l^2$ and correlation $\rho$, the above expressions can be rewritten as

$$\widehat{PRE}_z \sim N\left(v_i + \varphi\mu, \frac{\sigma_{\varepsilon i}^2}{T} + \varphi^2\sigma_l^2\right)$$

$$\widehat{POST}_z \sim N\left(v_i + \varphi\mu, \frac{\sigma_{\varepsilon i}^2}{T} + \varphi^2\sigma_l^2\right)$$

Hence, the change in governance in country $i$ is

$$\widehat{POST - PRE}_z \sim N\left(0, 2\frac{\sigma_{\varepsilon i}^2}{T} + 2\varphi^2\sigma_l^2(1-\rho)\right). \tag{2}$$

From (2), it is evident that the variance of $\widehat{POST - PRE}_z$ is equal to the sampling variance, $2\sigma_{\varepsilon i}^2/T$, plus the variance from the difference in leaders, $2\varphi^2\sigma_l^2$, less twice the covariance due to the correlation in leaders, $2\varphi^2\sigma_l^2\rho$. Moreover, if there is a shift in leader's quality after a leader's death, so that $El = \mu$ and $El' = \mu'$ then (2) becomes

$$\widehat{POST - PRE}_z \sim N\left(\varphi(\mu'-\mu), 2\frac{\sigma_{\varepsilon i}^2}{T} + 2\varphi^2\sigma_l^2(1-\rho)\right). \tag{3}$$

If the null hypothesis is true, then $\varphi = 0$ and (3) is now

$$\widehat{POST - PRE}_z \sim N\left(0, 2\frac{\sigma_{\varepsilon i}^2}{T}\right).$$

Thus, the test if leaders matter is a test of whether $\widehat{POST - PRE}_z$ is distributed according to $N\left(0, 2\frac{\sigma_{\varepsilon i}^2}{T}\right)$ or not. If the null is rejected the distribution of $\widehat{POST - PRE}_z$ is according to (3) and leaders *do* matter.

Given the hypothesis above, the resulting Wald test is

$$J = \frac{1}{Z}\sum_{i=1}^{Z}\frac{\left(\widehat{POST - PRE}_i\right)}{2\frac{\widehat{\sigma_{\varepsilon i}^2}}{T}}, \tag{4}$$

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where $\widehat{\sigma_{\varepsilon i}^2}$ is an estimate of $\sigma_{\varepsilon i}^2$ and $\overline{POST-PRE_i}$ is defined as the change in the governance around a leader's death in country $i$ and $Z$ is the number of leaders. If the number of observations of country $i$ is large enough then $\widehat{\sigma_{\varepsilon i}^2}$ is a good estimate of $\sigma_{\varepsilon i}^2$ and $J$ is distributed as a $\chi^2(Z)$.

At this point, the Wald test deserves some comments. Leader effects will be detected if the variance of $\overline{POST-PRE_z}$ under the alternative is greater than the null. Thus leader effects will be detectable if

$$1+\frac{\varphi^2\sigma_l^2(1-\rho)}{\dfrac{\sigma_{\varepsilon i}^2}{T}}>1$$

Observing this expression, it can be easily noticed that if $\rho$ is close to 1 or $\sigma_l^2$ is close to 0, meaning that successive leaders are similar, the test will fail to reject the null. In addition, if the process tends to be noisy, such that $\sigma_{\varepsilon i}^2$ is high, the possibility of failing to reject the null is increased.

What's more, there may be substantial heterogeneity in $\varphi$ and $\rho$ across countries, so that leaders may affect governance in some countries but not in others. In order to control for this possibility, subsamples of the original leader sample can be created according to some observable characteristics that leaders share.

## 1.4 Data

This study uses data for leaders and governance indicators. The leader dataset has been very kindly provided by one of the authors of JO. The institutional indices are compiled by PRS and comprise part of its ICRG (International Country Risk Guide) indicators. PRS is a firm that supply assessments of the socioeconomic environment of countries to investors and its measures are widely used in the academic literature.[7] In this paper, I use three of these indicators; corruption, bureaucratic

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[7] See, for instance, the review in Lambsdorff (2006).

quality and the rule of law.[89] An advantage of these indicators is that they are provided yearly since 1984, being the longest available series.[10]

As mentioned in Section 2, the original leaders dataset covers the post-war period between 1945-2000. Hence, the overlapping period of the leaders and governance datasets is only 17 years. As a result, the sample of leadership transitions is significantly reduced from 57 to just 13 leaders' deaths. This is one of the major shortcomings of this study, which unfortunately cannot be mitigated due to the lack of alternative measures with longer time span.[11]

## 1.5 Results

The specification used to perform the Wald test is

$$g_{it} = \alpha_z PRE_z + \beta_z POST_z + v_i + u_t + \varepsilon_{it}, \qquad (5)$$

where $g_{it}$ is the change in governance, $i$ denotes the country, $t$ the time and $z$ the leader death. The two regressors, $v_i$ and $u_t$ represent the country and time fixed effects respectively. There are also the two dummies, $PRE_z$ and, $POST_z$ assigned to each leader's death. The former is a dummy equal to 1, $T$ years before leader's $z$ death, while the latter is a dummy equal to 1, $T$ years after leader's $z$ death. Moreover, two separate dummy coefficients, $\alpha_z$ and $\beta_z$, are assessed for each leader $z$. $\varepsilon_{it}$ is a normally distributed error term with mean 0 and variance $\sigma_{\varepsilon i}^2$. In order for the time fixed effects to be estimated, equation (5) is run for all countries and years of the dataset, including countries without leaders' deaths.

The $T$ years of the observation period for the two dummies are equal to 5. Furthermore, the two dummies are set in a way that the actual year of leader's death is not included in neither of them. This way, the model refrains from incorporating any short-term distortions stemming from the transition period.

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[8] Definitions of these variables are presented in the Appendix (as made by Knack (2001)).

[9] Typically, these measures range between 0 (worst) and 6 (best), but in this occasion they have been rescaled onto the interval [0,1], where higher value denotes better institutional environment.

[10] It would have been instructive to test the findings against experience-based measures of corruption such as the Global Barometer Survey of Transparency International and World Business Environment Survey from the World Bank, but these are only available for one or two years.

[11] JO also reports some results using less than 10 leader transitions. Surprisingly, in one of these cases, there is just 1 leader death. Of course, this does not constitute a formal line of reasoning, however, it highlights the fact that sometimes when the resources are limited, inference might hold some credibility even under otherwise inadequate conditions.

Table 1 presents the first results from the estimations of leaders' impact on institutions, focused on bureaucratic quality and the rule of law. Columns (1) and (3) present the J-statistics defined in (4) and columns (2) and (4) their corresponding p-values. Further computations were performed (not shown here) for a subsample of leaders who remained in office at least two years prior to their death, but the results remain qualitatively (and to a large extent quantitatively) unchanged.[12][13]

Three different timings of the *PRE* and *POST* dummies are presented. The actual timing is $t$. In the table are also presented $t+1$ and $t+2$ timings, which shift the *POST* dummy 1 and 2 years later in time. These are included, in order to ensure that whatever the effects that are ascribed to leaders, are not due to temporary changes during the transition period of their deaths. Particularly, in the

**Table 1**
Dependent Variables: Change in Bureaucratic Quality/Rule of Law

|  | Bureaucratic Quality | | Rule of Law | |
| --- | --- | --- | --- | --- |
|  | (1)<br>J-statistic | (2)<br>p-value | (3)<br>J-statistic | (4)<br>p-value |
| Treatment Timings |  |  |  |  |
| $t$ | 2.074 | 0.013** | 2.014 | 0.016** |
| $t+1$ | 2.669 | 0.002*** | 2.331 | 0.007*** |
| $t+2$ | 2.481 | 0.006*** | 2.337 | 0.009*** |
| Control Timings |  |  |  |  |
| $t-5$ | 1.099 | 0.358 | 1.146 | 0.323 |
| $t-6$ | 0.946 | 0.483 | 0.996 | 0.440 |
| Number of leaders | 13 | 13 | 13 | 13 |
| Number of observations[14] | 5567 | 5567 | 5567 | 5567 |

The null hypothesis is that the level of corruption is similar before and after the randomly-timed leader transition. p-values show the probability that the null is true. The J-statistic is presented in equation (4) and when the null is true, it is equal to 1. Higher values of J indicate higher probability of the null being false. The p-values in column (2) are from Chi-squared tests, where the POST and PRE dummies are estimated using OLS. The timings "t+1" and "t+2" shift the POST dummy 1 and 2 years in the future respectively. The timing "t" considers the change in the dependent variable during 5 years before and after the transition year. The control timings shift both dummies 5 and 6 years in the past. Significance at the 10 percent, 5 percent and 1 percent level are denoted by *, **, *** respectively.

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[12] In fact, the leader sample remains essentially the same in this occasion, thus this is no surprise.

[13] The same exercise was also performed for corruption producing similar outcomes.

[14] The number of observations is included only in this table because it remains constant throughout the rest of the tests.

$t+1$ timing, the transition year is excluded along with the subsequent year. The same goes for the $t+2$ timing, excluding 2 subsequent years instead of 1.

Furthermore, the table includes estimations for "control timings", which, in effect, work as robustness checks. These timings shift dummies 5 and 6 years in the past, denoted $t-5$ and $t-6$ respectively. They are estimated in order to ensure that the identification strategy and process (1) are valid. Hence, these timings should fail to reject the null if the assumptions for the identification and error structure are true.

The results strongly suggest that leaders matter for both of these institutional features. The null hypotheses are strongly rejected at time $t$ as well as at timings $t+1$ and $t+2$, indicating that the impact of leaders on bureaucratic quality and the rule of law should not be attributed to temporary effects during the transition. At the same time, all the control timings fail to reject the null suggesting that the identification and error structure assumptions are true. To present a sense of magnitude of the leaders' effects, both J-statistics are exceeding the value of 2 suggesting more than 100 percent increase than the normal in the variation of the coefficients on $POST-PRE$ at the time of the leader's death. The proposed scale of impact might be considered an overestimation given the limited sample; nonetheless, it can be suggestive that the leaders' influence is different from naught.[15] Additionally, a non-parametric version of the Wald test in (4), which is independent of the assumptions about the structure of governance, is run and the results remain qualitatively unchanged.[16]

In contrast with the previous findings, corruption (Table 2) does not seem to be statistically associated with leadership transitions. All p-values in the treatment timings are higher than 10 percent and the $t-5$ control timing unequivocally rejects the null. Only the $t-6$ timing provides encouraging signs. However, this is not enough to counterbalance the lack of support of the alternative hypothesis ($\varphi \neq 0$).

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[15] At this point, it would be instructive to mention that the latter and forthcoming results indicate the *existence* of a leadership effect on the two governance components; not the direction of the effect. Such inferences would be beyond the function of this model and the scope of this study.

[16] This is true for the forthcoming results too.

**Table 2**
Dependent Variable: Change in Corruption

|  | (1) J-statistic | (2) p-value |
|---|---|---|
| Treatment Timings |  |  |
| $t$ | 0.595 | 0.860 |
| $t+1$ | 0.756 | 0.685 |
| $t+2$ | 1.433 | 0.158 |
| Control Timings |  |  |
| $t-5$ | 3.629 | 0.000*** |
| $t-6$ | 1.236 | 0.267 |
| Number of leaders | 13 | 13 |

See notes to table 1.

These latter findings should not come as a surprise. The ICRG corruption index, being part of a group of similar aggregate corruption measures[17], represents *perceptions* of analysts rather than actual experience of the incidence of malfeasance. The pitfall in this circumstance is that such beliefs about the level of wrongdoing might be coloured by the country's economic performance, media exposure of scandals, anti-corruption campaigns and prejudice. As a result, this indicator cannot accurately capture the pervasiveness of misconduct. On top of that, the use of this particular measure has been cautioned in the literature, because, in reality, it does not evaluate the level of corruption but the political instability stemming from its incidence (Svensson (2005); Lambsdorff (2006)). Also, Arsenis (2013) provides statistical evidence of the measure's limited reliability in comparison to scales of the same class. All in all, given the inherent methodological, conceptual and statistical shortcomings of this measure, the aforementioned outcomes should not be short of our expectations.

Having performed the first round of tests two patterns emerge. On the one hand, bureaucratic quality and the rule of law are unambiguously affected by leaders' decisions and actions. On the other hand, corruption seems to be quite immune to their power. What's more, I have already argued above that this result is probably driven by the inadequacy of the data. But is this an outcome one should expect even

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[17] For instance, in the same group can be found the Corruption Perceptions Index from Transparency International and the Control of Corruption from the World Bank.

when suitable data is available? Probably, yes. As mentioned in the Introduction there is an increasing literature that corroborates the view that current levels of institutional quality are historically rooted. Furthermore, corruption seems to be shaped by institutional quality (Jain *et al.*, 2011) along with other predetermined factors such as British heritage and Protestant tradition (Treisman, 2000). Given these findings and combining them with the inherent classified nature of wrongdoing, one can imagine that changing the prevalence of such an obscure variable seems to be a very problematic issue, even for powerful individuals. Bureaucratic quality and the rule of law, however, are more likely to be influenced by the political elite, since these reflect straightforward regulations and laws that intertwine the governmental mechanisms. To sum up, the data shortcomings in conjunction with the very perplexing nature of corruption constitute its tractability doubtful and vindicate the lack of effect witnessed here.

## 1.6 Extensions

So far, results have established that leaders have significant impact on bureaucratic quality and the rule of law, but not on corruption. The extent of leaders' impact though might be driven by the institutional framework under which they act. In order to incorporate such dynamics into the existing framework, I investigate how subsamples of leaders who share common institutional attributes interact with governance.

Using the "polity" variable from the Polity IV dataset, leaders are classified according to the score they achieve. In particular, the leaders whose nations score less than or equal to 0 in the year prior to leader's death are defined "Autocrats", while those who score above 0 are defined "Democrats". The results for all three governance attributes are presented in tables 3, 4 and 5.

The findings support the hypothesis of interaction of leaders with the institutional context. Only autocrats appear to have substantial impact on bureaucratic quality (Table 3) and the rule of law (Table 4). This is true even when shifting the POST dummy 1 and 2 years forward in time. Accordingly, the p-values of the control timings are sufficiently high, such that no concerns about the identification strategy should be raised. As far as corruption (Table 5) is concerned, neither autocrats nor democrats present evidence of any statistical association. The corresponding statistics of the control timings only verify this outcome; in most

occasions the null is rejected when the opposite would validate the identification process.

**Table 3**
Dependent Variable: Change in Bureaucratic Quality

|  | Autocrats | | Democrats | |
| --- | --- | --- | --- | --- |
|  | (1) J-statistic | (2) p-value | (3) J-statistic | (4) p-value |
| Treatment Timings |  |  |  |  |
| $t$ | 2.211 | 0.011** | 1.336 | 0.263 |
| $t+1$ | 2.688 | 0.004*** | 2.610 | 0.074* |
| $t+2$ | 2.840 | 0.004*** | 1.160 | 0.313 |
| Control Timings |  |  |  |  |
| $t-5$ | 1.275 | 0.258 | 0.677 | 0.556 |
| $t-6$ | 0.614 | 0.720 | 1.603 | 0.186 |
| Number of Leaders | 11 | 11 | 2 | 2 |

See notes to table 1. Leaders are classified according to their nation's "polity" score from the Polity IV dataset one year before the leader's death. Autocrats are the leaders, whose countries have achieved a score of less than or equal to 0. Democrats, accordingly, scored greater than 0.

**Table 4**
Dependent Variable: Change in Rule of Law

|  | Autocrats | | Democrats | |
| --- | --- | --- | --- | --- |
|  | (1) J-statistic | (2) p-value | (3) J-statistic | (4) p-value |
| Treatment Timings |  |  |  |  |
| $t$ | 2.16 | 0.014** | 1.218 | 0.296 |
| $t+1$ | 2.581 | 0.006*** | 1.260 | 0.284 |
| $t+2$ | 2.758 | 0.005*** | 0.736 | 0.479 |
| Control Timings |  |  |  |  |
| $t-5$ | 0.778 | 0.606 | 1.968 | 0.116 |
| $t-6$ | 0.845 | 0.535 | 1.271 | 0.282 |
| Number of Leaders | 11 | 11 | 2 | 2 |

See notes to table 3.

**Table 5**
Dependent Variable: Change in Corruption

|  | Autocrats | | Democrats | |
|---|---|---|---|---|
|  | (1) J-statistic | (2) p-value | (3) J-statistic | (4) p-value |
| Treatment Timings |  |  |  |  |
| $t$ | 0.422 | 0.947 | 1.553 | 0.212 |
| $t+1$ | 0.640 | 0.764 | 1.294 | 0.274 |
| $t+2$ | 1.531 | 0.141 | 1.103 | 0.332 |
| Control Timings |  |  |  |  |
| $t-5$ | 4.137 | 0.000*** | 2.420 | 0.064* |
| $t-6$ | 0.521 | 0.793 | 2.652 | 0.047** |
| Number of Leaders | 11 | 11 | 2 | 2 |

See notes to table 3.

Contemplating on the outcomes above two suggestions emerge. Firstly, the uniformity of the bureaucratic quality and rule of law outputs reflects the fundamental differences between democracies and autocracies. Comparing the two institutional systems, democracies hold their leaders more accountable for their actions and place more constraints on their authorities and prerogatives. Leaders of autocratic regimes tend to exert more power in institutions retaining most (if not all) of their control, while it is unlikely that they will become liable for their unlawful actions during their tenure. Nevertheless, it is necessary to exercise prudence when explaining these findings, since the limited number of leaders, especially in democratic regimes, allows for debate. In any case, the results *do* support the intuition if this is to endow them with some level of credibility. Secondly, corruption, once again, does not manage to demonstrate any association with leaders, underpinning the initial findings and the following interpretation.

A final concern about my main results that I would like to address in this section is whether African and Latin American countries drive the effects observed. From the 13 leaders of my sample, 5 are from these regions, leaving 8 to be included in this specification check. Table 6 reports the results including only the p-values to save space. As can be easily verified, the results remain qualitatively unaffected. Bureaucratic quality and the rule of law maintain their significance, while corruption never achieves sufficiently low p-values. The control timings confirm the

assumed governance process for the former two variables, but they invalidate it for the latter in one case.

**Table 6**
Dependent Variable: Change in Corruption/Bureaucratic Quality/Rule of Law

| | p-values | | |
|---|---|---|---|
| | Bureaucratic Quality | Rule of Law | Corruption |
| Treatment Timings | | | |
| $t$ | 0.024** | 0.014** | 0.788 |
| $t+1$ | 0.009*** | 0.008*** | 0.543 |
| $t+2$ | 0.008*** | 0.006*** | 0.196 |
| Control Timings | | | |
| $t-5$ | 0.698 | 0.576 | 0.054** |
| $t-6$ | 0.795 | 0.889 | 0.135 |
| Number of Leaders | 8 | 8 | 8 |

See notes to table 1. Only p-values are reported. Leaders of African and Latin American countries are excluded.

## 1.7  Conclusion

It is an established notion that healthy institutions promote economic development around the world. Understanding the factors that structure sound institutional environments could lead to greater economic equality and prosperity within and across nations. The suggested determinants spring from history, geography and psychology. This study though draws attention to the influential forces of individualism. The assumption that I seek to substantiate is whether political leaders bear the capacity to reshape the quality of governance, either in a constructive or detrimental way.

I exploit an existing framework to structure the empirical test, which will answer the hypothesis. Even though the data is embedded with limitations, the findings are quite strong and robust in that leaders affect bureaucratic quality and the rule of law. Corruption, however, does not show any noteworthy association with leadership; an outcome probably determined by the inadequacy of the measure but perhaps, also, the virulence of the disease. Another important finding is the significant interaction of leaders with the existing institutional framework. It is shown that the impact of their actions could depend on the level of totalitarianism of the state. Autocratic

regimes obtain more power for their leaders granting them greater capacity to change the quality of the bureaucratic mechanism and the rule of law.

Despite the fact that this study has substantial scope for improvement in the future, these preliminary results point towards a new direction when pondering the institutional causes. Specifically, despite the fact that the roots of institutions can be traced back in history and the natural environment, leaders are the individuals who decide how to use the society's endowments. Hence, a nation's path on the way to prosperity lies (at least to a certain extent) on the peoples' hands whose aspirations are reflected by their leaders' demeanour and actions. This realisation is crucial, especially for countries that are trapped in vicious circles of poverty and inequality and want to escape from their unfortunate circumstances.

# 1.8   Appendix

*Corruption*

Lower scores of corruption under ICRG indicate that "high government officials are likely to demand special payments", "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licenses, exchange controls, tax assessment, police protection, or loans".

*Bureaucratic Quality*

High scores indicate "an established mechanism for recruitment and training", "autonomy from political pressure", "strength and expertise to govern without drastic changes in policy or interruptions in government services" when governments change.

*Rule of Law*

This variable "reflects the degree to which the citizens of a country are willing to accept the established institutions to make and implement laws and adjudicate disputes". Higher scores indicate "sound political institutions, a strong court system, and provisions for an orderly succession of power". Lower scores indicate "a tradition of depending on physical force or illegal means to settle claims". Upon changes in government new leaders "may be less likely to accept the obligations of the previous regime" in low scoring countries.

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# Corruption, Fertility, and Human Capital[*]

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**Abstract**

We build an overlapping generations model in which reproductive households face a child quantity/child quality trade-off and bureaucrats are delegated with the task of delivering public services that support the accumulation of human capital. By integrating the theoretical analyses of endogenous growth, corruption and fertility choices, we offer a novel mechanism on the driving forces behind a salient feature of demographic transition. In particular, we attribute the decline in fertility to the endogenous change in the incidence of bureaucratic corruption that occurs at different stages of an economy's transition towards higher economic development. Additionally, the model accounts for the empirically established incident of volatile fertility rates.

*Keywords:* Corruption; Demographic transition; Human capital; Economic growth

*JEL Classification:* D73; H52; J13; O41

## 2.1  Introduction

One of the most striking aspects of demographic transition is the observation that the reduction in birth rates appears to coincide with an increase in the amount of resources that parents devote to the physical and mental development of each of their offspring. This fact has led to the idea that parents face a trade-off between child quantity and child quality – a trade-off whose balance shifts away from the former and towards the latter as an economy goes through the more advanced stages of its development process. Empirical support for this hypothesis has been provided by a plethora of analyses over the years (e.g., Rosenzweig and Wolpin 1980; Hanushek 1992; Black *et al.* 2005; Bleakley and Lange 2009). Existing theoretical analyses have attributed this outcome to characteristics of more developed economies, such as reduced child mortality (Kalemli-Ozcan 2003; Soares 2005); the higher efficiency of educated parents in educating their own children (Moav 2005); the reduced need for the income derived from child labour (Hasan and Berdugo 2002); and the reduction in income inequality (de la Croix and Doepke 2003).

In this paper we offer a new explanation for this aspect of demographic transition. In particular, we attribute it to the endogenous change in the incidence of bureaucratic corruption that occurs at different stages of an economy's transition towards higher economic development.

The relation between bureaucratic corruption and economic development has been investigated extensively in the past. It is still a major issue of concern for economists interested in the dynamics of growth and development. Despite the fact that some earlier studies asserted that corruption may benefit economic growth through the role of bribery as 'speed money' that reduces the costs associated with red tape (Leff 1964), the most recent evidence establishes a negative association between the incidence of corruption and economic growth. Mauro (1995) shows that public sector corruption has a negative effect on growth, mainly through its adverse impact on private investment. Keefer and Knack (1997) find that the lagged convergence of less-developed countries to the growth rates of developed countries is (to a large extent) attributed to deficient institutions and widespread corruption. Gyimah-Brempong (2002) presents evidence of a substantial adverse effect of corruption on the growth rate of real per capita GDP in African countries. Aidt (2009) studies the relationship between corruption, institutions and economic

development, and finds evidence suggesting that corruption is a serious impediment to measures of sustainable development that incorporate human capital, natural capital and institutional quality, in addition to physical capital investment. Gundlach and Paldam (2009) employ a novel methodological approach to show that the causality in the relation between economic development and corruption runs from the former to the latter. Bhattacharyya and Hodler (2010) argue that the failing of democratic institutions can increase the incidence of corruption in economies that are rich in natural resources.

The argument we provide in our analysis is the following. The return to the resources that parents offer for the mental development of their children (for example, their human capital) is supported by the delivery of such productive services as public education, public health and other forms of public infrastructure investment. Insofar as bureaucratic corruption hinders the delivery and the quality of such services, parents will have a reduced incentive in providing resources that support child quality. Hence, they will find optimal to divert their resources towards child quantity. As the incidence of bureaucratic corruption may decline at advanced stages of economic development, a demographic transition may occur as a direct outcome of reduced corruption in the public sector of the economy.

We verify this assertion in the context of an overlapping generations model in which households face a child quantity/child quality trade-off and bureaucrats are delegated with the task of procuring public services that support the accumulation of human capital. At low stages of development, some bureaucrats find optimal to choose low quality public projects because this allows them to embezzle part of the funds that are otherwise devoted to the procurement of public services. At higher stages of development, the incentive for this type of malversation disappears. As a result of the two-way causal effects between economic growth and the incidence of corruption, the model admits a threshold effect that is responsible for multiple growth equilibria. Furthermore, this threshold effect is translated into a demographic transition that is attributed to the fall in the incidence of bureaucratic corruption: as the economy grows, the endogenous decline in corruption will improve the provision of productive public services, thus inducing households to substitute child quality for child quantity.

All in all, our model implies a positive relationship between fertility and corruption, in the sense that higher corruption prevalence induces higher fertility

rates. Specifically, corruption triggers a child quantity/child quality trade-off through diminished productive public spending towards human capital accumulation, due to embezzlement of public funds. Thus, the mitigating effect of corruption on the return to human capital accumulation is the crucial link in the emergence of the model's mechanism. The empirical analysis of Mauro (1998) substantiates this mechanism since his cross-country econometric study that examines the effect of corruption on the composition of public spending suggests that corruption is a serious impediment to public spending on education.

To further motivate our analysis, we also present below some graphs illustrating the correlations between the aforementioned relationships. All figures pertain to the period from 1984 to 2008 and use the corruption indicator from the International Country Risk Guide (ICRG) of the PRS Group. Higher scores of this measure (in a scale from 0 to 6) indicate lower levels of corruption. Figures 1, 2 and 3 show the correlations of fertility rates, secondary education and literacy rates with corruption, respectively, evaluated on average for the discussed period. The fertility and human capital measures were taken from the World Development Indicators of the World Bank. All diagrams support the implications of our model presenting a positive relationship of corruption with fertility (fig. 1) and negative with human capital (fig. 2 and 3). Even though these are preliminary results and do not constitute robust empirical evidence, they are suggestive of the mechanism we are introducing here.

The preceding discussion reveals that our model can simultaneously account and provide a previously unexplored link for some distinct, but well known, stylised facts of economic development. On the one hand, there is the declining trend of population growth as per capita income increases. On the other hand, we have the lower incidence of corrupt practices from public officials in developed countries. Nevertheless, a closer look at the data reveals that, at the cross section, the latter observation may not necessarily imply a monotonically negative relation between corruption and per capita income. Blackburn (2012) presents some very informative summary statistics on the variation of Transparency International's Corruption Perception Index (CPI thereafter). He shows that whereas the CPI is uniformly high among high income countries and uniformly low among low income countries, a

closer inspection among middle income economies reveals a large variation on the value of the CPI and thus the presence of corruption – ranging from low to high.[18]
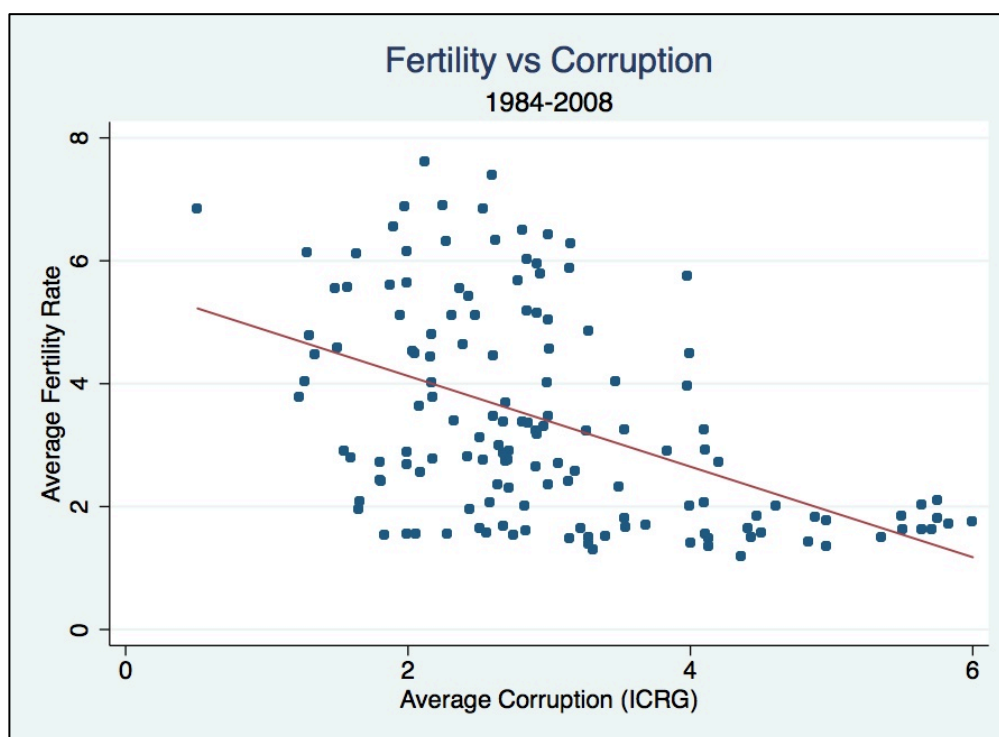
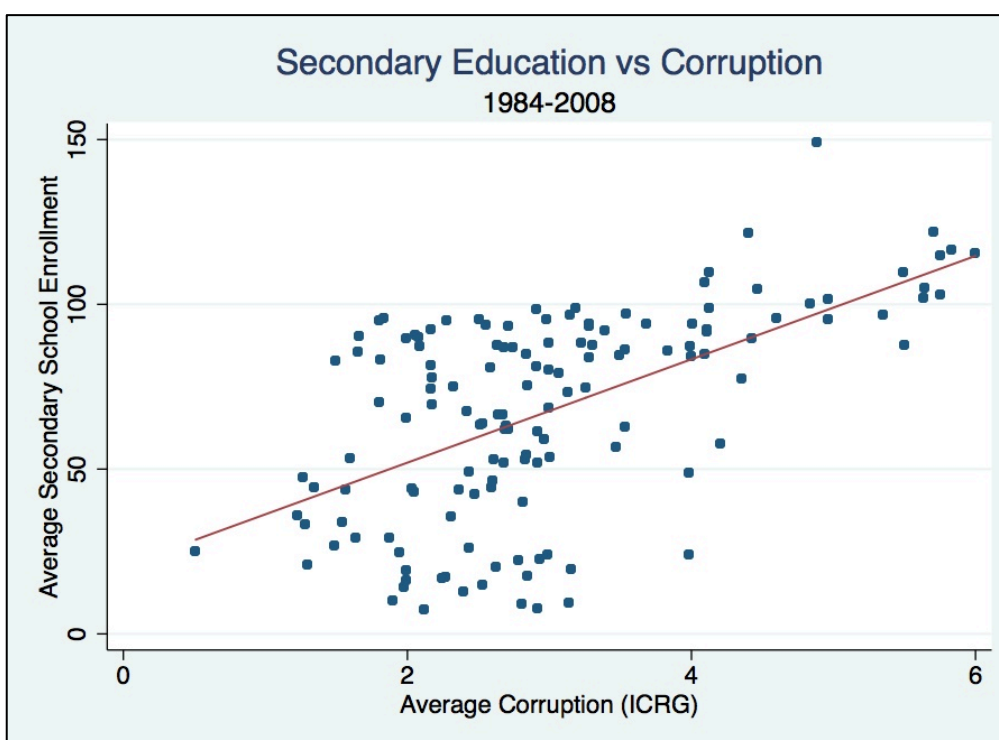**Fertility vs Corruption**
1984-2008

**Figure 1**

**Secondary Education vs Corruption**
1984-2008

**Figure 2**

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[18] Like the ICRG measure, the higher is a country's score in the CPI, the lower is extent corruption in that country.
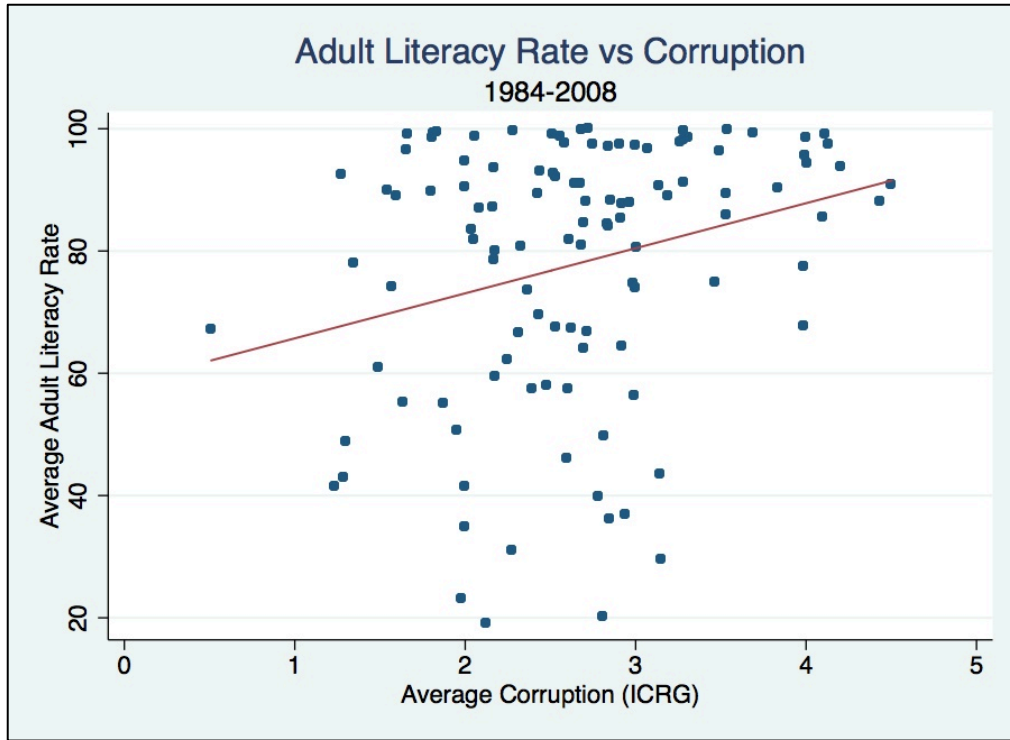
**Figure 3**

Our model can also account for this observation once we modify it to include monetary (in addition to utility) costs for corrupt bureaucrats who are eventually apprehended. The reason is the emergence of some type of strategic complementarity according to which the individual benefits of being corrupt are higher when there is a larger incidence of corruption among the bureaucracy. Consequently, for intermediate levels of income we find that equilibrium corruption is indeterminate – it can be either high or low. Given our model's mechanisms, this effect is infused into the equilibrium growth rate and the households' fertility decisions, thus rendering them indeterminate as well. Naturally, such indeterminacies are associated with the presence of (endogenous) volatility. Hence, our model can also shed some light on the empirical observation that fertility rates are volatile (see Easterlin 1987; Lee 1997).

Even though there are several analyses that investigate the incidence of corruption within the context of dynamic general equilibrium models of economic growth (e.g., Ehrlich and Lui 1999; Sarte 2000; Baretto 2000; Alesina and Angeletos 2005; Blackburn *et al.* 2006; Blackburn and Forgues-Puccio 2007; Blackburn and Sarmah 2008; Eicher *et al.* 2009; de la Croix and Delavallade 2011) to the best of our knowledge this is the first analysis to provide an explicit link

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between corruption, education and fertility choices.[19] Hence, it contributes to three distinct strands of literature – i.e., those analysing the links between education and economic growth, demographic transition and economic growth, and bureaucratic corruption and economic growth.

The remaining paper is organised as follows. In Section 2 we present the basic set-up of our economy, with detailed discussion on the characteristics of the government, the bureaucrats, and the households. Section 3 shows that corruption is endogenously determined and establishes its effect on public services, whereas Section 4 derives the economy's growth rate and attributes demographic transition to the reduction in the incidence of corruption. In Section 5 we enrich the set of penalties imposed to apprehended bureaucrats and discuss the equilibrium implications. Section 6 offers an extension regarding the reproductive characteristics of bureaucrats. In Section 7 we conclude.

## 2.2  The Economy

Time takes the form of discrete intervals that are indexed by $t = 0,1,2,\ldots$. The economy is populated by overlapping generations of agents who face a finite lifespan of two periods – *childhood* and *adulthood*. Each period, nature divides the population of newly-born agents into two separate groups: a fraction $\lambda \in (0,1)$ become *bureaucrats* and the remaining fraction $(1-\lambda) \in (0,1)$ become *households*. Henceforth, these two types of agents are going to be distinguished by a superscript $i = \{B,H\}$: for $i = B$ the person is a bureaucrat while for $i = H$ the person is a household. When they reach adulthood, all agents receive an endowment of a time unit which (depending on their type) they may allocate to various activities in a manner that will be described shortly.

Agents do not make any decisions during their childhood. All decisions are made during their adulthood. In particular, each adult will behave optimally by maximising her utility function

$$u_t^i = \alpha^i \ln(c_t^i) + (1-\alpha^i)\ln(n_t^i h_{t+1}^i), \tag{1}$$

[19] Blackburn and Sarmah (2008) analyse demography and corruption in a growth model, but they do not consider endogenous fertility. In their framework, each parent gives birth to one child exogenously and demographic changes are only due to variations in life expectancy. Our framework is rather different in that we focus on an aspect of demographic transition for which the endogeneity of fertility choices is of paramount importance.

where $c_t^i$ is the adult's consumption of the economy's homogeneous good, $n_t^i$ is the number of children she wants to rear, and $h_{t+1}^i$ denotes each child's human capital. The last term of the utility function indicates that adults are imperfectly altruistic towards their offspring. Specifically, a parent gets satisfaction by observing her children's human capital. This is meant to capture the idea that parents care about their offspring's future prospects and social status. The parameter $\alpha^i \in (0,1]$ weights the two arguments of the utility function.

By devoting $e_t^i$ units of time per child, the parent improves the human capital of each child according to

$$h_{t+1}^i = v\overline{h}_t + F_t (e_t^i)^x, \qquad (2)$$

where $v \in (0,1)$ and $x \in (0,1)$. The first term in (2) is meant to capture the idea that a child can pick-up a fraction $v$ of the economy's average human capital stock (that is, $\overline{h}_t$) even in the absence of any parental effort towards human capital improvements. The variable $F_t$ captures the benefit from the productive public services that the government will offer in support of the adults' efforts to educate their children. We do not need to associate these services solely with education. There can be other services that promote the efficiency of resources towards human capital and higher productivity – services such as public health; transportation; information technology infrastructure etc.[20] The provision of these public services requires that the government employs people that are able to deliver them – this is where the distinction between households and bureaucrats becomes important. We assume that the only group of adults with the innate ability to use their labour in order to deliver public services are the bureaucrats; households do not possess this ability. However, all adults (households and bureaucrats) have the ability to work for private sector firms.

We shall also assume that, if hired by the government, bureaucrats will have to devote their whole unit of time inelastically in the process of delivering public services. For this reason, most of our remaining analysis will be making use of the

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[20] The supporting effect of public spending on private effort towards education, captured by the term $F_t(e_t^i)^x$ in our model, is widely used in the existing literature. For instance, see the analyses of Kaganovich and Zilcha (1999); Blankenau and Simpson (2004); and Palivos and Varvarigos (2013).

assumption that nature does not bestow any altruistic motives to bureaucrats; only households are characterised by the altruistic motive to raise and educate children. Without this restriction, no bureaucrat would wish to work for the public sector because the time they would require for raising and educating their offspring would not allow them to devote the (required) unit of time in the process of procuring public services. Nevertheless, such occupational opportunity is essential for our analysis. Hence, we restrict our attention to

$$\alpha^H = \alpha \text{ and } \alpha^B = 1.$$ (3)

On the outset, this may appear to be a restrictive assumption. To appease the reader's concerns, in Section 6 we revise the original set-up so as to allow bureaucrats to be reproductive and to face a child quantity-child quality trade-off, exactly as households do. It will be shown that all the main results and their corresponding mechanisms remain intact even if we allow bureaucrats to be reproductive and altruistic towards their children. The reason why the results remain intact is because bureaucrats do not internalise the effect of their own (potentially corrupt) behaviour on the *aggregate* provision of public services and on the benefit that these services entail for their offspring. As we shall see later in more detail, each bureaucrat operates a single public investment project that is infinitesimally small as a part of the total mass of projects that comprise aggregate public services. For this reason, her fertility decisions would be qualitatively identical to that of a household. Nevertheless, this scenario generates additional complications entailing the presence of strong complementarities among bureaucrats when they make their individual decision on whether to be corrupt or not. Given that we try not to blur the intuition on the pure effect of economic development on the incidence of corruption, and consequently on the demographic characteristics of our economy, we shall proceed to the main part of the analysis utilising the assumption in (3). Then, we shall use Section 6 to establish that the main implications of our model remain unaffected, even when we generalise the fertility choices of the population by including bureaucrats in the reproductive cohort. Note that issues of complementarities in the bureaucrats' decision making process (i.e., when they decide on their disposition while in public office) will also be formally analysed and extensively discussed in Section 5 where we present a different extension to our original set-up.

The assumptions for the economy's demographics together with the restriction in (3) imply that the populations of adult households and adult bureaucrats in any period $t$ are given by $N_t^H = (1-\lambda)N_{t-1}^H n_{t-1}^H$ and $N_t^B = \lambda N_{t-1}^H n_{t-1}^H$ respectively. Consequently, we have

$$\frac{N_t^B}{N_t^H} = \frac{\lambda}{1-\lambda} \ . \tag{4}$$

Furthermore, in what follows we are going to remove the superscripts from variables over which only a household makes a choice, i.e., $n_t$, $e_t$ and $h_{t+1}$.

Taking account of (1), (2) and (3), a household member will choose how many children to rear, how much time to devote for the human capital of each child, as well as her consumption of the economy's homogeneous good in order to maximise her utility

$$u_t^H = \alpha \ln(c_t^H) + (1-\alpha)\ln(n_t h_{t+1}) , \tag{5}$$

subject to

$$c_t^H = w_t[1-(q+e_t)]h_t , \tag{6}$$

and

$$h_{t+1} = v\overline{h}_t + F_t e_t^x , \tag{7}$$

taking $F_t$ and $w_t$ as given. The parameter $q > 0$ in (6) captures the fixed cost (in units of time) of raising each child, while $h_t$ is her stock of human capital. Thus, the term $[1-(q+e_t)]h_t$ is her labour (measured in efficiency units) for which she receives a wage rate $w_t$.

The economy's homogeneous good is produced by a large mass (normalised to one) of perfectly competitive firms who employ *effective* labour, denoted $L_t$, to produce $y_t$ units of output according to

$$y_t = AL_t, \ A > 0 . \tag{8}$$

Firms face a flat tax $\tau_t \in (0,1)$ per unit of revenue. Therefore, the wage per unit of effective labour is equal to

$$w_t = (1 - \tau_t)A. \qquad (9)$$

As mentioned previously, these firms represent the only occupational option for households, whereas bureaucrats have two such options: they can be employed either in private sector firms or in the public sector. Thus, the equilibrium level of $L_t$ (which will be derived later) will take account of both households and bureaucrats employed in the private sector.

## 2.2.1 The Government

As we explained above, the government delegates the task of public service delivery to adults that have the ability to undertake such a task, i.e., to the bureaucrats. Every period, the government will devote $g_t$ units of output towards this purpose. We further assume that the government's spending on public services is proportional to the economy's GDP according to[21]

$$g_t = \theta\, y_t, \ 0 < \theta < 1. \qquad (10)$$

The funds available for public service delivery will be equally allocated among public sector employees. The government will instruct them to use all these funds, together with their unit of time, in order to finance a project that delivers the desired public services. In exchange, each bureaucrat employed in the public sector will receive remuneration equal to $\omega_t^B$.

There are two types of public projects that a bureaucrat can use in order to deliver public services. The Type-1 project's return is random: it will deliver $\xi > 1$ units of service with probability $\pi \in (0,1)$, or $\gamma < 1$ units of service with probability $(1-\pi) \in (0,1)$, for every unit of output invested to it. Note that the shock is not aggregate but idiosyncratic to each bureaucrat operating the project.[22] The Type-2 project can deliver $\dfrac{\gamma}{\delta}$ units of service with certainty for every unit of output invested to it. Note that $1 > \delta > \gamma > 0$ so that $\dfrac{\gamma}{\delta} < 1$. The government instructs each employed bureaucrat to operate the project that has the higher expected rate of

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[21] See Barro (1990).

[22] Naturally, we also assume that this idiosyncratic shock is private information (i.e., not observable by the government) as well.

return (in terms of services) per unit of invested output. Assuming that $\pi\xi \geq 1$, the government will instruct all bureaucrats to operate the Type-1 project.

We shall assume that each bureaucrat's ability restricts the size of a project that she can undertake. In particular, the maximum project size that a bureaucrat can handle is $\frac{g_t}{\kappa N_t^B}$, where $\kappa < 1$. It is also natural to assume that the government will wish to ensure a given amount of public services at the minimum possible cost. This entails that the government employs the minimum number of bureaucrats necessary to guarantee that public projects can be operated at the minimum possible salary. With respect to the number of public sector employees, it is straightforward to establish that the number of bureaucrats hired will be $\kappa N_t^B$.[23] With respect to their remuneration, bureaucrats will only be willing to accept a contract that will offer them $\omega_t^B \geq w_t h_t$. Given that bureaucrats could earn a salary of $w_t$ per unit of efficient labour by working in the private sector, any person accepting a contract with $\omega_t^B < w_t h_t$ would immediately convey to government authorities her opportunistic nature: she can only be willing to work for $\omega_t^B < w_t h_t$ if she expects to cover the shortfall by expropriating part of the public sector resources to which she will gain access.[24] Thus, the government can minimise the cost of hiring the necessary number of $\kappa N_t^B$ bureaucrats by offering a remuneration that satisfies

$$\omega_t^B = w_t h_t. \tag{11}$$

Every period, the government abides by a balanced-budget rule. Formally,

$$\tau_t y_t = g_t + \omega_t^B \kappa N_t^B. \tag{12}$$

According to (12), the government allocates its tax revenues between its spending for the delivery of public services and the total labour costs of the public sector.

### 2.2.2 The Bureaucrats

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[23] When $\kappa = 0$, the model is reduced to a standard one in which the government delivers services directly without the need of public workers. This is because an infinitesimal number of bureaucrats are sufficient to handle projects of any possible scale. We abscond from this scenario due to its limited interest.

[24] Recall that bureaucrats supply their unit of time inelastically irrespective of their occupation.

In this section we are going to discuss the characteristics of bureaucrats in more detail. We shall assume that they are heterogeneous in their moral attitudes concerning the option of misconduct that materialises when they work for the public sector. In particular, a fraction $p \in (0,1)$ of bureaucrats are *corruptible* in the sense that, when the opportunity arises, they may find optimal to illegally expropriate public resources for their own personal benefit. The remaining fraction $(1-p) \in (0,1)$ of bureaucrats is *non-corruptible* in that they have a strong moral stance that deters them from considering the embezzlement of public funds. This innate characteristic is private information to each bureaucrat and it is not observable by the government.

As we mentioned in the preceding part of the analysis, the government offers a contract of $\omega_t^B = w_t h_t$ that induces all bureaucrats to apply for a public sector job. Given its inability to observe each applicant's innate characteristic (whether she is corruptible or not) the government will randomly pick a fraction $\kappa$ of applicants and employ them in the public sector, instructing them to deliver public services according to the description of the previous section. Therefore, a number $p\kappa N_t^B$ of hired bureaucrats are corruptible while the remaining $(1-p)\kappa N_t^B$ hired bureaucrats are non-corruptible.

The applicants that are not hired, i.e., a number $(1-\kappa)N_t^B$ of them, will work for the private sector: by supplying their whole unit of time, they offer efficient labour of $h_t$ for which they receive labour income $w_t h_t$. They subsequently use this income to purchase consumption goods. Thus, their utility is $\ln(w_t h_t)$.

Each hired bureaucrat will be allocated $\dfrac{g_t}{\kappa N_t^B}$ units of funds with the instruction to operate the Type-1 project. Each non-corruptible bureaucrat will abide by the government's instructions and operate the Type-1 project, thus delivering $\xi \dfrac{g_t}{\kappa N_t^B}$ units of public service with probability $\pi$ or $\gamma \dfrac{g_t}{\kappa N_t^B}$ units of public service with probability $1-\pi$. As noted above, she will devote her whole unit of time in operating the project and will receive an income of $\omega_t^B$. Her utility is therefore $\ln(\omega_t^B)$.

Corruptible bureaucrats have the choice to behave either honestly or dishonestly. In the former case, they behave identically to non-corruptible bureaucrats and enjoy utility according to

$$u_t^{B\,(honest)} = \ln(\omega_t^B). \tag{13}$$

In the latter case however, a corruptible bureaucrat has the incentive to act as follows: she will only use $\delta \dfrac{g_t}{\kappa N_t^B}$ units of the funds allocated to her and operate the Type-2 project, thus delivering $\gamma \dfrac{g_t}{\kappa N_t^B}$ of public services. Yet, she will falsely claim that she operated the Type-1 project but had a bad realisation of her idiosyncratic shock. Hence, she will gain illegal rents of $(1-\delta) \dfrac{g_t}{\kappa N_t^B}$ in addition to her remuneration $\omega_t^B$.

Of course, by observing the aggregate outcomes in terms of public service delivery, the government will realise that some public sector workers engaged in wrongful conduct. In response, the government will use an imperfect monitoring technology that can identify, with probability $\eta \in (0,1)$, the bureaucrats whose behaviour was fraudulent. In this case, bureaucrats revealed as being corrupt pay a utility cost for their malversation. Particularly, they face a proportional utility cost of $\sigma \in (0,1)$. This cost captures the psychological distress of imprisonment, social stigma, embarrassment etc. Given these, the utility of a corrupted bureaucrat is given by

$$u_t^{B\,(dishonest)} = \begin{cases} \ln\left( \omega_t^B + (1-\delta)\dfrac{g_t}{\kappa N_t^B} \right) & \text{with prob.} \quad (1-\eta) \in (0,1) \\[4ex] (1-\sigma)\ln\left( \omega_t^B + (1-\delta)\dfrac{g_t}{\kappa N_t^B} \right) & \text{with prob.} \qquad \eta \in (0,1) \end{cases}. \tag{14}$$

As it is evident from (14), the penalty for bureaucratic malfeasance is psychological (e.g., imprisonment) and not pecuniary (e.g., confiscation of wealth through a monetary penalty). This may be the case where the corrupt official is successful in securing her wealth from government authorities (e.g., through money laundering). Nevertheless, to improve the robustness of our results under a more

general setting, in Section 5 we modify the model by adding a pecuniary penalty as well. It will transpire that this addition will not alter the main implication concerning the impact of corruption on fertility decisions. Nevertheless, it adds further equilibrium outcomes that merit discussion on their own right.

## 2.2.3 The Households

Households allocate their unit of time optimally by solving the problem described in equations (5)-(7). We can use the first-order conditions associated with this problem to get

$$n_t = \frac{1-\alpha}{q+e_t}, \tag{15}$$

and

$$\frac{\alpha n_t}{1-(q+e_t)n_t} = \frac{(1-\alpha)xF_t e_t^{x-1}}{v\overline{h}_t + F_t e_t^x}. \tag{16}$$

Equation (15) reveals that the marginal utility cost and the marginal utility benefit of having children must be equal. The former is the total time (rearing and education) that the household devotes to her offspring. The latter is equal to the relative weight of the altruistic motive in the adult's utility function. Given that this is constant, the result in (15) shows that the parent faces a quantity-quality trade-off in the determination of her family size.

Substituting (15) in (16) and multiplying both sides by $e_t$ yields

$$\frac{e_t}{q+e_t} = \frac{xF_t e_t^x}{v\overline{h}_t + F_t e_t^x}. \tag{17}$$

This result will determine the optimal amount of time that parents devote to the education of their offspring. By Equation (15), this will also determine the number of children that each household gives birth to. From Equation (17) we can see that productive public services represent an important element in the determination of these outcomes, as this is manifested by the presence of the variable $F_t$. Nevertheless, the ultimate provision of such public services depends on the extent of corruption among the bureaucrats who are delegated with the task of delivering them. In the next section, we turn our attention to this issue.

## 2.3 Endogenous Corruption and Productive Public Services

From Equations (13) and (14), it is obvious that a corruptible bureaucrat will act dishonestly as long as

$$E(u_t^{B\,(dishonest)}) > u_t^{B\,(honest)}, \tag{18}$$

or alternatively

$$(1-\eta\sigma)\ln\left(\omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}\right) > \ln(\omega_t^B). \tag{19}$$

Given our previous discussion, the total amount of efficient labour in the economy will be

$$L_t = (1-\kappa)h_t N_t^B + [1-(q+e_t)n_t]h_t N_t^H, \tag{20}$$

i.e., it is the sum of the efficient labour supplied by bureaucrats that are not employed in the public sector and by households. Substituting (20), together with (4) and (15) in (8) yields

$$y_t = Alh_t N_t^H = y(h_t), \tag{21}$$

where $l = (1-\kappa)\dfrac{\lambda}{1-\lambda} + \alpha$. Next, we can substitute (21), together with (4), (9), (10) and (11), in the government's budget constraint which is given in (12). This will determine the equilibrium tax rate as

$$\tau_t = \frac{\theta l + \kappa\dfrac{\lambda}{1-\lambda}}{l + \kappa\dfrac{\lambda}{1-\lambda}} = \hat{\tau}, \tag{22}$$

where $\hat{\tau} \in (0,1)$ because $\theta \in (0,1)$ by assumption.

Now, we can use (4), (9), (10), (11), (21) and (22) in (19) to get

$$(1-\eta\sigma)\ln\left(h_t\left[(1-\hat{\tau})A + \frac{(1-\delta)\theta Al/(1-\lambda)}{\kappa\lambda}\right]\right) > \ln(h_t(1-\hat{\tau})A). \tag{23}$$

As explained before, this condition determines a corruptible bureaucrat's incentive to be corrupted. It allows us to derive

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**Proposition 1.** *There is a threshold $\tilde{h}$ such that for $h_t < \tilde{h}$ all corruptible bureaucrats are corrupted while for $h_t \geq \tilde{h}$ none of the corruptible bureaucrats is corrupted.*

*Proof.* See the Appendix.  ∎

The result in Proposition 1 reveals that the incidence of corruption is an endogenous outcome that is determined by the economy's level of development. Other things being equal, in an economy with $h_t < \tilde{h}$ some bureaucrats have the incentive to raid on the economy's public coffers in order to maximise their own personal benefit. Such incentive does not exist in an economy for which $h_t \geq \tilde{h}$. The intuition behind this outcome is straightforward: as the economy develops and improves its stock of human capital, diminishing marginal utility implies that the increase in the marginal benefit from being corrupted becomes progressively smaller compared to the increase in the marginal benefit from being honest.

Note that the result in Proposition 1 has interesting implications on how institutional characteristics may affect the long-term prospects of an economy, despite the fact that they do not impinge on the accumulation of human capital directly. They do so indirectly by determining the incentive for illegal rent-seeking by corruptible bureaucrats. For instance, one can check Equation (A1) in the Appendix (where we provide an explicit expression for $\tilde{h}$) to establish that in economies where the punishment for this type of misdemeanour is more severe (higher $\sigma$) and more certain (higher $\eta$) the scope for misconduct in public office is limited.

Of course, we expect that the occurrence of corruption will impinge on the provision of productive public services. In order to establish this, let us derive the equilibrium for the variable $F_t$. First of all, we shall assume that the public services offered by the government are non-excludable but rival: as more families try to access them, the benefit to each family becomes limited due to congestion. Formally, we can write

$$F_t = \frac{f_t}{N_t^H},\tag{24}$$

where $f_t$ denotes the overall amount of public services.[25] Given the assumption about the two different types of projects through which bureaucrats can procure public services, we can associate the ultimate provision of these services with the incidence of corruption through

**Proposition 2.** *The overall amount of public services, $f_t$, is equal to*

$$f_t = f(h_t) = \Phi(h_t) y(h_t) \begin{cases} \{(1-p)[\pi\xi+(1-\pi)\gamma]+p\gamma\}\theta\, y(h_t) = \underline{\varphi}\, y(h_t) & if \quad h_t < \tilde{h} \\[2ex] [\pi\xi+(1-\pi)\gamma]\theta\, y(h_t) = \overline{\varphi}\, y(h_t) & if \quad h_t \geq \tilde{h} \end{cases} ,(25)$$

*where $\overline{\varphi} > \underline{\varphi}$ are composite parameter terms. Thus, $f'(h_t) > 0$.*

*Proof.* See the Appendix. ∎

As expected, the amount of productive public services that the government is able to offer depends on the occurrence of corruption among public sector workers. Insofar as some bureaucrats have the incentive to mislead authorities and expropriate funds away from productive investments, the economy will not be able to achieve its full potential in terms of public service delivery. The evidence provided by Mauro (1998) actually corroborates with the result of Proposition 2.

Looking at Equations (15) and (16), it is logical to expect that the effect of corruption on public service delivery will impinge on the economy's demographics as well as the accumulation of human capital. These are outcomes that we analyse in the following section.

## 2.4    Corruption, Growth, and Demographic Transition

Let us go back to Equation (17), multiply both sides by $\dfrac{q+e_t}{e_t}$, use $\overline{h}_t = h_t$ and substitute (21), (24) and (25). Eventually, we get

$$\frac{x\Phi(h_t)Ale_t^x(q+e_t)}{[v+\Phi(h_t)Ale_t^x]e_t} = 1. \tag{26}$$

We can use Equation (26) to derive

---

[25] This is an innocuous assumption, employed purely as a device to remove scale effects from the accumulation of human capital.

**Proposition 3.** *There exists $e_t = e(h_t) > 0$ such that*

$$e(h_t) = \begin{cases} \underline{e} & \text{if} \quad h_t < \tilde{h} \\ \overline{e} & \text{if} \quad h_t \geq \tilde{h} \end{cases}, \tag{27}$$

*where $\overline{e} > \underline{e}$ are composite parameter terms.*

*Proof.* See the Appendix. ∎

In a less-developed economy, the presence of corrupted bureaucrats implies that the quality of public services is lower compared to the situation in which corruption among bureaucrats vanishes at relatively high stages of development. However, these public services determine the parent's utility return on spending time towards each child's human capital formation. Thus, when productive public services increase, households finds optimal to boost their efforts for the improvement of their children's human capital.

Now, let us substitute $h_t = \overline{h}_t$, (21), (24) (25) and (27) in (7) to write the growth rate as

$$\psi(h_t) = \frac{h_{t+1}}{h_t} - 1 = v + A l \Phi(h_t)[e(h_t)]^x - 1. \tag{28}$$

We can use Equation (28) to derive

**Proposition 4.** *There are multiple growth equilibria for which*

$$\psi(h_t) = \begin{cases} v + A l \underline{\varphi}\, \underline{e}^x - 1 = \underline{\psi} & \text{if} \quad h_t < \tilde{h} \\ v + A l \overline{\varphi}\, \overline{e}^x - 1 = \overline{\psi} & \text{if} \quad h_t \geq \tilde{h} \end{cases}, \tag{29}$$

*where $\overline{\psi} > \underline{\psi}$.*

*Proof.* It follows from Equations (25), (27) and (28). ∎

The reason why there are multiple, path-dependent growth equilibria in this economy rests on the two-way causal relation between corruption and development. On the one hand, a positive growth rate brings forth the relatively high level of development necessary to reduce the incentive for transgression by corruptible

bureaucrats. On the other hand, the reduction of corruption implies a higher provision of productive public services, which improves the growth rate both directly and indirectly (through the higher effort that parents devote for the human capital improvements of their offspring).

In addition to the above, the model's results have significant implications for the optimal fertility rate. In particular, our framework is able to generate a demographic transition which can be attributed to development-induced changes to the incidence of corruption. We can formalise this argument through

**Proposition 5.** *Consider* $h_0 < \tilde{h}$. *There exists a time period* $T \geq 1$ *such that*

$$
n_t = \begin{cases} \bar{n} & \textit{for} \quad t \in (0,T) \\ \\ \underline{n} & \textit{for} \quad t \in (T,\infty) \end{cases},
$$

*where* $\bar{n} > \underline{n}$ *are composite parameter terms.*

*Proof.* Combining Equations (15) and (27) we can write

$$
n(h_t) = \frac{1-\alpha}{q+e(h_t)} = \begin{cases} \dfrac{1-\alpha}{q+\underline{e}} = \bar{n} & \text{for} \quad h_t < \tilde{h} \\ \\ \dfrac{1-\alpha}{q+\overline{e}} = \underline{n} & \text{for} \quad h_t \geq \tilde{h} \end{cases}. \tag{30}
$$

For $v + A l \varphi \underline{e}^x > 1$, the economy's growth rate is always positive. Therefore, as long as $h_0 < \tilde{h}$, there must be a time period $T$ after which the economy will switch regimes and will have $h_t \geq \tilde{h}$ for $t = T+1, T+2, \dots$. Together with (30), this argument completes the proof. ∎

We can see that the economy experiences a demographic transition, which is attributed to the change in the occurrence of corruption. As the economy grows, at some point potentially corruptible bureaucrats will find optimal to behave honestly. The absence of corrupt actions among bureaucrats will enhance the provision of productive public services and will induce households to support the formation of their children's human capital. However, the presence of a quantity-quality trade-off implies that households will also decide to rear fewer children. Thus, a demographic

transition occurs as a result of reduced corruption in the public sector of the economy.

It should be noted that all the results we have obtained so far find strong support from existing empirical studies. The negative association between economic growth/development and corruption (see the literature cited in the Introduction), the adverse effect of corruption on public education spending (Mauro 1998), and the fertility decline at higher stages of economic development (Galor 2005) are occurrences that are so widely observed that they almost represent stylised facts. Our model promotes the idea that, to some extent, there is a link to these empirical regularities that conventional wisdom had previously viewed as being determined separately.

## 2.5 Pecuniary Penalties for Corrupt Bureaucrats

In this section we consider the case where every corrupt bureaucrat who is apprehended by authorities faces a monetary penalty, in addition to the utility cost associated with being found guilty for her misdemeanour. In particular, we assume that the government is able to seize a fraction $\mu \in (0,1)$ of an apprehended bureaucrat's total wealth (salary plus ill-gotten gains). In this case, the expected utility of a corruptible bureaucrat is

$$(1-\eta)\ln\left(\omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}\right) + \eta(1-\sigma)\ln\left((1-\mu)\left[\omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}\right]\right). \quad (31)$$

Therefore, she will act dishonestly as long as

$$(1-\eta\sigma)\ln\left(\omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}\right) + \eta(1-\sigma)\ln(1-\mu) > \ln(\omega_t^B). \quad (32)$$

Substituting (4), (9), (10), (11) and (21) allows us to write the condition in (32) as

$$h_t < \left\{\frac{\left[(1-\tau_t)A + \frac{(1-\delta)A\theta l(1-\lambda)}{\kappa\lambda}\right]^{1-\eta\sigma}}{(1-\tau_t)A}\right\}^{\frac{1}{\eta\sigma}}(1-\mu)^{\frac{(1-\sigma)}{\sigma}} \equiv \tilde{h}_t(\tau_t), \quad (33)$$

where $\tilde{h}_t'(\tau_t) > 0$.

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Now let us consider what happens with the funds that the government confiscates from apprehended bureaucrats. We shall assume that the government will try to use the illegal rents it recovers as they were originally intended. Thus, although the part of the bureaucratic salary seized, $\mu\omega_t^B$, can be used as a source of additional revenue, the illegal rents recovered by authorities, i.e., $(1-\delta)\frac{g_t}{\kappa N_t^B}$ per apprehended bureaucrat, will be invested to projects that increase public service delivery. However, by now all remaining bureaucrats in the economy have already offered their unit of time to other public projects (if hired originally) or to the private sector's firms (if not hired originally). In this case, how can the government ensure that the recovered funds are put into use for the procurement of public services? We address this issue by assuming that the government can resort to bureaucrats hired from "abroad". Having recovered a total of $\eta p \kappa N_t^B \mu (1-\delta)\frac{g_t}{\kappa N_t^B}$ units of output, the government can hire foreign bureaucrats to operate the projects and therefore deliver public services.[26] Of course, this is a costly decision given that these bureaucrats have to be compensated for their work. We shall assume that the total cost of hiring them is equal to

$$k_t = \zeta \eta p \kappa N_t^B \omega_t^B,\qquad(34)$$

where $\eta p \kappa N_t^B \omega_t^B$ is the domestic equivalent of salary costs necessary to reinvest the recovered rents. Therefore, $\zeta > 1$ is assumed in order to guarantee that it is certainly more costly for the government to hire bureaucrats from abroad instead of hiring domestic bureaucrats for the same purpose. If this was not the case, then it would make sense to hire foreign bureaucrats in the first place. Furthermore, we shall assume that all foreign bureaucrats are not corruptible and will operate the Type-1 project.[27]

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[26] Note that each corrupt bureaucrat has confiscated an amount $(1-\delta)\frac{g_t}{\kappa N_t^B}$. The number of those who are caught is equal to $\eta p \kappa N_t^B$ and authorities are able to successfully seize a fraction $\mu$ of ill-gotten gains from each of them.

[27] We are actually considering the best case scenario here. Our results would be even stronger had we assumed that some foreign bureaucrats are corruptible or that they only have the ability to operate the low-return projects.

Naturally, these events have repercussions for the government's budget and therefore the equilibrium tax rate. To see this, we shall consider the two possible scenarios that emerge given the description of the economy's environment. First of all, let us consider the case where all corruptible bureaucrats decide to behave honestly. It is straightforward to see that the government's budget constraint is identical to the one given in (12), thus leading to the tax rate

$$\tau_t = \hat{\tau}, \tag{35}$$

that we obtained in (22). Now, let us consider the scenario under which all corruptible bureaucrats behave dishonestly. Given the presence of a monetary penalty for those apprehended, the government's budget constraint will become

$$\tau_t y_t + \eta \mu \omega_t^B p \kappa N_t^B = g_t + \omega_t^B \kappa N_t^B + k_t. \tag{36}$$

If we substitute (4), (9), (10), (11), (21) and (34) in (36), we can obtain the equilibrium tax as

$$\tau_t = \frac{\theta l + \kappa \dfrac{\lambda}{1-\lambda}[1 + p\eta(\zeta - \mu)]}{l + \kappa \dfrac{\lambda}{1-\lambda}[1 + p\eta(\zeta - \mu)]} = \breve{\tau}. \tag{37}$$

A comparison of (37) with (22) reveals that $\breve{\tau} > \hat{\tau}$. In other words, bureaucratic corruption leads to an increase of the (endogenously determined) tax rate. This is because the high cost of hiring bureaucrats from abroad, in order to deliver the services that domestic bureaucrats should have delivered in the first place, has to be met by a higher tax rate.

A look at Equation (33) reveals that the incentive to engage in illegal rent-seeking increases with a higher tax rate. The previous analysis has also established that a higher tax rate is (among other things) an outcome associated with a greater extent of rent-seeking by corrupt bureaucrats. These two-way causal effects have important implications for equilibrium outcomes as we establish in

**Proposition 6.** *There are two thresholds $\tilde{b}^1$ and $\tilde{b}^2$, satisfying $\tilde{b}^1 > \tilde{b}^2$, such that:*

i.  *For $b_t < \tilde{b}^2$, all corruptible bureaucrats are corrupted;*

ii.  *For $\tilde{b}^2 \leq b_t < \tilde{b}^1$, either all corruptible bureaucrats are corrupted or none of the corruptible bureaucrats is corrupted;*

*iii.    For $h_t \geq \tilde{h}^1$, none of the corruptible bureaucrats is corrupted.*

*Proof.* See the Appendix.    ■

One important implication from this proposition can be summarised through

**Corrolary 1.** *For intermediate levels of development, the incidence of corruption is indeterminate.*

In comparison to Proposition 1, we can see that the presence of a monetary penalty for apprehended bureaucrats results in an additional case of equilibrium indeterminacy. The reason for this outcome is associated with the positive feedback in the relation between corruption and taxation. On the one hand, the presence (absence) of bureaucratic corruption results in a relatively high (low) tax rate. On the other hand, the high (low) tax rate reduces (increases) the return from a bureaucrat's legal income – i.e., her salary – thus increasing (lowering) the utility return from being corrupt. This potential indeterminacy at intermediate stages of development could illustrate the empirical observation for which there is a large variation on the incidence of corruption among middle income economies – ranging from low to high (see Blackburn 2012).

Let us now consider the results concerning the delivery of public services. These results are established in

**Proposition 7.** *The overall amount of public services, $f_t$, is equal to*

$$f_t = f(h_t) = \Phi(h_t)\, y(h_t) = \begin{cases} \underset{\sim}{\varphi}\, y(h_t) & \text{if} & h_t < \tilde{h}^2 \\ \text{either } \underset{\sim}{\varphi}\, y(h_t) \text{ or } \tilde{\varphi}\, y(h_t) & \text{if} & h_t \in [\tilde{h}^2, \tilde{h}^1) \\ \tilde{\varphi}\, y(h_t) & \text{if} & h_t \geq \tilde{h}^1 \end{cases} , \quad (38)$$

*where* $\quad \underset{\sim}{\varphi} = (1-p)[\pi\xi + (1-\pi)\gamma]\theta + p\{\gamma + \eta\mu(1-\delta)[\pi\xi + (1-\pi)\gamma]\}\theta \quad$ *and*

$\tilde{\varphi} = [\pi\xi + (1-\pi)\gamma]\theta$. *Thus, $\tilde{\varphi} > \underset{\sim}{\varphi}$.*

*Proof.* See the Appendix.    ■

Correspondingly, we can determine the amount of resources that parents will devote for the human capital formation of their offspring through

**Proposition 8.** *There exists $e_t = e(h_t) > 0$ such that*

$$e(h_t) = \begin{cases} \underset{\sim}{e} & if & h_t < \tilde{h}^2 \\ either \ \underset{\sim}{e} \ or \ \tilde{e} & if & h_t \in [\tilde{h}^2, \tilde{h}^1) \\ \tilde{e} & if & h_t \geq \tilde{h}^1 \end{cases} , \qquad (39)$$

*where $\tilde{e} > \underset{\sim}{e}$ are composite parameter terms.*

*Proof.* See the Appendix. ∎

So far we can observe that the results are similar to those established in the baseline model presented in Sections 2 to 4. In particular, the incidence of bureaucratic corruption determines the delivery of productive public services. Thus, it also determines the incentive of parents to devote resources for the accumulation of their children's human capital. As we established before, higher corruption implies a lower procurement of public services, hence it motivates parents to reduce their own effort in support of their offspring education. However, we can also check that the possible indeterminacy established in part (ii) of Proposition 6 has additional repercussions for the aforementioned outcomes. Naturally, such repercussions are transmitted to the determination of the economy's growth and fertility rates, thus allowing us to infer the result in

**Proposition 9.** *Consider $h_0 < \tilde{h}^2$. There exist time periods $\underset{\sim}{T}$ and $\tilde{T}$, satisfying $\tilde{T} > \underset{\sim}{T}$, such that the economy' growth rate is*

$$\psi_t = \begin{cases} \underset{\sim}{\psi} & if & t \in (0, \underset{\sim}{T}) \\ either \ \underset{\sim}{\psi} \ or \ \tilde{\psi} & if & t \in (\underset{\sim}{T}, \tilde{T}) \\ \tilde{\psi} & if & t \in (\tilde{T}, \infty) \end{cases} ,$$

*where $\underset{\sim}{\psi} = v + Al\varphi\underset{\sim}{e}^x - 1$, $\tilde{\psi} = v + Al\tilde{\varphi}\tilde{e}^x - 1$ and $\tilde{\psi} > \underset{\sim}{\psi}$. Furthermore, the economy's fertility rate is*

$$n_t = \begin{cases} \tilde{n} & if & t \in (0, \underset{\sim}{T}) \\ either \ \tilde{n} \ or \ \underset{\sim}{n} & if & t \in (\underset{\sim}{T}, \tilde{T}) \\ \underset{\sim}{n} & if & t \in (\tilde{T}, \infty) \end{cases} ,$$

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*where $\tilde{n} > \underset{\sim}{n}$ are composite parameter terms.*

*Proof.* The use of Equations (28), (38) and (39) allow us to derive the equilibrium growth rate under different regimes. Next, we can combine (15) and (39) to get

$$n(h_t) = \frac{1-\alpha}{q+e(h_t)} = \begin{cases} \dfrac{1-\alpha}{q+\tilde{e}} = \tilde{n} & \text{for} & h_t < \tilde{h}^2 \\[3mm] \dfrac{1-\alpha}{q+\tilde{e}} = \underset{\sim}{n} & \text{for} & h_t \geq \tilde{h}^1 \\[3mm] \text{either } \tilde{n} \text{ or } \underset{\sim}{n} & \text{for} & \tilde{h}^2 \leq h_t < \tilde{h}^1 \end{cases} \qquad (40)$$

Assuming that $v + A/\underset{\sim}{\varphi} e^x - 1 > 0$, the economy's growth rate is always positive. Therefore, as long as $h_0 < \tilde{h}^2$, there must be a time period $\underset{\sim}{T}$ after which the economy will switch regimes and will have $h_t \geq \tilde{h}^2$ for $t = \underset{\sim}{T}+1,...,\tilde{T}$. For similar reasons, it will be $h_t \geq \tilde{h}^1$ for $t = \tilde{T}+1, \tilde{T}+2,...$. Together with (40), this argument completes the proof. ∎

Once more, the transition of the economy from a low- to a high-growth regime and from a high- to a low-fertility regime, both associated with lower corruption, is conceptually similar to the transition we analysed in Sections 2 to 4. For this reason, the intuition behind this transition is identical as well. Nevertheless, the possibility of equilibrium indeterminacy for intermediate values of the economy's human capital stock provides further and important implications concerning the outcomes that may transpire during this transition. We can clarify this argument through the following

**Corrolary 2.** *During periods for which $\underset{\sim}{T} < t < \tilde{T}$, the economy may experience endogenous fluctuations in both growth and fertility rates.*

As the previous corollary suggests, the economy may exhibit (endogenous) fluctuations in growth and fertility rates at some interval of its development process. These fluctuations are of course associated with the equilibrium indeterminacy generated by self-fulfilling prophecies in the determination of the ultimate actions by potentially corrupt bureaucrats. As it is evident from Proposition 6, whether these bureaucrats decide to engage in the extortion of public money depends on

whether they expect a similar behaviour from others. On the one hand, a bureaucrat that expects the others to be corrupt will have the incentive to be corrupt as well. On the other hand, the expectation that the others will act honestly is an incentive to act in a similar manner. Of course, these interactions occur every period by different populations of (corruptible) bureaucrats. Periods in which expectations are conducive to honest behaviour may be followed by periods in which such expectations provide the incentive for bureaucratic malfeasance and vice versa. Given that the changes in the incidence of corruption impinge on the quality of public services, they shift the balance of the quantity-quality trade-off faced by parents, thus they lead to corresponding changes to human capital accumulation, economic growth and fertility.

The idea that fertility rates may display fluctuations is not just a theoretical curio. On the contrary, the fact that fertility rates have displayed significant variations around their declining trends has been established empirically be various authors (e.g., Easterlin 1987; Lee 1997). The result we summarised through the previous corollary may be thought as an additional explanation on the possible driving forces behind fluctuations in fertility rates.

## 2.6   The Case of Reproductive Bureaucrats

For reasons of concreteness, we shall use this section in order to show that our main results (and their corresponding mechanisms) survive in a scenario where both households and bureaucrats are reproductive. As we shall establish below, this is indeed the case as long as bureaucrats do not internalise the effect of their own actions on *aggregate* public service delivery. This is a realistic assumption, given the large population mass and the corresponding mass of individual public investment projects that comprise the aggregate level of public services.

Let us denote the fertility rates of households and bureaucrats by $n_t^H$ and $n_t^B$ respectively. Retaining the assumption that a fraction $\lambda \in (0,1)$ of newly born agents are bureaucrats and the remaining fraction $(1-\lambda) \in (0,1)$ of newly born agents are households, we have $N_t^H = (1-\lambda)(N_{t-1}^H n_{t-1}^H + N_{t-1}^B n_{t-1}^B)$ and $N_t^B = \lambda(N_{t-1}^H n_{t-1}^H + N_{t-1}^B n_{t-1}^B)$, meaning that Equation (4) still holds. Now let us assume that each individual is born with an endowment of $K > 1$ units of time. For households, the lifetime utility maximisation problem is the same apart from the

fact that we have increased the time endowment to $K$. Therefore, denoting the household's education resources per child by $e_t^H$, the results in Equations (15) and (16) are replaced by

$$n_t^H = \frac{(1-\alpha)K}{q + e_t^H},\qquad(41)$$

and

$$\frac{\alpha n_t^H}{K - (q + e_t^H)n_t^H} = \frac{(1-\alpha)xF_t(e_t^H)^{x-1}}{v\overline{h}_t + F_t(e_t^H)^x},\qquad(42)$$

respectively. It is also straightforward to combine (41) and (42) to establish that the result in Equation (17) remains intact.

Now, let us revise our original set-up so as to consider a child quantity-child quality trade-off for bureaucrats. Similarly to our original set-up, we can assume that the operation of a public investment project requires that each bureaucrat devotes a unit of time. Therefore, she is left with $K - 1$ units of time which she allocates between child-rearing and education effort per child (measured in units of time) denoted by $e_t^B$. Thus, the bureaucrat will choose $e_t^B$ and $n_t^B$ to maximise

$$u_t^B = E[\alpha^B \ln(c_t^B) + (1-\alpha^B)\ln(n_t^B h_{t+1})],\qquad(43)$$

subject to

$$(q + e_t^B)n_t^B = K - 1,\qquad(44)$$

and

$$h_{t+1} = v\overline{h}_t + F_t(e_t^B)^x,\qquad(45)$$

taking $F_t$ as given. In fact, the latter is now equal to

$$F_t = \frac{f_t}{N_t^H + N_t^B},\qquad(46)$$

an expression that corresponds to Equation (24) of Section 3. The difference in (46) is that we consider reproductive bureaucrats as an additional source of congestion effects determining the productivity of public services. Note that, similarly to the original set-up, we have $c_t^B = \omega_t^B$ if a bureaucrat decides to behave honestly (or if

she is non-corruptible on the outset) and $c_t^B = \omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}$ if the bureaucrat is

corrupt. Given that the latter case entails the possibility of being caught, in which case we retain the assumption that the bureaucrat faces a proportional loss of her utility, the term $E[\cdot]$ indicates the expected utility that encompasses all the possible outcomes that stem from her disposition while employed as a public servant.

As it is evident from this set-up, the bureaucrat does not internalise the effect of her own actions on the aggregate quality of public services, irrespective of whether she is corrupt or not. In other words, she takes $F_t$ as given whatever her actions as a bureaucrat. As we argued before, this is the more realistic assumption since the aggregate amount of public services is comprised of a large number of projects, each operated by a different bureaucrat. For this reason, the utility maximisation problem leads to

$$\frac{e_t^B}{q+e_t^B} = \frac{xF_t(e_t^B)^x}{v\bar{h}_t + F_t(e_t^B)^x}, \tag{47}$$

from which we can implicitly derive the optimal amount of resources devoted to each child's education. Obviously, this expression is identical to Equation (17), i.e., the corresponding solution for households. Furthermore, it can also be used to derive the optimal solution for fertility after combining it with (44). This allows us to establish that bureaucrats face a child quantity-child quality trade-off, exactly as households do.

Finally, we can complete this section by considering the decision making process of a corruptible bureaucrat. Her decision to act honestly will lead to $u_t^{B\,(honest)} = \alpha^B \ln(\omega_t^B) + (1-\alpha^B)\ln(n_t^B h_{t+1})$. If she decides to engage in illegal rent-seeking by operating a low-quality public project and confiscating funds that are otherwise intended for public investment, she can increase her overall income but she faces a probability $\eta \in (0,1)$ of being found out. Following the original set-up, in this case she suffers a proportional utility cost of $\sigma \in (0,1)$. Thus, her expected

lifetime utility is $E(u_t^{B\,(dishonest)}) = (1-\eta\sigma)\left[\alpha^B\left(\omega_t^B + (1-\delta)\frac{g_t}{\kappa N_t^B}\right) + (1-\alpha^B)\ln(n_t^B h_{t+1})\right]$.

Given these, the condition $E(u_t^{B\,(dishonest)}) > u_t^{B\,(honest)}$ will determine the conditions for

which a corruptible bureaucrat will be corrupt. Substituting Equations (4), (8)-(11), (22) and (45)-(47), we can manipulate this condition and write is as

$$b_t < A^{-1} \left\{ \frac{\left[ 1 - \hat{\tau} + \frac{(1-\delta)\alpha^B \theta l/(1-\lambda)}{\kappa\lambda} \right]^{(1-\eta\sigma)\alpha^B}}{(1-\hat{\tau})^{\alpha^B}[(K-1)(e_t^B)^{x-1}\varphi_t/(1-\lambda)]^{(1-\alpha^B)\eta\sigma}} \right\}^{\frac{1}{\eta\sigma}} \equiv \tilde{b}_t, \qquad (48)$$

where according to the results in Propositions 2 and 3, $e_t^B$ is either $\underline{e}$ or $\overline{e}$ and $\varphi_t$ is either $\underline{\varphi}$ or $\overline{\varphi}$ depending on whether corruptible bureaucrats are corrupt or not corrupt respectively.[28] Although this expression is more complicated compared to the corresponding one in the original model (see Equation A1 in the Appendix), its main message is the same. There is a threshold level of development below (above) which a corruptible bureaucrat decides to be (not to be) corrupt. The added complication here relates to the presence of strategic complementarities in the process of the bureaucrats' decision making – complementarities that emerge due to the presence $e_t^B$ and $\varphi_t$. These could lead to the type of indeterminacy that we encountered in Section 5 when we considered the addition of pecuniary penalties for corrupted bureaucrats who are caught having engaged in illegal expropriation of public funds. All in all, the preceding analysis has shown that relaxing the assumption of non-reproductive bureaucrats have not altered the main mechanisms leading to the results of the original model.

## 2.7  Conclusion

In this paper, we have sought to integrate the theoretical analyses of endogenous growth, corruption and fertility choices. We have thus offered a novel mechanism on the driving forces behind one of the important aspects of demographic transition. In particular, we argued that one of the causal links between economic development and fertility reductions is the decline in the occurrence of bureaucratic corruption.

Our analysis has focused in only one of the many facets through which public sector corruption may actually materialise. Apart from the obvious need for analytical tractability, this approach allowed us to present a theory in which all the

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[28] Note that the composite term $l$ is given by $l = \alpha K \left[ \frac{(1-\kappa)\lambda}{1-\lambda} + 1 \right]$ in this case.

analytical mechanisms are clarified and the intuition is not blurred. It would be interesting however to examine a framework in which corruption may permeate the highest ranks of public administration, i.e., the government.

Whereas we are not aware of any existing empirical analyses that examine the relation between corruption and fertility choices, there is strong evidence in support of the elements that jointly constitute the main mechanism of our result (e.g., the negative relation between corruption and economic growth/development; the mitigating effect of corruption on public education spending; the reduction in population growth rates at later stages of development). Thus, although this is a paper whose focus is theoretical, we are confident that it offers empirically relevant ideas that, on the one hand, certainly improve our current understanding on the incidence of demographic change and on the other hand, they offer important policy implications.

## 2.8   Appendix

**Proof of Proposition 1**

Assume that the initial value $h_0$ is sufficiently high so that $h_0(1-\hat{\tau})A > 1$. The terms inside the logarithms are therefore greater than one and the condition in (23) can be written as

$$h_t^{1-\eta\sigma}\left[(1-\hat{\tau})A + \frac{(1-\delta)A\theta l(1-\lambda)}{\kappa\lambda}\right]^{1-\eta\sigma} > h_t(1-\hat{\tau})A \Leftrightarrow$$

$$h_t^{\eta\sigma} < \frac{\left[(1-\hat{\tau})A + \frac{(1-\delta)A\theta l(1-\lambda)}{\kappa\lambda}\right]^{1-\eta\sigma}}{(1-\hat{\tau})A} \Leftrightarrow$$

$$h_t < A^{-1}\left\{\frac{\left[1-\hat{\tau} + \frac{(1-\delta)\theta l(1-\lambda)}{\kappa\lambda}\right]^{1-\eta\sigma}}{1-\hat{\tau}}\right\}^{\frac{1}{\eta\sigma}} \equiv \tilde{h}. \tag{A1}$$

Thus, we can see that corruptible bureaucrats will (not) be corrupt as long as $h_t < \tilde{h}$ ($h_t \geq \tilde{h}$), where $\tilde{h}$ is defined in (A1).   ■

## Proof of Proposition 2

Let us begin with the case where $h_t < \tilde{h}$. As we have seen from Proposition 1, all corruptible bureaucrats choose the Type-2 project in order to expropriate public funds. Each corruptible bureaucrat will deliver $\gamma \frac{g_t}{\kappa N_t^B} = \gamma \frac{\theta y_t}{\kappa N_t^B}$ units of public service, therefore, with $p \kappa N_t^B$ corruptible bureaucrats, their total delivery of public services will be $p \gamma \theta y_t$. Each non-corruptible bureaucrat is expected to deliver an amount of public services equal to $[\pi \xi + (1-\pi)\gamma]\frac{g_t}{\kappa N_t^B} = [\pi \xi + (1-\pi)\gamma]\frac{\theta y_t}{\kappa N_t^B}$ because they choose to operate the Type-1 project. Given that there are $(1-p)\kappa N_t^B$ of such bureaucrats, their overall expected delivery of public services is equal to $(1-p)[\pi \xi + (1-\pi)\gamma]\theta y_t$. Summing up these effects we get

$$f_t = \underline{\varphi} y_t,$$

where $\underline{\varphi} = \{(1-p)[\pi \xi + (1-\pi)\gamma] + p\gamma\}\theta$.

Now, let us consider the case where $h_t \geq \tilde{h}$. In this case, none of the bureaucrats (whether corruptible or not) decides to embezzle public funds – all of them operate the Type-1 project. Therefore, all $\kappa N_t^B$ will operate a project with an expected return of $[\pi \xi + (1-\pi)\gamma]\frac{g_t}{\kappa N_t^B} = [\pi \xi + (1-\pi)\gamma]\frac{\theta y_t}{\kappa N_t^B}$ units of service per bureaucrat. Therefore, the overall amount of public services is given by

$$f_t = \overline{\varphi} y_t,$$

where $\overline{\varphi} = [\pi \xi + (1-\pi)\gamma]\theta$. It is straightforward to check that $\overline{\varphi} > \underline{\varphi}$ holds. Furthermore, equation (21) reveals that $y_t = y(h_t)$ such that $y'(h_t) > 0$, thus completing the proof. ∎

## Proof of Proposition 3

Define

$$J(e_t, \Phi(h_t)) = \frac{x\Phi(h_t)Ale_t^x(q+e_t)}{[v+\Phi(h_t)Ale_t^x]e_t} - 1. \tag{A2}$$

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Given (A2) and Equation (26), an equilibrium will exist if there is at least one $e_t^*$ for which $J(e_t^*, \Phi(h_t)) = 0$. Using (A2), we have $J(0, \Phi(h_t)) = \infty$. Furthermore, using L'Hôpital's rule we can establish

$J(\infty, \Phi(h_t)) = \lim_{e_t \to \infty} \dfrac{x\Phi(h_t)Al}{(1-x)ve_t^{-x} + \Phi(h_t)Al} - 1 = x - 1 < 0$. Furthermore, it is

$$J_{e_t}(\cdot, \cdot) = \frac{x\Phi(h_t)Ale_t^x}{[v + \Phi(h_t)Ale_t^x]^2 e_t^2}\beta(e_t), \qquad (A3)$$

where

$$\beta(e_t) = (q + e_t)vx - q[v + \Phi(h_t)Ale_t^x]. \qquad (A4)$$

From (A3) and (A4), it is obvious that the sign of $J_{e_t}(\cdot, \cdot)$ depends on the sign of $\beta(e_t)$. Moreover, given $J(0, \Phi(h_t)) > 0$, $J(\infty, \Phi(h_t)) < 0$ and $\beta(0) = qv(x-1) < 0$, for an equilibrium $e_t^*$ with $J(e_t^*, \Phi(h_t)) = 0$ to exist, it is sufficient to establish that $\beta(e_t)$ – and consequently $J_{e_t}(\cdot, \cdot)$ – will change sign only once . In this case, the equilibrium will be also unique.

From (A4) we have

$$\beta_{e_t}(\cdot) = vx - xq\Phi(h_t)Ale_t^{x-1}, \qquad (A5)$$

$$\beta_{e_t e_t}(\cdot) = -(x-1)xq\Phi(h_t)Ale_t^{x-2} > 0. \qquad (A6)$$

The results in (A5) and (A6) reveal that, indeed, $\beta(e_t)$ changes sign only once. Thus, there is a unique $e_t^*$ for which $J(e_t^*, \Phi(h_t)) = 0$ and $J_{e_t^*}(\cdot, \cdot) < 0$.

Now, let us use implicit differentiation to get

$$\frac{de_t^*}{d\Phi(\cdot)} = -\frac{J_{\Phi(\cdot)}(\cdot, \cdot)}{J_{e_t^*}(\cdot, \cdot)} > 0, \qquad (A7)$$

given that we can use (A3) to establish that $J_{\Phi(\cdot)}(\cdot, \cdot) > 0$. To complete the proof, we combine (A7) with the result in Proposition 2.  ∎

## Proof of Proposition 6

Let us consider the decision problem facing a corruptible bureaucrat. Given that all potentially corrupt bureaucrats are identical, each of them will consider two possible scenarios. First, let us assume that a corruptible bureaucrat expects all the others to be corrupt. In this case, she expects the tax rate given in (37). Therefore, according to (33) she will also have the incentive to be corrupt as long as $h_t < \tilde{b}^1$ where $\tilde{b}^1 = \tilde{b}_t(\bar{\tau})$. Secondly, we will consider the case where the corruptible bureaucrat expects all the others to act honestly. Naturally, in this case she expects the tax rate to be the one given in (22) and (35). Given the condition in (33), she will also decide to behave honestly as long as $h_t \geq \tilde{b}^2$ where $\tilde{b}^2 = \tilde{b}_t(\hat{\tau})$. Taking account that $\tilde{b}'_t(\tau_t) > 0$, we have $\tilde{b}^1 > \tilde{b}^2$. Thus, for $h_t < \tilde{b}^2$ the pure strategy Nash equilibrium entails that all corruptible bureaucrats decide to be corrupt, whereas for $h_t \geq \tilde{b}^1$ the pure strategy Nash equilibrium is one where all of them will avoid being corrupt. For $\tilde{b}^2 \leq h_t < \tilde{b}^1$, there are two possible equilibria: bureaucrats will (not) be corrupted insofar as they believe that the others will (not) be corrupted as well. ∎

## Proof of Proposition 7

Similarly to the proof of Proposition 2, when none of the bureaucrats decides to embezzle public funds, thus operating the Type-1 project, the overall amount of public services is given by

$$f_t = \tilde{\varphi}\, y_t,$$

where $\tilde{\varphi} = [\pi \xi + (1-\pi)\gamma]\theta$. Given Proposition 6, this is the only outcome when $h_t \geq \tilde{b}^1$.

When $h_t < \tilde{b}^2$, all corruptible bureaucrats choose the Type-2 project because this allows them to embezzle public funds. Each corruptible bureaucrat will deliver $\gamma \frac{g_t}{\kappa N_t^B} = \gamma \frac{\theta y_t}{\kappa N_t^B}$ units of public service, therefore, with $p\kappa N_t^B$ corruptible bureaucrats, their total delivery of public services will be $p\gamma\theta y_t$. In this case, however, the number of corruptible bureaucrats that are apprehended, i.e., $\eta p\kappa N_t^B$, will lose a fraction $\mu$ of their ill-gotten gains. Thus, the government will reinvest a

total amount $\eta p \kappa N_t^B \mu (1-\delta) \frac{g_t}{\kappa N_t^B} = \eta p \mu (1-\delta) \theta y_t$ according to the description provided

in Section 5. This activity will lead to public service delivery of $[\pi \xi + (1-\pi)\gamma] \eta p \mu (1-\delta) \theta y_t$. Taking account of the projects operated by non-corruptible bureaucrats, we can conclude that the total amount of public services satisfy

$$f_t = \underset{\sim}{\varphi} y_t,$$

where

$$\underset{\sim}{\varphi} = (1-p)[\pi \xi + (1-\pi)\gamma]\theta + p\{\gamma + \eta \mu (1-\delta)[\pi \xi + (1-\pi)\gamma]\}\theta.$$

Given that $\eta \mu (1-\delta) < 1$ holds by assumption, it is straightforward to establish that $\tilde{\varphi} > \underset{\sim}{\varphi}$ holds.

Obviously, Proposition 6 has established that, for $h_t \in [\tilde{b}^2, \tilde{b}^1)$, one of these two different scenarios will prevail. Together with Equation (21), these arguments complete the proof. ∎

## Proof of Proposition 8

The proof follows directly from the results established in Proposition 7, together with the corresponding proof of Proposition 3. ∎

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# Corruption and its Measurement

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**Abstract**

I suggest a new index of corruption derived from the information contained in existing indicators. Firstly, I construct a new dataset, which includes extant measures of perceived corruption along with survey questions. I then identify 10 of these measures taking into account their nature and reliability. To these, I apply a Bayesian latent variable approach to generate a new index for this latent variable, where scores are also accompanied by their corresponding measurements errors. Most importantly, the strength of the new scale lies on its capacity to consistently combine the efforts of numerous researchers and analysts to produce corruption measures. The model offers additional tools to compare the different levels and reliability of the constituent measures being set on the same underlying latent scale.

## 3.1 Introduction

Virtually all the societies around the world experience the incidence of corruption at some level. A simple online search using "corruption" as keyword would suffice to do justice to this claim. At the same time, there is a large and ever expanding empirical literature, which investigates the causes and consequences of corruption relying on perceived corruption indices.[29] More recently, scholars have started to use objective measures of corruption (Di Tella and Schargrodsky (2003); Reinikka and Svensson (2004); Olken (2006); Hsieh and Moretti (2006); Aidt (2009)). As a result, nowadays, there is an increasing list of indicators of corruption at the researcher's disposal, which can create controversy and confusion with respect to the appropriateness and reliability of each scale.

Of course each type of measure has its own merits and drawbacks. Perceived corruption measures offer aggregated assessments on a cross-national level making possible the evaluation of the extent of wrongdoing from a macroeconomic perspective. The main objection that such measures face is that they reflect *perceptions* rather than actual experience. Effectively, they are opinions that could be coloured by the country's economic performance, media exposure of scandals, anti-corruption campaigns and prejudice. On the other hand, objective measures overcome these issues providing hands-on account of misconduct. However, their reliability might be questionable due to respondent's misreporting for fear of retaliation from the authorities, different interpretation of what "corruption" involves or even inaccurate memory. All in all, neither constitutes a panacea for the measurement of corruption and studies that use them should be very cautious when explaining their results.

This paper attempts to reconcile these views by applying the approach of Pemstein *et al.* (2010a) who employ a Bayesian latent variable approach to propose a new measure of democracy (Unified Democracy Scores) that encompasses 10 different existing scales. The strength of this technique is that it draws its authority from the expertise of a plethora of scholars and analysts who have worked on the subject. Additionally, the model provides estimates of the measurement errors accompanying the scores, where the consistency across measures enhances the credence of these scores. Importantly, it is straightforward to reapply this method as

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[29] Prominent reviews of this literature are Jain (2001), Lambsdorff (2006) and Treisman (2007).

improvements in its underlying assumptions and limitations and demonstrates a significant leap forward toward the measurement of unobservable concepts.

Similarly, in this study, the aforementioned model is applied in a selection of measures of corruption in order to produce a new scale, which assimilates all the advantages of this framework. For this purpose, a new dataset is constructed, which includes the majority of the extant indicators of corruption. The dataset is not only limited to the prevailing measures, but also covers many surveys that include relevant questions. The outcome is a data compilation of more than 500 variables, each sharing a more or less intimate relationship with corruption. Unfortunately, such a large number of measures would be infeasible.[30] As a result, a strict selection process was followed to reach a set of just 10 variables. Apart from the proposal of a new scale, the model embodies the capacity to perform comparative exercises among the existing measures. This feature could be quite beneficial to applied researchers by helping them pick the most suitable measure given their research interest. To sum up, this study in conjunction with the presentation of a new dataset, shows an innovative way to produce more inclusive indicators of corruption as well as to evaluate important features of the existing scales.

The remaining paper is organised as follows. In Section 2, I explore the methodology involved, while in Section 3 I present the data used along with the process to reach the composition of the final dataset. Section 4 investigates the model fit and Section 5 demonstrates and discusses the latent corruption scores. Section 6 conducts comparative exercises among the existing measures and, finally, Section 7 concludes.

## 3.2   Methodology[31]

Corruption, by its nature, is an unobservable (latent) variable. The current corruption indicators can only capture certain aspects of this obscure variable. Thus, it is straightforward to treat such ratings as approximations to a continuous unidimensional latent variable.

In particular, I assume that the "true" latent corruption level of each of $1,…,n$ country-years is denoted by $Z_i$. Furthermore, each of the $1,…,J$ judges or raters,

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[30] As discussed in the next section each additional variable increases the dimension to the distribution to be integrated.

[31] This section follows the notation of Johnson and Albert (1999) and the approach of Pemstein *et al.* (2010a).

provides a rating $t_{ij}$ for country-year $i$. Therefore, judge's $j$ perception of corruption in country-year $i$ is given by

$$t_{ij} = Z_i + \varepsilon_{ij}, \varepsilon_{ij} \sim N(0, \sigma_j^2) \quad (1)$$

where the error term encompasses the mistake judge $j$ makes in estimating the corruption level in country-year $i$ and the inaccuracy in the assessment of the objective value $Z_i$. The normality assumption of the error term can be vindicated, at least up to a certain level, on the basis that each judge draws the conclusion about the incidence of corruption for a specific country-year from a multitude of small effects. The latter represent differences in the conceptualisation, aggregation and measurement errors across raters, which, due to the Central Limit Theorem, might result in an error term with a Gaussian distribution. Each judge determines the true corruption level under a different perspective, thus making its evaluation distinctive, and it might be challenging to identify the judge's systematic bias between information negligence and methodology. Hence, even though equation (1) might not be a perfect model, it can be a sensible approach for the ratings structure.

The model thus far provides a parsimonious framework upon which an understanding on the measurement process can be built. Moving on, however, I encounter a serious obstacle; none of the quantities of equation (1), $t_{ij}$, $Z_i$ and $\sigma_j^2$, are actually observable. This issue is resolved with the use of the multirater ordinal probit model, a framework proposed for the analysis of ordinal ratings, when supplied by several judges (Johnson (1996); Johnson and Albert (1999)). The observable item in this process is an $n \times m$ data array, denoted by $\overline{y}$, where $y_{ij}$ is the rating assigned to country-year $i$ by judge $j$. Effectively, these are rankings, which are produced by an unknown function of the judges' underlying perceptions. In this dataset I include 10 judges, from which only one can be treated as ordinal.[32]

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[32] The judges that comprise the dataset are: World Governance Indicators (WGI) by the World Bank, International Country Risk Guide (ICRG) by the PRS Group, Transparency International (TI), World Economic Forum (WEF), the corruption indicator by Dreher *et al.* (2007), two measures from Eurobarometer (EB1, EB2), World Values Survey (WVS), Wolrd Business Environment Survey (WBES) by the World Bank and International Crime Victim Survey (ICVS). The upcoming Data section offers an extensive discussion about the data structure.

This is the ICRG, whose 76% of its observations consists of integer values.[33] The rest of the judges (WGI, TI, WEF, Dreher *et al.* (2007), EB1, EB2, WVS, WBES, ICVS) provide continuous, supposedly interval-level, ratings.

There are several ways of approaching the aforementioned ratings. One seemingly attractive option would be to treat them as interval-level scores and assume a linear relationship between judge's $j$ perception for country-year $i$, $t_{ij}$, and the corresponding score, $y_{ij}$. Quinn (2004) has proposed a similar hybrid model, which can cope with mixed ordinal and continuous data. Even so, a caveat worth considering here is the interval-level assumption.

Following Pemstein *et al.* (2010b), let's assume that the continuous ratings are ordinal rather than interval. In other words, the assumption is that these ratings provide estimates of relative rankings of corruption across country-years, but equal intervals generated at several points along these scales do not correspond to constant-range differences in the underlying corruption scale. In such a case, a model like Quinn's (2004) will produce biased estimates, due to the linearity assumption it imposes between the ratings and the latent variable. Alternatively, if the interval assumption is met, then the ratings' conversion to ordinal measures generates unbiased estimates because the ordinal assumption does not come into conflict with the linearity assumption between observed scores and latent corruption. On the other hand, the hybrid model in this case will be more efficient than the model that treats continuous measures as ordinal. The conclusion is that it is a matter of efficiency of the hybrid model when the assumption in question is satisfied against the flexibility of the ordinal model, which can be applied confidently in any case. In the end, I opted for the latter and the decision ensues from two arguments: a) there are empirical evidence strongly suggesting that the interval-level assumption is not valid and b) here, bias is more important than efficiency.

A careful examination of the continuous ratings showcases why the interval assumption is challengeable. All the continuous ratings demonstrate significant clusterings around several intervals, indicating that a smoothly performed ordinal treatment is probably preferable to a continuous approach. For instance, the TI

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[33] One option would have been to discard the remaining 24% of values, this way, generating a purely ordinal rating. However, this would lead to a significant loss of information and as a result I chose to fully discretise ICRG. The cutoffs I have used in this and the remaining cases are presented below.

measure concentrates almost 30% of its values on the interval (2,3) on a scale between 0 and 10. Similarly, WBES exhibits highly clustered points with almost 54% of its values distributed on just three point-one intervals on a 0 to 1 scale. These facts imply that these ratings can hardly be considered interval-level. Additionally, the non-expert ratings (EB1, EB2, WVS, WBES, ICVS), originate from ordinal measures, thus, further compromising the assumption in question.[34]

The second line of defence with respect to the decision to reject the hybrid model comes from the output of the ordinal model itself. Having adopted an ordinal treatment for the continuous measures, the model itself provides serious objections to the interval assumption. Particularly, even though I have allocated several cutoff points to constant-length intervals along each scale, the estimated cutoffs are unevenly dispersed along the latent corruption scale.[35] Figure 6 illustrates my point. The Dreher *et al.* (2007) and WBES cutpoints follow a clearly unbalanced distribution along the scale while the WGI and TI cutpoints are stretched toward the lower extreme of the scale. Therefore, the estimations show that it is possibly riskier to assume an interval-level model rather than using them as ordinal.

Having turned all of the ratings into ordinal rankings, now, each judge $j$ allocates each country-year $i$ to one of the $K_j$ ordered categories generating the observed rating $y_{ij}$. Categories vary in number across judges, ranging from 3 to 9. Furthermore, not all judges rate all country-years.[36] This is one of the strengths of the model, granting the freedom to include in the analysis not only the widely used expert corruption projects but also non-expert surveys, which despite their limited coverage contain information valuable for an inclusive latent corruption scale. For instance, surveys reflect the views of people who experience misconduct in their everyday life which is indicative of its level of prevalence.

Each country-year $i$ is placed in category $c$ by judge $j$ if

$$\gamma_{jc-1} < t_{ij} \leq \gamma_{jc} \tag{2}$$

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[34] See the Data section.

[35] The cutpoints for each judge are as follows: WGI: -2.5-2.5, by 1s; ICRG: 0-6, by 1s; TI: 2, 3, 4, 5, 6, 7, 8, 9; WEF: 2, 3, 4, 5, 6; Dreher *et al.* (2007): 0.7, 0.8, 0.9, 1, 1.2, 1.4; EB1: 0.03, 0.05, 0.07, 0.1, 0.2, 0.4; EB2: 0.2, 0.4; WVS: 0.25, 0.5; WBES: 0-1, by 0.2s; ICVS: 0.8, 0.9, 0.95. In most ratings there are irregularities in the distribution of cutpoints due to sparsity of observations in the corresponding intervals. Several intervals are collapsed and loss of information incurs, yet, it is deemed necessary because a sufficient number of observations is required to identify each cutoff.

[36] I assume that a judge's decision not to rate a country-year does not depend on the qualities of either the judge or the country-year.

where $\gamma_{jc-1}$ and $\gamma_{jc}$ are judge specific cutpoints. I also assume that the lower and upper cutoffs are unbounded, $\gamma_{j0} = -\infty$ and $\gamma_{jK_j} = \infty$ respectively. The vector of cutoffs for judge $j$ is denoted by $\overline{\gamma_j} = \{\gamma_{j1},...,\gamma_{jK_j-1}\}$ and the vector of cutoffs for all judges is $\overline{\gamma} = \{\gamma_1,...,\gamma_J\}$. According to (2), given judge $j$ and country-year $i$, the rating $y_{ij} = c$ is observed if judge's perception, $t_{ij}$, falls in the interval $(\gamma_{jc-1}, \gamma_{jc}]$. In addition, the distribution function of a rescaled version of the error term, $\varepsilon_{ij}$, is written as $F(\varepsilon_{ij}/\sigma_j)$, where $F(.)$ is a known cumulative distribution function. A convenient choice here is the standard normal distribution, $\Phi(.)$. Combining (1), (2) and the assumptions above, the conditional probability that country-year $i$ is assigned to category $c$ by judge $j$ is

$$\Pr\left(y_{ij} = c \mid Z_i, \gamma_j, \sigma_j\right) = \Phi\frac{\left(\gamma_{jc} - Z_i\right)}{\sigma_j} - \Phi\frac{\left(\gamma_{jc-1} - Z_i\right)}{\sigma_j}, \tag{3}$$

Given the latent trait vector $\overline{Z} = \{Z_i\}$ and the judge variance vector $\overline{\sigma} = \{\sigma_j\}$, the likelihood function of observed data $\overline{y}$ is

$$L\left(\overline{Z}, \overline{\gamma}, \overline{\sigma}\right) = \prod_{i=1}^{n} \prod_{j \in C_i} \Phi\frac{\left(\gamma_{jy_{ij}} - Z_i\right)}{\sigma_j} - \Phi\frac{\left(\gamma_{jy_{ij}-1} - Z_i\right)}{\sigma_j}, \tag{4}$$

where $C_i$ is the set of judges that rated country-year $i$.

It is suggested that models as describe in equation (4) and above should be estimated using Bayesian inference (Johnson (1996); Johnson and Albert (1999); Pemstein *et al.* (2010a)).[37] As shown in Johnson and Albert (1999), it is necessary to specify our prior distributions for our parameters, $\overline{Z}$, $\overline{\gamma}$ and $\overline{\sigma}$. First, I assume, on the grounds of convenience, that the elements of $\overline{Z}$ are distributed from independent standard normal distributions. To the cutoff vectors $\gamma_j$, I attribute independent uniform priors subject to the ordering constraint $\gamma_{j1} \leq ... \leq \gamma_{jK-1}$. It is also assumed that the error variances $\sigma_1^2,...,\sigma_J^2$ are independent and are distributed

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[37] A model like in equation (4) is characterised by identifiability problems and even though a classical approach is plausible, Bayesian inference offers more robust estimators (Johnson (1996)).

from inverse-gamma distributions. The inverse-gamma density for error variance $\sigma_j^2$ is

$$g\left(\sigma_j^2;\lambda,\alpha\right)=\frac{\lambda^\alpha}{\Gamma(\alpha)}\left(\sigma_j^2\right)^{-\alpha-1}\exp\left(-\frac{\lambda}{\sigma_j^2}\right),\ \lambda,\alpha>0\,.$$

The choice of this distribution offers conjugacy for the sampling model in (4), hence facilitating the computation of the corresponding posterior distribution.[38] Finally, given $Z_i$, the conditional distribution of each judge's perception $t_{ij}$ is independent and normally distributed with mean $Z_i$ and variance $\sigma_j^2$.

Following Johnson and Albert (1999), the computational method that is used in this model is a hybrid Metropolis-Hastings/Gibbs sampler.[39] The algorithm starts by sampling from the conditional distribution of $\bar{Z}$ and proceeds with the convergence of the components of the cutoffs vector $\bar{\gamma}$, given the new value of $\bar{Z}$. Estimates of the judges' perceptions $t_{ij}$ can be drawn from a truncated normal distribution with mean $Z_i$ and variance $\sigma_j^2$, sampled in the interval $\left(\gamma_{jy_{ij}-1},\gamma_{jy_{ij}}\right)$. Finally, the computation of the posterior distribution of $\sigma_j^2$ generates an inverse-gamma distribution assisted by the (conjugate) prior structure I have initially assumed. I run 20,000 iterations of the algorithm, using the first 10,000 as burn-in, and storing every 100th observation of the second half, thus forming a posterior sample of 100 observations.

The output of the model provides estimates of the latent corruption level $Z_i$ by calibrating each judge's contribution given its error variance. On top of that, the latent scores are accompanied by their respective confidence intervals, offering a measure of credibility of the scores. Additionally, the model is capable of generating estimates of the judges' $\gamma_j$ with confidence intervals. These estimates are displayed on the same latent scale promoting this way the comparability of empirical studies of corruption where different measures are used. The model also

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[38] Conjugacy for a sampling model is achieved when the class of prior and posterior distribution is the same for a given parameter. The introduction of conjugacy allows for easier posterior calculations, but the prior it assumes may not reflect the "true" prior. See Hoff (2009) for an introduction to Bayesian statistics.

[39] I refrain from using a simpler Gibbs algorithm because it transpires that the computation of the posterior for the vector of cutoffs $\bar{\gamma}$ can be problematic (Johnson and Albert (1999)).

offers the option to assess the reliability of each judge by supplying each measure's error variance $\sigma_j^2$ along with its confidence interval. This is an extremely useful feature of the model that can help researchers choose the most suitable measures of corruption and raters to improve their methods.

## 3.3 Data

Despite the fact that the data consists of 10 measures of corruption, this is only a very small part of the original dataset. Therefore, before I go through the ultimate set of variables, I regard it worthwhile to shed some light on the process I applied to reach the final data structure.

Table 7 presents the sources I have used and the number of variables they have contributed to the initial dataset. In addition, the table accounts for the "type" of source that reports these variables, in the sense that it can either be a large-scale project whose ratings are generated by the analysis of experts' opinion (expert type) or it can represent the views or experiences of ordinary people or managers taken without any further examination from surveys (non-expert type). Last but not least, I have also considered a corruption index generated from the structural equation model of Dreher *et al.* (2007).[40]

From the table it is evident that the variables of the initial dataset originate from 15 sources, 9 of which are of non-expert type and 6 of expert type. Moreover, a distinct difference between these two types comes from the number of variables they contribute. All of the expert type sources provide 1 variable each, apart from WEF with 21, while for the non-expert type the variable number ranges from 1 up to 196.[41] This comes as no surprise if one reflects on the nature of these two types. Each expert type variable is the outcome of a methodologically intensive process whose output is contained in a single variable. Besides, this is why the use of several of these measures is so appealing to applied researchers (Jain (2001); Lambsdorff (2006); Jain *et al.* (2011)). On the other hand, non-expert type variables

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[40] I allocate Dreher *et al.* (2007) to the expert type because this can be implied by the paper's structural model and its authors' views. The structural model comprises of factors and indicators of corruption, which probably inhibit the analysts' minds rather than ordinary people. In addition, the paper conducts sensitivity tests for its corruption measure by examining its correlation with the corruption perceptions index from TI because it is "of the same concept".

[41] WEF reports indices that cover several other aspects of the occurrence of corruption, such as business costs, frequency and reliability of bribes as well as bribes in specific sectors like exports-imports, tax collection and other.

are directly picked from surveys, each one representing an alternative perspective of the corruption phenomenon. Nonetheless, the large number of measures of corruption, a total of 528(!), reveals its importance as a subject of applied research and underpins the worldwide concern on the subject and the significant efforts made to understand and fight it.

**Table 7**
Sources of corruption

| Source | Number of variables | Type |
|---|---|---|
| Afrobarometer | 82 | Non-expert |
| Asianbarometer | 17 | Non-expert |
| Business International | 1 | Expert |
| Dreher *et al.* (2007) | 1 | Expert |
| Eurobarometer | 196 | Non-expert |
| European Bank | 35 | Non-expert |
| International Country Risk Guide | 1 | Expert |
| International Crime Victim Survey | 52 | Non-expert |
| Latinobarómetro | 69 | Non-expert |
| Transparency International | 1 | Expert |
| World Bank Enterprise Survey | 32 | Non-expert |
| World Business Environment Survey | 17 | Non-expert |
| World Economic Forum | 21 | Expert |
| World Governance Indicators | 1 | Expert |
| World Values Survey | 2 | Non-expert |
| Total count | 528 | |

The sources are presented in alphabetic order.

Notwithstanding the vast amount of information the original dataset incorporates, it is totally impractical for my purpose. If I were to input this number of variables in the model, the computational burden would be unmanageable. As a result, it is necessary to be selective in order to end up with a feasible number of variables.

The selection criteria applied brings forward the previous discussion about the strong or weak link of the variables with corruption. Fundamentally, I am interested in the measurement of the incidence of corruption, which pervades the transactions of government officials or political leaders with citizens or businesses. The variables that most effectively help toward this direction are going to comprise the second-phase "compact" dataset.

In certain circumstances, the thorough examination of several variables led to ad hoc manipulations. In particular, a few variables from certain sources appear repeatedly throughout the years without changing their definition, only their names. In these cases I have collapsed them in a single variable with time coverage equal to its constituents. Other cases would involve more intricate adjustments. Several *groups* of variables appear repeatedly through time. If each of these groups is perceived as a unity, it could represent the perceptions or experiences with respect to corruption for a certain country-year. For example, variables "v764", "v765" and "v766" from Eurobarometer 64.3 ask about the degree of pervasiveness of corruption in local, regional and national institutions respectively. Even though the extent of corruption in each of these institutions is quite interesting in its own right, the study is more concerned with the overall institutional perception of corruption. Thus, collapsing the constituent institutional variables provides a catch-all new variable, which can be further collapsed across time, as indicated in the previous case, if the group reoccurs through time. The advantage of undergoing these manipulations is that it facilitates the formation of a smaller, more tractable dataset whose variables are as much inclusive as possible. Furthermore, this approach promotes the comparability of the variables' ratings, which is an essential feature of the model, as it will become apparent later on.

The outcome of the selection process presented above is a compact dataset of 51 corruption variables i.e. less than 10% of its original size. As I have already discussed, such a downsizing was imperative if the data were to become fit for the model. Still, though, further machinery has to be introduced to make the dataset manageable.

The methodology section presented how each judge's error variance $\sigma_j^2$ is incorporated and quantified by the model. This is a very useful tool at this phase of the data analysis because it offers a straightforward and transparent method of choosing the best judges for the model. Besides, the simultaneous use of 51 judges is still computationally unwieldy.

The final dataset consists of an equal share of expert and non-expert types of judges i.e. 5 expert and 5 non-expert judges. This structure was chosen because a) there is no reason why there should be a preference toward one type over the other and b), intuitively speaking, this is the most balanced approach. Next, each judge's

error variance was evaluated exploiting the model's capabilities. Firstly, a group of 3 judges was picked that would set the benchmark for the rest of the raters upon which were going to be assessed. WGI, ICRG and TI were selected for the benchmark group, due a) to their popularity and because b) it was expected that they would demonstrate low variance due to the analytical rigour they incorporate, which they did. Then, a series of exhaustive consecutive model runs were performed for the remaining 48 variables, always in conjunction with the benchmark group in order to find the most reliable raters. In cases where similar error variance values appeared I opted for the judge with the smaller confidence interval. Table 8 shows the final sample of judges. The table is partitioned according to the judge's type. The upper half contains the expert type and the lower half the non-expert type. The definitions of the variables are available in the Appendix.

A problem that is encountered with the non-expert judges is that they are not exactly suited to the analysis. These judges do not provide a single-valued assessment for a country-year as the expert judges do, but a sample of ordinal subjective assessments from individuals for each country-year. In other words, I do not directly observe a rating $y_{ij}$ for country-year $i$ by judge $j \in \{\text{non-expert judges}\}$, but $\bar{Y} = \{Y_{ij1}, \ldots, Y_{ijm}\}$, where an individual $k$ perceives a country-year $i$ for judge $j$ as $Y_{ijk}$. The problem is resolved if I create a new continuous variable for each judge that will represent the share of individuals who regards corruption as a less severe problem in a specific country-year. Thus, the higher the share, the lower the level of corruption for country-year $i$ by judge $j \ \forall \ j \in \{\text{non-expert judges}\}$. The Appendix presents this part of the data analysis for each of the non-expert judges.

## 3.4   Model Fit

Before proceeding with the presentation of the latent corruption level it would be wise to examine how well the model fits the data since there might be concerns about the assumptions of the model. Thus, in the fashion of Gelman *et al.* (2004) and Pemstein *et al.* (2010a), I use the fitted model to generate a sample of artificial data, the posterior predictive distribution (PPD). Then, I compare the ratings from the observed data to the PPD to verify whether the actual data could be a representative draw from the fitted model. It is important to emphasise that this is

not a test that examines whether the model is correct or not. It should be thought of as a technique of inspecting whether the model's simplifying assumptions could lead to erroneous inferences.

**Table 8**
The 10 corruption judges

| Source | Variable(s) | Countries | Years | Scale |
|---|---|---|---|---|
| WGI | Control of corruption | 152-211 | 1996, 1998, 2000, 2002-2009 | -2.5-2.5 |
| ICRG | Corruption | 105-141 | 1984-2008 | 0-6 |
| TI | Corruption perceptions index | 42-80 | 1995-2010 | 0-10 |
| WEF | Irregular payments and bribes | 134 | 2010 | 1-7 |
| Dreher *et al.* (2007) | Indicator of corruption from a structural equation model | 65-106 | 1980, 1985, 1990, 1997 | -1-1 |
| EB1[*] | EB 64.3: v764, v765, v766 EB 68.2: v125, v126, v127 EB 72.2: qb1_2, qb1_3, qb1_4 | 27, 29 | 2005, 2008, 2009 | 1-4 |
| EB2[*] | Flash-EB 236: q1_c | 27 | 2008 | 1, 2, 9 |
| WVS | WVS 1981-2004: e196 | 1-23 | 1994-1999, 2004 | 1-4 |
| WBES | WBES 1999: gcorr | 80 | 2000 | 1-4 |
| ICVS | ICVS 1989-2005: c14a100 | 1-43 | 1992, 1995-1998, 2000-2002, 2004, 2005 | 1, 2, 3, 99 |

The upper part of the table presents the expert judges and the lower part the non-expert. The * indicates variables that have been collapsed across their groups and time. The judges are: World Governance Indicators (WGI) by the World Bank, International Country Risk Guide (ICRG) by the PRS Group, Transparency International (TI), World Economic Forum (WEF), the corruption indicator by Dreher *et al.* (2007), two measures from Eurobarometer (EB1, EB2), World Values Survey (WVS), World Business Environment Survey (WBES) by the World Bank and International Crime Victim Survey (ICVS).

Specifically, given the model parameters, $\overline{Z}$, $\overline{\gamma}$ and $\overline{\sigma}$ and the observed data $\overline{y}$ the PPD is defined as

$$\Pr\left(\overline{y}^{*} \mid \overline{y}\right) = \int \Pr\left(\overline{y}^{*} \mid \overline{Z}, \overline{\gamma}, \overline{\sigma}, \overline{y}\right) \Pr\left(\overline{Z}, \overline{\gamma}, \overline{\sigma} \mid \overline{y}\right) d\theta, \tag{5}$$

where $\overline{y}^{*}$ is the new data. Equation (5) implies that $\overline{y}^{*}$ is what would have been observed if the model in (4) with the parameter values that produced the observed data was run again. Ultimately, the data distribution from (5) should resemble the observed data if the model is consistent with the latter.

The sensitivity test is presented in Figure 4. I compare the pattern of rankings for each judge with the PPD to examine the consistency of the model. The histograms illustrate how each judge has allocated its ratings. For example, TI assigned between 100 and 200 observations in its lowest ranking, while WVS assigned between 10 and 15 observations in its highest ranking. Upon each histogram bar there is also the ranking's box plot derived from the PPD of the fitted model. The figure demonstrates a very good match of the observed data with the PPD. All category frequencies for each judge fall both within the 95% credible intervals and the interquartile ranges of the generated distributions. Hence, the figure strongly validates the fit of the model.
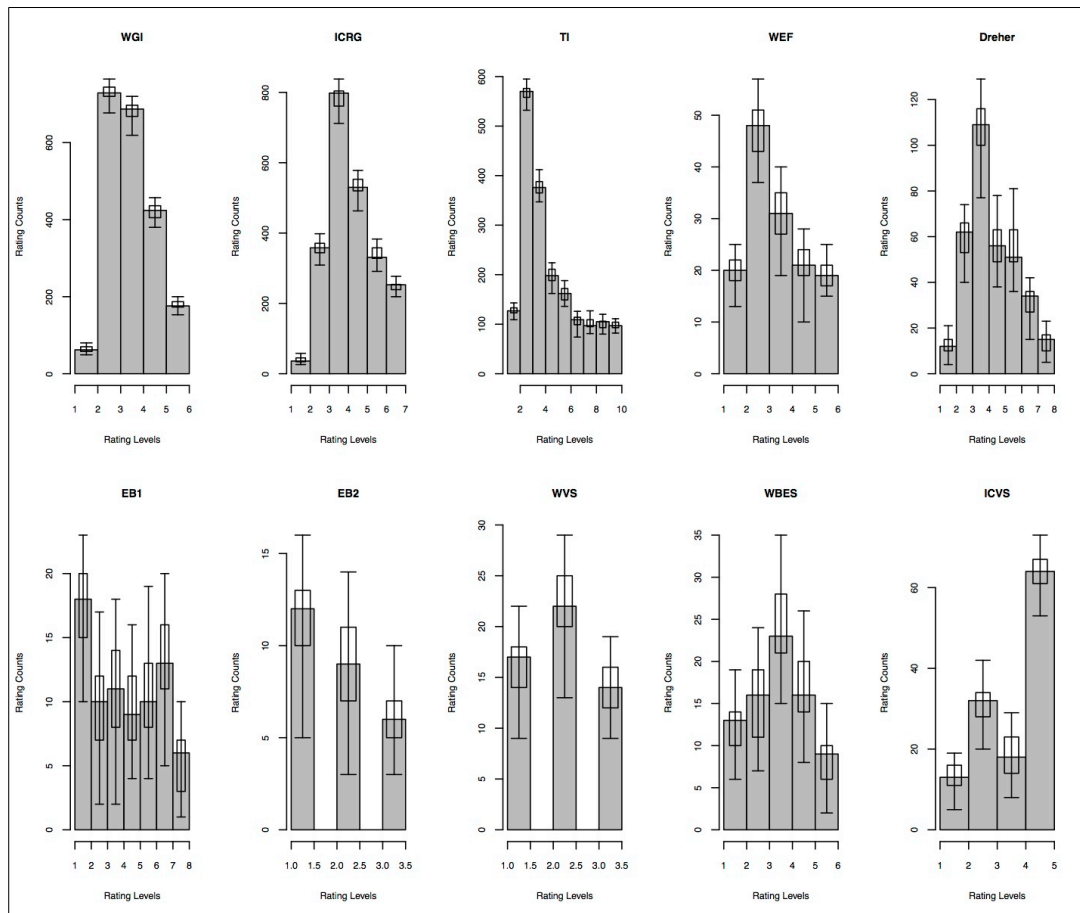


**Figure 4**

Clearly, the assumptions of the model do not seem to be questionable. All 10 measures fit the model very well and the results underpin that the parsimonious approach of equation (1) and the extensive continuous-to-ordinal conversions I have performed do not cause serious impediments to the model's performance.

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## 3.5  Latent Corruption Level

The model is run for the majority of the countries around the world covering all the years between 1980 and 2010, apart from the period 1981-1983. Figure 5 shows the latent corruption rankings for a set of 212 countries in 2008. Naturally, the model can be run for the rest of the years of the dataset, however, I have chosen 2008, because this year several judges contribute to the corruption assessment and it is a time period in the recent past, hence the rankings should not be considered outdated.[42][43] The dots represent the mean posterior corruption scores for each country and the horizontal bars are the 95% highest posterior density (HPD) intervals of the point estimates.[44] At first glance, the figure offers a predictable sight. The Nordic countries occupy the first places along with the usual corruption-free suspects like New Zealand, Switzerland and Singapore. The bottom of the figure is mainly dominated by countries residing in Sub-Saharan Africa and South-East Asia, such as Equatorial Guinea and Myanmar respectively, while the middle section is settled by lower and upper-middle-income economies like Morocco and Colombia respectively.[45]

Like a few other existing measures (WGI and TI), the latent corruption scores come with their respective measurement errors as mentioned above. This feature of the model should not be ignored, because there is significant variability in the quantity and quality of judges that provide assessments for each country-year. As a result, not all scores should be treated with the same level of confidence.

The quantity effect on the measurement accuracy is evident both within and across samples. With respect to the 2008 sample shown here, there are cases where the quantity effect is observable. Ireland, France, Bahamas and Andorra have all attained similarly high scores ranging between 0.8 up to 1.2 (1.185, 1.070, 0.855 and 0.813 respectively). What's more, Ireland and France present similar confidence intervals, both around 0.6 (0.670 and 0.605). On the contrary, Bahamas and

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[42] Besides, institutional variables like corruption vary slowly over time.

[43] I acknowledge that it would be informative to include the scores of every year of my sample, however, my principal aim here is to introduce an alternative approach in the measurement of corruption hence, to this end, the 2008 sample is a good example.

[44] An $\alpha$ HPD interval is the $\alpha$ % of the posterior density that incorporates the parameter values with the highest probability. The standard confidence interval would have missed some of the high density parameter values, thereby becoming a second best option in this context.

[45] The income classification is in accordance with the World Bank main criterion, which is the 2011 Gross National Income (GNI) per capita. Lower-middle-income: $1,026-$4,035; Upper-middle-income: $4,036-$12,475.

Andorra scores are accompanied with much larger error bars (1.495 and 2.020) indicating much less faith in their ratings. The root of this accuracy differential is the varying number of judges that contribute to the corruption assessment. In particular, in 2008, five judges (WGI, ICRG, TI, EB1 and EB2) have supplied their ratings for Ireland and France, two (WGI and ICRG) for Bahamas and just one (WGI) for Andorra. The relationship between the model posterior distribution and the quantity of raters is vividly highlighted in this occurrence.

The same link can be detected across samples too. I rerun the model including only the three most popular measures of corruption – WGI, ICRG and TI – and I find a notable precision loss. Particularly, the HPD interval is increased by approximately 21.4% compared to the all-inclusive sample presented here.[46] To sum up, the model turns out to be quite sensitive to the number of judges involved in the analysis, underlining the need for a catholic approach toward the corruption assessment.

Of equal importance with respect to measurement accuracy is the quality effect. Refocusing on Figure 5, this hypothesis can be verified. As an example, let's consider Djibouti, Lesotho and Brunei. Firstly, all of them rank in the upper part of the latter half of the rankings managing similar ratings (-0.139, -0.152 and -0.156 respectively). Comparing their measurements bars, though, a contradicting picture emerges. Djibouti and Lesotho ratings suffer measurement errors around 1 (0.91 and 1.035). Brunei, however, bears a much more considerable error around 1.6 (1.592), which is an almost 54% increase with respect to Lesotho and even greater compared to Djibouti. This time, the disparity can be explained from the quality of the judges. Even though, all three country scores are provided by two judges, keeping one of them in common – WGI –, the second is different for one of these countries. Specifically, the second assessment for Lesotho and Djibouti comes from TI, while for Brunei from ICRG. As shown in Figure 7, their reliability evaluation is quite different, ICRG being clearly less trustworthy. Consequently, this difference is reflected on the corresponding HDP intervals, stressing the importance of the assessor quality in conjunction with quantity.[47]

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[46] The three-judge sample is also for 2008.
[47] Similar quality exercise has been performed for the 1997 sample, where the contributing judges exhibit more distinct reliability gaps. The quality effect is even more pronounced in that sample.
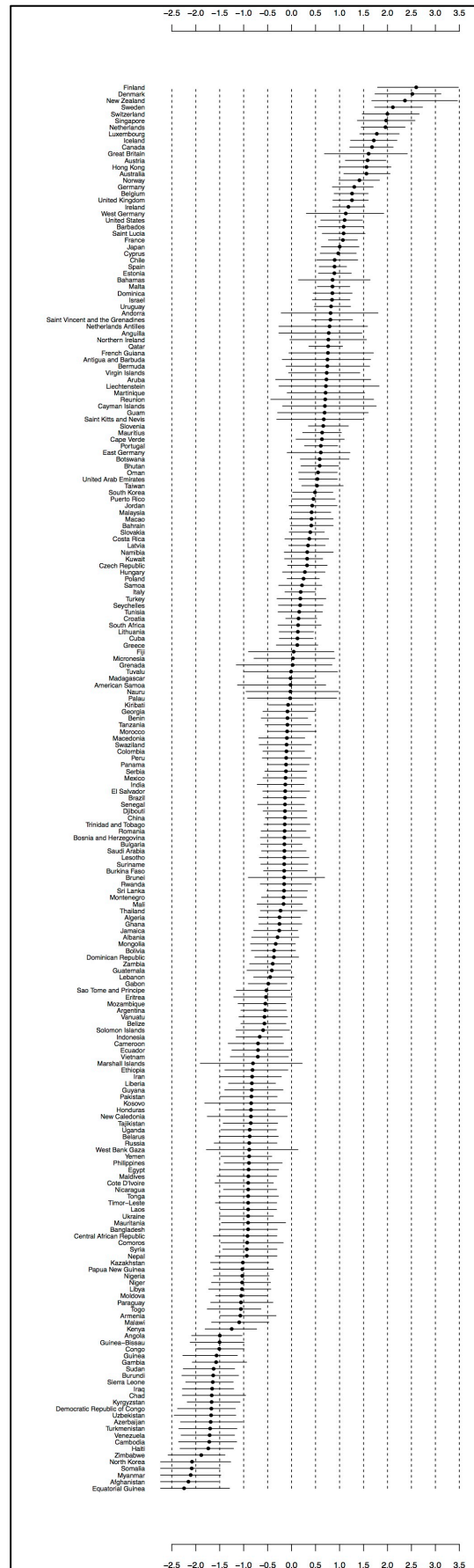
**Figure 5**

Despite having ascribed the majority of the extended error bars, present throughout the corruption scores, to the quantity and quality of the sample's judges, a few cases appear remain unexplained. The countries that appear to be the most corruption-free around the world, demonstrate surprisingly large measurement errors. This is not an unprecedented remark for such models though. Pemstein *et al.* (2010a) attribute this oddity to the inherent right truncation existing in the scale of the constituent measures that comprise their latent democracy level. Accordingly, this applies here as well (Treisman (2007)). The problem is that the degree of corruption prevalence in a country is not easily identifiable due to its innate abstract conceptualisation. The result is that judges compute and publish their ratings, each one using a more-or-less deterministic definition of corruption, thus, blurring the boundaries of the idea of wrongdoing. The definitions in the Appendix can shed some light in this respect. In effect, there is a set of basic criteria, standard for all raters, about how a corruption-free society can be identified, but at the same time there are several small idiosyncratic beliefs complementing each rater's discerning mechanism. The consequences of such individualistic elements are most conspicuous in the top-ranking countries. All raters largely recognise them as law-abiding and transparent economies, however, each judge has its own saying about how far up the scale they manage to climb. The model notices these small "disagreements" across raters and translates them into lengthy error bars.

Overall, the latent corruption scores demonstrate a new index for one of the most inconspicuous concepts in social sciences, whose measurement is a challenging task. The accompanying measurement errors allow the interest reader to place the appropriate level of confidence on each score and as more data become available the model's efficiency can only improve.

## 3.6 Scrutinising the judges

The use of the latent corruption scale could be good news for the researchers whose analyses are served better by an all-round measure. It is not uncommon though, that a scholar argues in favour of a specific measure because of its contextual relevance or its time span. The model has the capacity to offer aid to scholars in this respect, due to the comparative trials it can perform. The judges can be scrutinised in terms of their cutoff points and their reliability when considered over the same latent corruption scale.

### 3.6.1  Cutoffs

In the methodology section it was shown how the model can evaluate the cutoffs, $\overline{\gamma}$, of the constituent measures. This feature can help researchers understand the whereabouts of each scale's cutoffs in relation to other commonly used measures. Published tables of country-year rankings need no longer look like one-off corruption assessments, but pertinency can be established across judges and a better apprehension of where each country really stands in the global scale.

Figure 6 presents the cutoffs of the judges in the model exploiting all the information available throughout the three-decade period. Each bar across each measure represents the cutoff between two ranks on the same latent scale. The length of the bar per se, stands for the 95% HPD interval indicating the precision of each cutoff. The ICRG, for example, has five cutoffs that classify its six-level scale, while the ICVS three for its four-level scale. Also, an example with respect to the HPD intervals is the TI's first cutoff, which lies between -1.56 and -1.44 with probability 95%. It is apparent that across and within raters there is significant variation in the precision of the cutoffs, even though the former is much more accentuated. The lengthy bars are mainly the result of a lack of observations. It is no coincidence that the three most sizeable rater samples, i.e. WGI, ICRG and TI, exhibit the smallest intervals. Apart from the observation scarcity, the cutoff accuracy is also distorted by the inconsistency both across and within the judges' scales.

Another aspect of the cutoffs figure is the lack of overlapping within the judges. Most of the raters display distinct cutoff points spread throughout the scale suggesting a coherent ranking mechanism. The exception is EB1, where there is overlapping taking place in most of the ranks. In this case, collapsing into fewer categories might produce more clear-cut levels. Nevertheless, it is not always straightforward to identify the ideal cutoffs, especially when measures involved, have been through extensive manipulations.[48] In any case, EB1 cutoffs nicely demonstrate a common issue, which might arise when performing this comparative diagnostic.

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[48] See the end of the data section and the second part of the Appendix.

Further observation of ꜰɪɢᴜʀᴇ 6 reveals the level of linearity (or even non-linearity) across judges' cutoffs. For instance, TI and WEF present more evenly
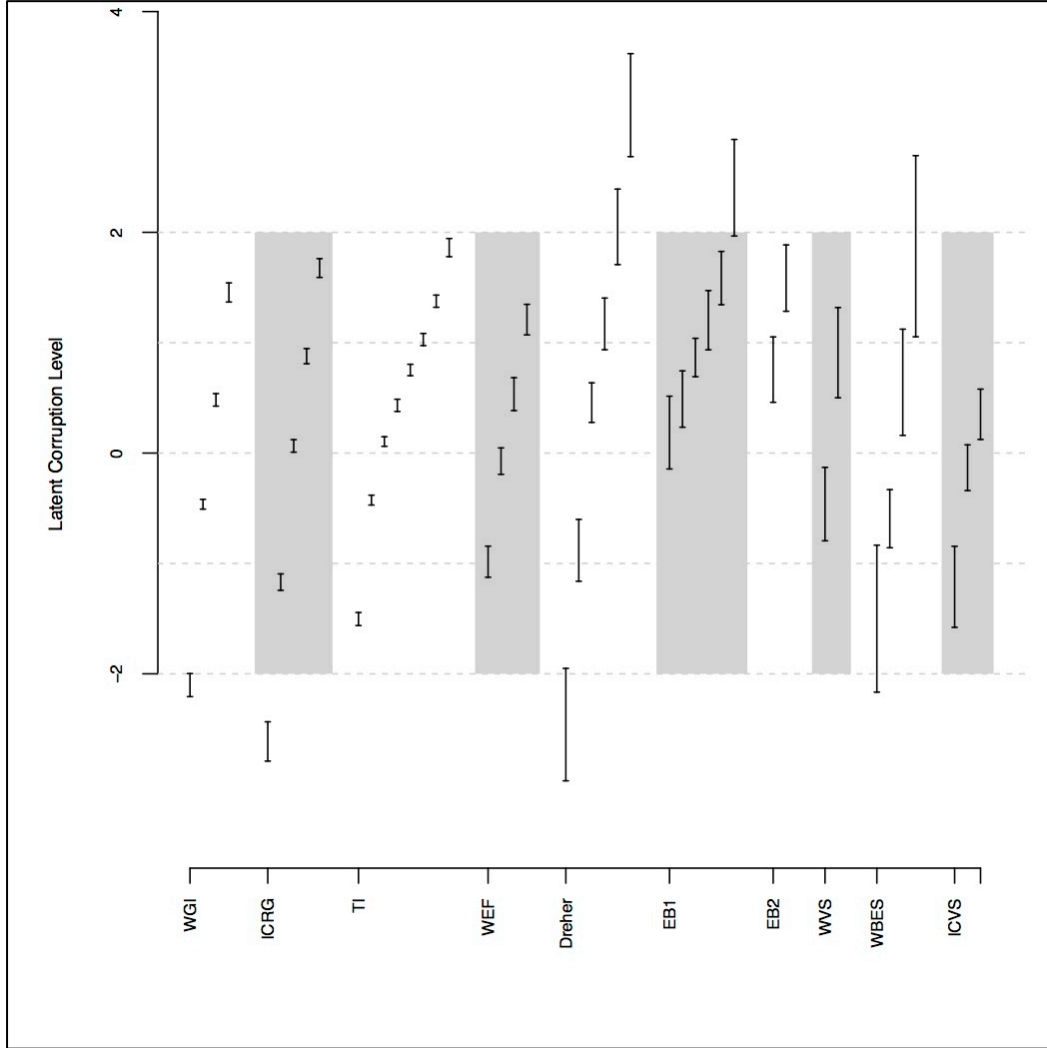


**Figure 6**

dispersed cutoffs on the latent scale, while the WBES seems to be clustered toward the extremes. However, all of the raters show, to a lesser or greater extent, cutoff asymmetries. As I have discussed in the methodology section, this supports the continuous-to-ordinal conversion I performed. Finally, the presence of non-linearities in several places underscores potential biases that might encroach the analyses of researchers who adopt interval-level approaches.

## 3.6.2 Reliability

Apart from the cutoffs estimation of the judges, the model can generate estimates of their idiosyncratic errors, $\sigma_j^2$. These errors represent the raters' tendency to avoid systematic mistakes and they depend on the level of agreement between the judges

for the data sample under consideration. Effectively, these estimates represent the raters' reliability. It would be difficult to overstress the importance of such assessments. It is imperative for every serious researcher to be aware of the level of confidence she can place on each rater. As a consequence, this knowledge has implications on the credibility of past and future applied corruption studies, while it encourages the under-performing raters to assume sturdier estimation techniques.

Figure 7 presents the error variances of the sample's raters accompanied by the corresponding 95% HPD intervals. Naturally, a higher point estimate of the error variance indicates lower reliability. The overall picture is of quite reliable judges except for WBES and Dreher *et al.* (2007) and justifies the faith researchers have shown in these measures through time.
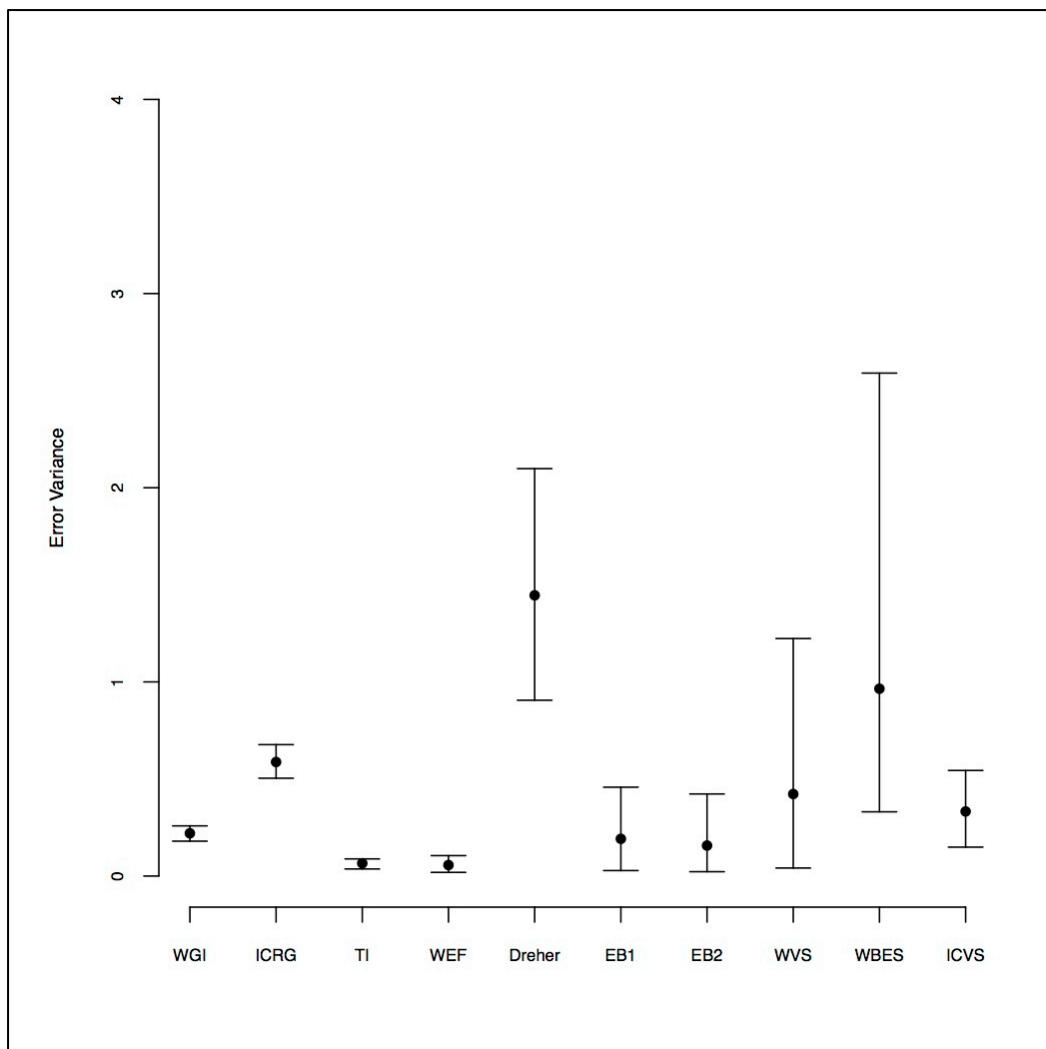


**Figure 7**

The three widely used judges (WGI, ICRG and TI) achieve medium to high levels of reliability. TI performs exceptionally well, being the second most reliable

measure (0.07), and substantiates the publicity it enjoys as a credible source of corruption awareness. WGI stands out as well, even though it does not seem to achieve the level of reliability of the first two. ICRG, on the other hand, is visibly less reliable (0.59) compared to the other two implying that its application warrants more cautiousness. The relatively increased error variance of ICRG should not come as a surprise though. As Lambsdorff (2006) has pointed out, this index does not actually rate corruption but the political instability induced by wrongdoing. Hence, it is expected that some disagreement might arise in their comparison. Furthermore, WGI incorporates the ICRG corruption index in its methodology, partially explaining the decreased reliability. On the contrary, TI increases its reliability by integrating WEF, the most accurate rater in the sample (0.06), in its composite index.

Focusing on the non-expert judges, on average, they perform quite well. All but one have lower error variances than ICRG implying that non-expert measures also provide reliable corruption estimates too.[49] A common feature of all non-expert judges is their prolonged intervals and the average-to-great uncertainty they involve. For example, EB1 has its lower end at 0.03, hypothetically making it the most reliable measure, while its top end at 0.46 exceeds WVS levels (0.43). These raters are characterised by observation paucity and it seems that this trait acts as a catalyst in this occasion.

Finally, it would be interesting to examine the potential causes behind the high error variance point estimates of Dreher *et al.* (2007) and WBES. As a matter of fact, one should expect such outliers to appear. The structural model of the former judge produces an index, which is quite different to the rest in the sense that it invokes potential factors and indicators of corruption. As for WBES, Treisman (2007) and Aidt (2009) have argued about the inconsistency this rater has shown in relation to expert type judges when causes and consequences of corruption have been investigated respectively. Recalling the case of ICRG, a group of judges is formed whose high unreliability is driven by conceptualisation or contextual disparities. By no means, though, these estimates should convey the impression that these judges are irrelevant or inappropriate. These results, actually, underpin the call

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[49] In fact, EB1 (0.19) and EB2 (0.16) perform slightly better than the WGI (0.22) in terms of reliability.

for a diversified, broad-based approach in the estimation of corruption, where every single rater plays a unique role by contributing its own knowledge and experience.

## 3.7 Conclusion

This paper embraces the latest developments in political analysis to show their application on the measurement of corruption. Lately, the latter has sparked discussions with respect to the reliability of the extant corruption measures and their association with the actual phenomenon. The proposed scale addresses these disputes with the inclusion of several existing indicators in a common framework; the endeavours and expertise of numerous scholars and analysts are constructively exploited to generate an all-inclusive measure. The accompanying measurements errors encompass the quantity and quality of the constituent measures and reflect the confidence that should be placed upon them.

My suggestion, however, does not imply the abandonment of the established measures. On the contrary, I acknowledge the need of scholars to show preference towards specific scales due to their unique qualities. In this respect, the model offers useful tools to compare their rankings among each other and their reliability. As a result, applied researchers can now choose the most appropriate measure for their cause based on more solid statistical criteria.

Furthermore, this is an initial incarnation of an ongoing project, which is open to improvements that can surpass the limiting assumptions of the underlying framework. For instance, future developments could potentially generalise the framework with the integration of continuous measures, apart from ordinal, as Pemstein *et al.* (2010a) have already highlighted. Nevertheless, the most important aspect of such an application is that it draws a new path of treatment of unobservable concepts. There is a greater scope that encircles this study extending to other institutional traits such as freedom of speech and the rule of law, whose understanding is essential for the evolution of societies.

## 3.8 Appendix

### Definition of the variables

- **WGI:** Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand

forms of corruption, as well as "capture" of the state by elites and private interests. (Kauffman *et al.* (2010))

- **ICRG:** Corruption: Lower scores of corruption under ICRG indicate that "high government officials are likely to demand special payments", "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licenses, exchange controls, tax assessment, police protection, or loans". (Keefer and Knack (1997))

- **TI:** Transparency International (TI) defines corruption as the abuse of entrusted power for private gain. This definition encompasses corrupt practices in both the public and private sector. The Corruption Perception Index (CPI) ranks countries according to perception of corruption in the public sector. (Transparency International (2010))

- **WEF:** Irregular Payments and Bribes: This indicator represents the score across the five components of the following Executive Opinion Survey question: In your country, how common is it for firms to make undocumented payments or bribes connected with (a) imports and exports; (b) public utilities; (c) annual tax payments; (d) awarding of public contracts and licenses; (e) obtaining favorable judicial decisions. (Sala-i-Martin *et al.* (2010))

- **EB1**

    **v764, v125, qb1_2:** How much do you agree about the existence of corruption in local institutions in your country.

    **v765, v126, qb1_3:** How much do you agree about the existence of corruption in regional institutions in your country.

    **v766, v127, qb1_4:** How much do you agree about the existence of corruption in national institutions in your country.

(Eurobarometer 64.3 (2005); Eurobarometer 68.2 (2008); Eurobarometer 72.2 (2009))

- **EB2:** The scale of the problem in corruption/wrongdoing in national government and institutions. (Flash Eurobarometer 236 (2008))

- **WVS:** "How widespread do you think bribe taking and corruption is in this country?" (World Values Survey 1984-2004 (2006))

- **WBES:** How problematic is corruption for the operation and growth of your business. (World Business Environment Survey (2000))
- **ICVS:** During [last year] has any government official in your country asked you, or expected you to pay a bribe for his or her services. (van Dijk *et al.* (2007))

## Further analysis of the non-expert ratings

- **EB1:** The ratings of judge EB1, $\overline{Y}^{\text{EB1}}$, can take integer values in the interval [1,4], where a higher value indicates lower level of corruption. Thus, for non-expert judge $j$ and country-year $i$, individual $k$ provides a ranking $Y_{ijk}^{\text{EB1}} = \{1,2,3,4\}$. The new continuous rating , $y_{ij}^{\text{EB1}}$, is derived from the latter observable ranking according to

$$y_{ij}^{\text{EB1}} = \frac{\sum_{k} Y_{ijk}^{\text{EB1}} = \{3,4\}}{\sum_{k} Y_{ijk}^{\text{EB1}} = \{1,2,3,4\}} . \tag{6}$$

Effectively, I evaluate the share of individuals who rate country-year $i$ on behalf of judge $j$ as 3 or 4, hence those that consider that country-year $i$ is characterised by low or very low levels of corruption. The choice of values 3 and 4 seems arbitrary since one could also evaluate the share of individuals who only assign a value of 4. The choice of these values, in this case and the following, was made on the basis of generating a continuous variable with an as much as possible broad distribution of values in the interval (0,1).

- **EB2:** The ratings of judge EB2, $\overline{Y}^{\text{EB2}}$, can take either the value of 1 or 2, the latter indicating less corruption. As before, the new continuous rating, $y_{ij}^{\text{EB2}}$, is given by

$$y_{ij}^{\text{EB2}} = \frac{\sum_{k} Y_{ijk}^{\text{EB2}} = \{2\}}{\sum_{k} Y_{ijk}^{\text{EB2}} = \{1,2\}} \tag{7}$$

- **WVS, WBES, ICVS:** The ratings of judges WVS and WBES take values in the interval [1,4], like EB1, while ICVS ratings has the same range of values as EB2. Accordingly, the new variables $y_{ij}^{\text{WVS}}$ and $y_{ij}^{\text{WBES}}$ are generated from an equation similar to (6) and $y_{ij}^{\text{ICVS}}$ similar to (7).

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# Conclusion

Whatever the disease, if it is to be fought effectively a certain level of understanding of its dynamics must be achieved. Likewise, the removal of corruption from modern societies requires a good grasp of its mechanics. The present thesis is a step toward this direction. It consists of three essays, each one examining a different aspect of the problem. The first essay is looking for a statistical link between certain features of institutional quality, including corruption, and political leaders. The findings suggest that leaders are important for bureaucratic quality and the rule of law. Nevertheless, their impact is not evident for corruption, an outcome that can be explained by the shortcomings of the data and the innate qualities of malfeasance. Next, the thesis explores the consequences of transgression showing it can affect the decision of parents when contemplating between child quantity and quality. Theoretically, it proves that the escalating incidence of malfeasance leads to a demographic transition from lower to higher fertility, decreasing human capital and lower growth. The third and final part examines the measurement of corruption, a task that many scholars and organisations have recently delved into. Applying an existing statistical framework to a newly built dataset the study suggests a new proxy for wrongdoing, which integrates the efforts of many experts in this issue. The measurement errors that accompany the corruption scores are indicative of the precision achieved and set the level of confidence that can be placed upon them. Last but not least, the model has the capacity to perform comparative exercises thus helping researchers choose the most reliable measure and better understand where each scale lies in comparison with the others.

Notwithstanding the answers this thesis has provided, there are many more questions left to be solved. The past two decades considerable leaps forward have been made in this respect, especially in the field of applied research. Ingenious ways are suggested to quantify corruption and, hence more accurately estimate the theoretical predictions. Nonetheless, given all this knowledge, probably, the most difficult task of all would be to design effective anti-corruption policies that can eradicate the problem and make a positive impact on the lives of the people. No matter how well the empirical results comply with the theory, both suggesting the adoption of specific policies, the idiosyncratic forces of every society will always

play an important role in the determination of the final outcome at a level that they might as well lead to the opposite direction in the end if they are ignored.