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3 January 2014

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Abstract

This work provides a parametric and semi-parametric analysis of the relationship between the proportionality degree of an electoral system and corruption. This allows us to properly consider mixed electoral systems alongside the two traditional ones, proportional and plurality. Results show that a reduction in the proportionality degree within the same proportional system is not beneficial in fighting corruption because it weakens the monitoring power of opponents (their representativeness reduces) without the introduction of the voters' monitoring. On the contrary, mixed rules allow both monitors to exercise their power to induce politicians to avoid corrupt behaviour. Increasing plurality elements into mixed systems is beneficial only up to certain proportionality degrees, after which the corresponding level of corruption begins to grow. Therefore, for governors who want to adopt mixed electoral systems, the choice of their proportionality degree becomes fundamental.

JEL Classification: D72, C23

Keywords: Electoral Systems, Corruption, Proportionality degree

1. Introduction

Corruption is a widespread phenomenon that is difficult to capture in a single definition. The World Bank's definition of corruption – political and bureaucratic – is the "abuse of public power for private benefit". It is generally found in the public sector involving government officials. Corruption is identified as "the single greatest obstacle to economic and social development".[1] This is the reason why a growing number of theoretical and empirical papers in economic, social and political literature have studied the causes of corruption. This work advances empirical studies on the political determinants of corruption;[2] in particular, it analyses how electoral systems affect corruption.

The role of electoral systems as a way of reducing corruption was first emphasized by Schumpeter (1950). In the following years, theoretical literature studying the link between electoral systems and corruption increased, often with ambiguous conclusions (Persson and Tabellini,1999, 2000, 2002; Myerson, 1993). Although empirical studies have confirmed that countries with proportional systems have much more widespread corruption than countries with majoritarian representations, the empirical question on the effects of the electoral system on corruption remains open for three reasons: 1) the difficulties in measuring corruption; 2) the effect of the electoral system on corruption appears fragile because the results are not robust to the inclusion of control variables or the use of data from different years (Treisman, 2007); 3) there have been no comprehensive studies on the effect of mixed systems on corruption so far, despite the trend of countries to change their extreme electoral positions towards mixed ones. Our analysis focuses on this third point.

Recently, political scientists have underlined that new electoral systems could be designed in order to maximize both the objective that defines the trade-off between representation, and the accountability of political parties which characterise the two "extreme" electoral rules, majoritarian and proportional. In this light, mixed systems, combining proportional representation (PR) and majoritarian elements, are becoming one the most attractive electoral rules nowadays. Therefore, it is important to understand the consequences that such a shift has on corruption.

Analysing mixed systems in an empirical framework is not easy. Previous works (Kunicova and Rose Ackerman, 2005) have studied those systems using a dummy variable, but this practice is misleading because some of them have a larger proportional element than others; that is, they may be designed with different degrees of proportionality. Therefore, in order to consider mixed systems properly, a continuous measure of the degree of proportionality of an electoral rule is needed. The use of the Gallagher disproportionality index as a measure of the proportionality degree of an

[1]The World Bank.

[2]Here, we are referring to *political corruption*; it is defined as the misuse of public office for private financial gain by an elected official (Treisman, 2000).

electoral rule is the first contribution that the present work gives to the empirical literature analysing how electoral systems affect corruption. Our hypothesis is that the effect of electoral rules on corruption greatly depend on the characteristics of responsiveness and accountability that PR and plurality representations have, respectively. These characteristics define the level of the monitoring power of opponents and voters over politicians, that shape their incentive to adopt corrupt behaviour. Therefore, the monitoring power of minorities and voters is the key to the interpretation of the correlation between the proportionality degree of an electoral system and corruption. Mixed electoral systems, combining PR and plurality elements, allow both voters and minorities in parliament to monitor politicians. This double monitoring effect is surely beneficial for the reduction of corruption. In terms of the relationship between the proportionality degree of electoral rules and corruption, we expect that mixed systems are correlated to less corruption, due to their having an intermediate level of proportionality rather than the extreme ones. This mathematically translates in a nonlinear curve with corruption assuming its minimum value within the range of proportionality.

The second contribution that this paper offers focuses on empirical methodology. Indeed, we conducted a cross-country analysis over 75 countries from 1984 to 2010 using both parametric and semi-parametric panel data techniques. The latter are, in general, very recent and they have never been employed in this field of literature. The results confirm that mixed systems work better than extreme systems only if they are designed with a certain proportionality degree. Graphically, we find that the relationship between the proportionality degree of electoral rules and the efficiency of government and business (which summarises our measure of corruption) is a sine curve function; this functional form appears very new and offers an interesting interpretation. Shifting from more to less proportional PR systems, corruption increases because the lower monitoring power of minorities is not substituted by the voters' monitoring. Instead, moving to mixed systems with a high proportionality degree and slightly reducing it, the monitoring power of opponents (ensured by PR elements) is flanked by the increasing monitoring power of voters (ensured by plurality elements), giving an incentive to politicians to avoid corruption. The consequence is that corruption decreases. On the contrary, mixed systems with high plurality characteristics and little PR features maintain a high accountability of incumbent politicians to voters, so the monitoring of minorities weakens, thus providing fertile ground for corrupt behaviour: corruption starts increasing again. The policy implications of such a result are straightforward: although mixed systems are better than extreme rules in fighting corruption, only certain proportionality degrees characterising mixed rules assure that corruption is minimised.

The remainder of this article is organised as follows. The next section summarises the theoretical and empirical literature on the link between electoral systems and corruption, and clarifies the theoretical framework for the empirical analysis. Then we present a description of data and variables. In section 4 we discuss both the parametric and semi-parametric specifications of the empirical model and the results, followed by the conclusion.

2. The literature and the theoretical framework

The principal agent theory defines the relationship between electoral rules and corrupt behaviour of politicians and bureaucrats (Kunikova and Rose-Ackerman, 2005; Persson et al., 2003): they are the agent and voters are the principal. Because of the asymmetry of information in the principal-agent relationship, politicians and bureaucrats have opportunities to extract rents. In particular, politicians face a trade-off between rent-seeking and appearing incorrupt and honest to their voters in order to increase the probability of re-election. The incentive to extract rent by politicians is affected by the characteristics of electoral rules.

For legislative bodies, electoral rules define how votes are converted into sets of legislators. Therefore, they permit citizens to select their own representatives. The basic distinction is between proportional systems (PR) and plurality/majoritarian systems. In PR systems legislative seats are allocated to political parties on the basis of the total votes won by each party. More precisely, in an open list PR system, voters may express preferences over particular candidates within a party, while in a closed list PR system, party leaders determine the order in which individual politicians are ranked on the party list. Once the total number of seats awarded to a party is determined, that number of politicians from the top of the list are elected. By contrast, in majoritarian systems, the candidate or party with the greatest number of votes wins all the seats in a district.

There is a general consensus among scholars that an ideal electoral system cannot be designed. Although many scholars harbour strong preferences for one type of system rather than another, it is widely argued that "the choice between majoritarian and proportional elections is a trade-off between accountability and responsiveness" (Persson and Tabellini, 2003). Majoritarian elections have the twin virtues of strength and accountability of the party government. "Strength" means a single-party (not coalition) government. Cohesive parties with a majority of parliamentary seats are able to implement their manifesto policies without the need to engage in post-election negotiations with coalition partners. At the end of their tenure in office, governments remain accountable to the electorate, who can remove them if they wish to, but the government is not always responsive to change in popular opinion. Proportional elections grant accurate representation of voters' desires,

but without the assurance of a clear cut majority, governments are less accountable for their decisions.

In the light of such characteristics, theoretical literature has studied the link between electoral systems and corruption according to the *district size* and the *electoral formula*. If the *district size* (i.e. the number of seats in a district) is considered, in majoritarian systems characterised by small districts with only one candidate in each, the incumbent, already well known in the constituency, is more likely to reach a relative majority. However, in a proportional system, large districts that appoint several candidates are more likely to push aside new candidates who got a minority of votes. Myerson (1993) and Ferejohn (1986) showed that small districts increase the barriers to entry. Therefore, with respect to majoritarian electoral systems, proportional electoral systems with a large district magnitude tend to have smaller barriers to entry, which is associated with stiffer competition, leading to smaller incumbent rent. Referring to the *electoral formula* (i.e. how votes are translated into seats), when voters vote for an individual candidate, there is a direct link between individual performance and individual reappointment because voters base the valuation of their representatives on their ability to represent interests of the community. Thus the incumbent faces strong incentives to perform well in order to maximise the probability of re-election. However, when voters vote for a list the chances of re-election depend on the candidate's rank in the list, and so each candidate has a weaker incentive to perform well. Therefore, according to that dimension of the analysis, in a proportional system the incentive for corruption is higher than in a majoritarian system (Persson and Tabellini (1999; 2000; 2002). The empirical works of Persson, Tabellini and Trebbi (2003), Gagliarducci, Nannicini, Naticchioni, (2011) suggest that countries with proportional systems have much more widespread corruption than countries with majoritarian systems. Kunicova and Rose Ackerman (2005) find that closed lists PR are more corrupt than open lists PR, and both are more corrupt than plurality systems. Golden and Chang (2001) and Chang (2005) conclude the opposite: open list PR and plurality systems could lead to more corruption than closed list PR, since the former allow voters to favour or disfavour individual politicians. Golden and Chang (2007) show that the previous relationship fails to hold up once district magnitude is considered. They have found that once the district magnitudes exceed a certain threshold, both at cross-national and at national (Italian) level, open-list PR systems (which allow voters to select individual candidates from party lists) are associated with greater corruption than closed-list systems (where candidate selection is controlled by the national party leadership) .

The common features of those empirical papers are 1) to identify PR and majoritarian systems with a dummy variable and 2) not to consider mixed systems at all or to consider them marginally, and always with a dummy variable, neglecting their proportionality degree.

Nowadays, mixed systems are becoming an interesting topic in political science literature because more and more countries are abandoning the "extreme" electoral rules in favor of mixed representation. A mixed electoral system uses both PR and plurality features for elections to the same legislative body, that is, some members are elected nominally and others from a party list. Kostadinova (2002) argued that mixed systems allow countries to enjoy the benefits of minority representation (within the Parliament) and, at the same time, they produce less fractionalisation than proportional systems. Mixed rules are usually adopted with the hope that the advantages of both "extreme" electoral designs can be enjoyed in a ''best of both worlds'' scenario (Shugart and Wattenberg, 2001).

This justifies the increasing interest on the part of political and economic scientists to explore the effects that mixed systems have on economic and political variables. Up to now, there have not been any comprehensive empirical studies on the effect of mixed systems on corruption.

Our theoretical framework in the analysis of the link between electoral systems and corruption is based on the characteristics of electoral rules; they shape the rent seeking incentive of politicians which depends on the probability of detection for corrupt behaviour. The higher accountability of plurality rules makes voters the monitor of politicians; the higher representativeness of PR rules makes opponents/minorities the monitor of politicians. We argue that mixed rules, giving the monitoring power to both voters and minorities, may balance the trade-off between accountability and responsiveness that reduces corruption. That is, mixed rules maintain the independent effects of responsiveness of PR and accountability of majoritarian representation, which are stronger in fighting corruption. But mixed electoral systems are a heterogeneous category. Virtually all of them employ some combinations of majoritarian and proportional representation, but there are substantial variations in the way in which they are combined; that is, mixed systems can be designed with different degrees of proportionality. Ideally one can locate the various possible mixed systems on a continuum from the most to the least proportional. Therefore, the correct way to consider them is to measure their proportionality by using a continuous measure of the proportionality degree of an electoral system. Political literature provides the Gallagher disproportionality index of electoral outcomes (see section 3). In this way, we can design a functional relationship between the latter and corruption. If our argument is correct, we should find a non-linear relationship between the proportionality degree and corruption which shows minimum levels of corruption in correspondence to electoral systems with an intermediate degree of proportionality. This implies that, in order to fight corruption, mixed representations are "better" than extreme ones, and that mixed systems should be designed with a proportionality degree which guarantees the presence and the independence of action of the two kinds of monitoring.

3. Data and variables

The dependent variable of our empirical analysis is a measure of corruption. At a macroeconomic level, the three most popular indices based on corruption perception are the Corruption Perception Index (Transparency International), the Control of Corruption index (the World Bank) and the Corruption index (the International Country Risk Guide - ICRG).[3] We choose to measure corruption using the Corruption index for two reasons: 1) the database of the ICRG provides , the longest time series of corruption data (from 1984 to 2010;[4]) for about 150 countries. 2) it is highly correlated with the two other indices largely used in the literature, such as Transparency International Index and Control of Corruption index.[5]

The Corruption index (thereafter *Corr*) is expressed on a scale reflecting the perception of respondents; it summarises the valuation of corruption within the political system; in particular, the presence of curruption is a threat to foreign investment because it "distorts the economic and financial environment; reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability, and introduces an inherent instability into the political process".[6] The result is that corruption makes it difficult to conduct business and, in some cases, it may force the withdrawal of investments. The Corruption index is based on comparable information done by assigning a risk point between the interval [0, 6] where 0 represents the highest risk of corruption and 6 the lowest.[7,8]

Figure 1 shows an overview of the corruption distribution for different countries. For each country in the figure we calculated the mean over years (1984-2010). To the left with a high index value (meaning low corruption risk) we find the Scandinavian countries and the three countries of Oceania (Australia, New Zealand and Papua New Guinea). European countries in the dataset show low/medium level of corruption while countries in Asia, Africa and South America have the highest value.

[3] The indices measuring corruption can be divided into two categories. One contains indices based on corruption perceptions; the other includes indices of experienced corruption.

[4] ICRG table 3B, published by The PRS Group.

[5] We display the autocorrelation matrix between the Corruption Index (CI), the Transparency International Index (TII) and Control of Corruption index (CCI), calculated over the 84 countries from 1996 to 2011 (we started from 1996 because of the availability of the TII and CCI).

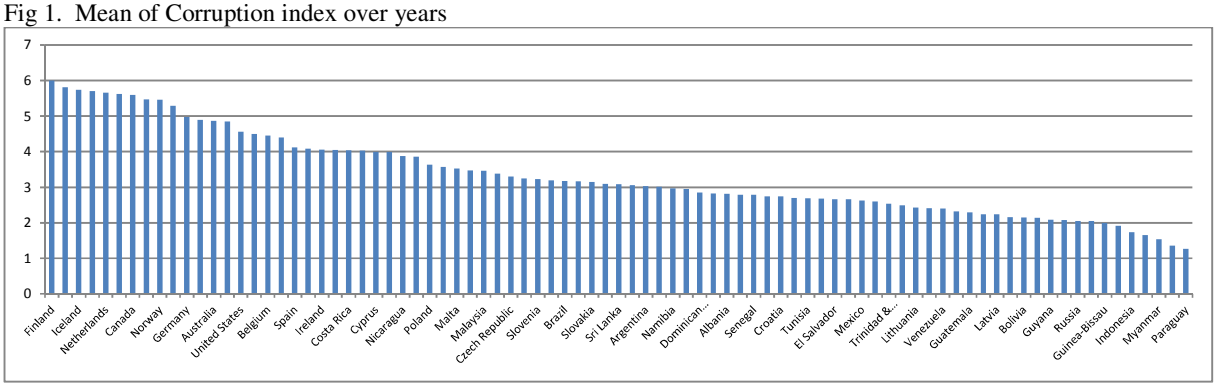
	CI	TTI	CCI
CI	1		
TII	0.8693	1	
CCI	0.8769	0.9781	1

[6] http://www.prsgroup.com/ICRG_methodology.aspx

[7] Even though the ICRG database includes a collection of records for about 150 countries, our analysis was performed on 75 countries. We avoided some countries because they were marginal with respect to our study.

[8] Table 1 in Appendix shows the descriptive statistics of *Corr*.

Fig 1. Mean of Corruption index over years



This measure of corruption (like all corruption measures based on perception) has various drawbacks (Lambsdorff, 2005); a significant gap between perception and facts being the major one . The main regressor of the analysis is the Gallagher disproportionality (of the electoral outcome) index; this is especially useful for comparing proportionality across electoral systems. The Gallagher index (or least squares index) is a representation index of political parties within a Parliament; it may be considered as a very good proxy for the measure of proportionality of an electoral system because of the link between the kind of electoral system and the kind of political parties representation.. Indeed, theoretical literature states (see Persson and Tabellini, 2000) that the electoral system that guarantees a greater representation of political parties is a more proportional one while the less representative one is less proportional. Blais (1988) confirmed that it is possible to classify electoral systems according to their electoral outcomes. Moreover, empirical studies have shown that a majoritarian system produces a higher level of dis-proportionality than a proportional representation system (Lijphart, 1994; Anckar and Akademi, 2001), whereas a mixed-electoral system produces an intermediate level (Powell and Vanberg, 2000; Anckar and Akademi, 2001). Therefore, the Gallagher index is an excellent proxy for the degree of dis-proportionality of the electoral system.[9] The Gallagher index (thereafter *GI*) is constructed as

$$GI = \sqrt{\frac{1}{2}\sum_i (v_i - s_i)^2}$$

where v_i and s_i are respectively the share of votes and of seats of a single political party (i=1,....,n political parties) at elections in each country in the time span under consideration. The index can take values from 0 to 100 with 0 indicating perfect proportionality between seats and votes and 100 meaning that the only seat at stake goes to the winner. Clearly the bounds of the *GI* (0 and 100) are only theoretical values. The *GI* between the investigated countries ranges from 0.26 to about 33.[10] In this range fall the countries that have experienced plurality, PR and mixed systems as shown in

[9] *Dis-proportionality* means the deviation of the parties' seat shares from their vote shares. Perfect proportionality is the situation in which each party receives exactly the same share of seats for the share of votes it receives.
[10] See table 1 (Appendix) for the descriptive statistics of all variables.

table 2 (Appendix). In the time span 1980-2011, some countries maintained the same electoral system, while other countries changed it. For example, Italy held a PR system from 1980 to 1993 and then a mixed one; Ukraine experienced all three systems: plurality 1994-1997, mixed 1998-2003 and PR since 2004. The concentration of mixed systems has been particularly pronounced in post-communist Europe, where six states (in the database) currently employ systems of this type - Romania, Lithuania, Hungary, Croatia, Poland and Albania. The majority of countries adopted PR and then a mixed representation, with the minority using plurality rules. Not all the countries in the dataset had democratic elections after 1980. Table 3 (Appendix) lists countries, in decades, from their first democratic election; the majority of countries have had democratic elections since the '80s, and only two countries since 2000.[11] Finally, in table 4 (Appendix), we provide the descriptive statistics of *GI* according to the three electoral rules. It can be noticed that the mean of *GI* within PR is lower than that within the mixed system and, in its turn, is lower than that within plurality; it confirms that *GI* is a good proxy for electoral systems. But it can happen that, for the same value of *GI*, electoral systems overlap. This happens because the *GI* is a proper representation index.

An important issue here is to deal with the possibility of endogeneity of the Gallagher index. All the theoretical literature analysing the link between electoral rules and corruption considers the first as a *determinant* of corruption and not the reverse. The endogeneity problem may arise when dealing with political institutions, not the electoral system (this is the reason why the variable *law_order* - that we will describe in the following paragraph - which controls for this kind of feature - is also considered endogenous). In this respect, two other considerations must be made: 1) it seems unlikely to think that the perception of corruption (as a menace to foreign investments) may affect the way in which electoral systems are designed by politicians; 2) if the electoral system was affected by corruption, the choice of one electoral rule rather than another would be a statement of corruption for incumbent politicians, and they would risk dismissal from office. Therefore, we can rule out the endogeneity issue of the dis-proportionality index.

The literature studying the causes of corruption names a long list of variables, claimed as statistically significant determinants. They can be divided into four groups: 1) economic and demographic, 2) political, 3) judicial and bureaucratic, 4) religious and geo-cultural (de Haan and Seldadyo, 2005).[12] A typical empirical study limits its attention to a small number of variables of particular interest. Unfortunately, it is almost impossible to find the "true determinants" of corruption: a variable found significant in a particular specification of the model, becomes insignificant in an alternative model, or when other variables are incorporated. In order to overcome

[11] it is clear that before the first year of a democratic election, *GI* shows missing values.

[12] For theoretical literature on the causes of corruption see e.g. Tanzi (1998), Rose-Ackerman (1999), Jain (2001); for empirical literature on the same topic see e.g. Treisman (2000).

this drawback, Sala-i-Martin (1997) proposed to use a Sensitivity Analysis to establish which of the potential determinants are robustly correlated with corruption.

In the choice of control variables we take a cue from the findings of the Sensitivity Analysis. Therefore, in the empirical model, we firstly include the two typical controls in cross-country analysis, the (log of) per capita GDP and the population size and secondly, in order to test the robustness of results, we add a set of control variables believed as the most robust determinant of corruption. The full list of control variables is the following:[13]

- Per capita GDP, in natural log (thereafter *lngdp*): it controls for structural differences in economic development (de Haan and Seldadyo, 2005). By far the strongest and most consistent finding of the new empirical work is that lower perceived corruption correlates closely with higher economic development (La Porta et al. 1999, Ades & Di Tella 1999, Treisman 2000) and it can be found in each region of the world (Treisman 2007),Kaufmann et al. (1999) and Hall and Jones (1999) question the causal relationship between corruption and income: the per capita GDP is high because of low corruption. For this reason we treat *lngdp* as endogenous.
- Population (thereafter *pop*): it controls for size. Empirical literature found contrasting evidence (Knack and Azfar, 2003; Tavares, 2003).
- Government stability (thereafter *gov_stab*): it controls for quality of government. The higher the quality of government, the lower the probability of corruption (de Haan and Seldadyo, 2005).
- Democratic accountability (thereafter *dem*): it controls for the level of democracy of a country. There is a general consensus that democracy reduces corruption (de Haan and Seldadyo, 2005).
- Law and Order (thereafter *law_order*): it controls for the rule of law as a measure of the confidence that agents have in the rules of society, the effectiveness of judiciary and the enforceability of contracts (de Haan and Seldadyo, 2005). A stronger rule of law reduces the likelihood of corruption taking place. Also in this regard, an issue of causality may emerge: agents may trust the rule of law because corruption is low. In order to take this problem into account, some estimations treat *law_order* as endogenous.
- Women (thereafter *wom*): it is the proportion of seats held by women in national parliaments (%); it controls for the gender dimension of corruption. Conventional wisdom states that women in public life can be an effective anticorruption strategy because women are less corruptible than men. While the concept of women inherently possessing a higher level of integrity has been challenged, studies have confirmed that there is a link between higher representation of women in government and lower levels of corruption (Dollar et al., 1999; Goetz, 2004; Sung, 2003).

[13] Table 5 (Appendix) provides a detailed description of variables.

- General government consumption expenditure (thereafter *G*) – in % of GDP: it controls for government size. There is no consensus among authors on the theoretical relationship between government size and corruption (Fisman and Gatti, 2002; Bonaglia et al., 2001; Ali and Isse, 2003). Moreover, in order to consider a possible endogeneity of government sector size, in some estimations we treat *G* as endogenous.
- Net enrollment primary rate, in natural log (thereafter *lnschool*): it controls for human capital development. Empirical literature found contrasting evidence (Ali and Isse, 2003; Frechette, 2001).[14]

We follow the standard practice of counting a country as democratic according to its rate of Polity IV political freedom score. Polity IV provides data on democracy level and regime duration. The Polity IV index is a combined polity score ranging from -10 (strongly autocratic) to +10 (strongly democratic), arrived at by subtracting the autocracy score from the democracy score. The democracy and autocracy indexes were originally constructed additively based on the following indicators: competitiveness of executive recruitment, openness of executive recruitment, constraints on the chief executive, regulation of participation and competitiveness of participation. Scholars have reduced the index to a dichotomous measure of democracy and autocracy. Two different thresholds are frequently used for this purpose: the strictest measure defines countries which score 6 or higher on the combined index (Raknerud and Hegre, 1997) as democratic, whereas more lenient studies have taken score 3 as their threshold (Gleditsch and Hegre, 1997). In this work, we follow the latter example and define as a democracy the countries whose score of Polity IV index is greater than +3 in the year of election.

4. Econometric specifications and results

The empirical analysis is twofold: parametric and semi-parametric

4.1 Parametric and semi-parametric analysis

We start with a description of the parametric specification of the model. In order to test the hypothesis specified in section 2 we choose a cubic specification of the link between corruption and the proportionality degree of the electoral system as the more general nonlinear function. Therefore, the estimated equation is

$$corr_{i,t} = \sum corr_{i,t-j} + \beta_1 GI + \beta_2 GI^2 + \beta_3 GI^3 + \sum \delta\, regressors_{i,t} + \alpha_i + \mu_t + \varepsilon_{i,t} \quad (1)$$

of country *I* at time *t*; α_i is a country-specific effect, μ_t is a time-specific effect. Two lags of the dependent variable are introduced in the estimated equation because of the dynamic of corruption.[15]

[14] Table 6 (Appendix) shows the correlation matrix of regressors.

Indeed, previous empirical analyses on corruption consider corruption as a dynamic phenomenon, where past levels of corruption affect present levels (Aidt, 2003). The linear, quadratic and cubic terms of *GI* catch the nonlinear specification of the model. The other regressors are those described in the previous section.

Equation (1) is a dynamic panel data model which has been estimated using Arellano-Bover (1995)/Blundell-Bond (1998) system GMM panel data techniques. The empirical analysis has been conducted on a panel of 75 countries[16] over 27 years (from 1984 to 2010).

The estimation results of the parametric analysis are in table 7 (Appendix). In order to control for heteroskedasticity, every estimated equation has robust standard errors. The second-to-last row of table 7 shows the Chi^2 (and the p-value in parenthesis) of the Hansen test whose null hypothesis is that over-identification restrictions are valid; we do not reject the null and the model is correctly specified.[17] The last row of table 7 displays the p-value of the Arellano-Bond test for second-order autocorrelation in the first differenced residuals: in all the specifications there is no autocorrelation of residuals.

An attempt to overcome the limits of parametric analysis of non-linear models is strongly recommended. A priori, we ignore any hint useful for the choice of a specific functional form. A more general approach to the estimation of non-linear models is a non-parametric regression that does not require the specification of the underlying functional form (Li and Racine, 2007).

The parametric analysis of corruption takes advantage of a rich econometric specification. A dynamic model for panel data accounts for the persistence of corruption, its lagged response to explanatory variables and residuals autocorrelation. Furthermore, some of the explanatory variables can be endogenous. Non-parametric methods for panel data are not as well developed as the parametric ones, and a dynamic model like (1) can hardly be estimated in a non-parametric setting. It is well known how a full non-parametric analysis faces the "curse of dimensionality" given by the rate of convergence of estimators being inversely related to the number of covariates. A widely accepted answer to this problem is provided by semi-parametric models where some components

[15]The estimation of equation (1) - without lags of *corr* - using fixed effect panel data techniques showed autocorrelation of residuals. In order to solve this problem, we introduced two lags of the dependent variable in the right-side of the equation (1).

[16] Countries are: Albania; Argentina; Australia; Austria; Bahamas; Bangladesh; Belgium; Bolivia; Botswana; Brazil; Bulgaria; Canada; Chile; Costa Rica; Croatia; Czech Republic; Denmark; Dominican Republic; Ecuador; El Salvador; Finland; France; Germany; Greece; Guatemala; Guinea-Bissau; Guyana; Honduras; Hungary; Iceland; India; Indonesia; Ireland; Israel; Italy; Jamaica; Japan; South Korea; Lithuania; Luxembourg; Malta; Moldova; Mongolia; Mozambique; Myanmar; Namibia; Netherlands; New Zealand; Nicaragua; Norway; Papua New Guinea; Paraguay; Peru; Philippines; Poland; Portugal; Romania; Senegal; Slovakia; Slovenia; South Africa; Spain; Sri Lanka; Suriname; Sweden; Switzerland; Taiwan; Thailand; Trinidad & Tobago; Turkey; Ukraine; United Kingdom; United States; Uruguay; Zambia.

[17] We also compute, but we do not show, the difference-in-Hansen test in order to test the joint validity of the full instrument set; we do not reject the null.

enter with a non-specified functional, while others are parametric. Here we apply the methods of Baltagi and Li (2002) to the panel data model:

$$y_{i,t} = x'_{i,t}\gamma + g(x_{i,t}) + \mu_i + v_{i,t}, \qquad i = 1, \dots\dots, N; t = 1, \dots\dots, T \tag{2}$$

where $x_{i,t}$ is a vector of explanatory variables, $z_{i,t}$ is a variable with a nonlinear relation to the dependent variable, μ_i denotes fixed effects and $v_{i,t}$ are i.i.d random errors. The function $g(z_{i,t})$ is not specified.

Model (2) can be transformed by taking the first difference to eliminate individual fixed effects. The new equation contains a non-linear component $g(z_{i,t})$-$g(z_{i,t-1})$ that represents the main problem for model estimation. The solution advanced by Baltagi and Li (2002) is to approximate $g(z)$ with the series $p^k(z)$, where $p^k(z)$ is the vector of the first k approximating functions. This implies that $g(z_{i,t})$-$g(z_{i,t-1})$ is approximated by $p^k(z_{i,t})$-$p^k(z_{i,t-1})$. Spline functions are among the most used to approximate an unknown function. Splines are piece-wise polynomial functions defined over intervals of the support of z delimited by $1,\dots,k$ knots. The methodology advanced by Baltagi and Li (2002) proceeds with the estimation of the parameter vector γ with the series method. This estimate is used to build an estimate of the error component $v_{i,t}$ that becomes the dependent variable in the non-parametric estimation of $g(z_{i,t})$.

We use this panel regression method to estimate a model of cross-country corruption where we distinguish a non-parametric component $g(GI_{i,t})$ and a linear relationship between a set of control variables and the corruption index. In order to concentrate our analysis on the non-parametric relationship, we make some simplifying specification choices. The model is static, aiming at an estimation of the long-run relationship. Questions with omitted dynamics are tackled with the use of country time series made up of five-years averages and the introduction of time dummies among regressors. The use of time averages also has the advantage of reducing the attenuation bias which derives from possible measurement errors in the variables.

4.2 Results

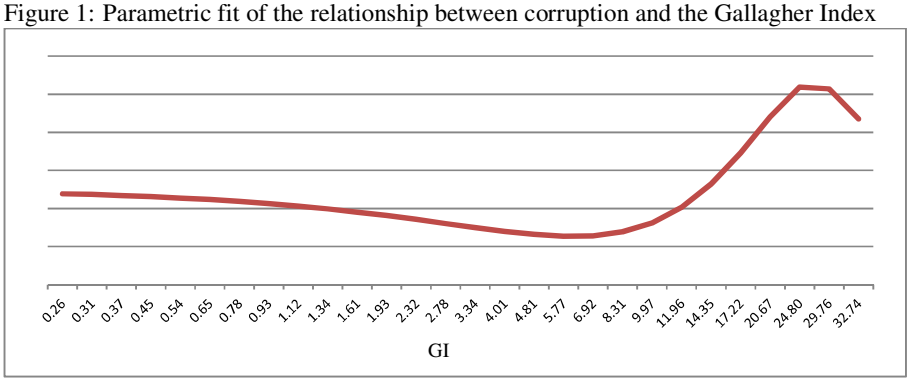
Column (a) in table 7 shows the estimation of equation (1) only with *lngdp* and *pop*. The coefficients of *GI*, GI^2 and GI^3 are all highly significant, as well as the two lags of *corr* and *lngdp*. In order to graph the effect of the *GI* index on corruption, we use the following long-run equation:

$$corr = -\frac{0.19}{0.23}GI + \frac{0.017}{0.23}GI^2 - \frac{0.00038}{0.23}GI^3 + \frac{0.139}{0.23}lngdp \tag{3}$$

In figure 1 below, on the horizontal axis we have constructed a scale of disproportionality index values starting with the minimum value (among countries) and increasing it by 1.1 to the maximum

value; then we calculate the Corruption index according to equation (3) using the estimated coefficients of *GI*, GI^2, $GI^3$and *lngdp* (the coefficient of *pop* is not significant).

Figure 1: Parametric fit of the relationship between corruption and the Gallagher Index



From the graph above, it emerges that the relationship between the proportionality degree of electoral system and corruption has a minimum and maximum value. The value of *GI* which maximises the Corruption index (that is, which minimises the level of corruption) is about 20, while the value of *GI* which minimises the Corruption index (that is, which maximises the level of corruption) is about 8. This shape of the proportionality degree-corruption relationship offers an interesting interpretation. Initially, moving from the extreme left of the horizontal axis towards the right, while the proportionality degree of the electoral system slightly reduces, the Corruption index decreases (corruption increases) to its minimum value. It is reasonable to believe that this happens because the electoral rule remains proportional, even though the proportionality degree of the electoral system changes. Indeed, the PR degree of proportionality may vary according to factors such as the precise formula used to allocate seats[18], the number of seats in each constituency or in the elected body as a whole[19], and the level of any minimum threshold for election. Therefore, reducing the proportionality degree of the electoral rule within PR systems (that is, without adding some majoritarian elements) implies the reduction of the monitoring power of opponents without introducing the voters' monitoring on incumbent politicians - that means fertile ground for corrupt actions: in figure 1 Corruption index decreases (corruption increases). Instead, when the *GI* starts increasing (for example, it goes beyond 8, according to our estimations), it is also reasonable to believe that the corresponding electoral system has become mixed. This means that the monitoring power of opponents (ensured by PR elements) is reinforced by that of voters' (ensured by plurality elements): the effects of responsiveness of PR and accountability of majoritarian representation, put

[18]Ranking PR formulas have been approached both theoretically (Gallagher 1992; Lijphart 1986; Loosemore and Hanby 1971) and empirically (Gallagher 1991; Blondel 1969). The most widely accepted ranking is Lijphart's (1986), which considers the Hare and Droop largest remainder (LR) methods to be the most proportional, followed by the Sainte-Lagu¨e highest-average (HA) method, followed by Imperiali LR, d'Hondt HA, and Imperiali HA. A critical re-examination of the ranking of electoral formulas was proposed by Benoit (2000).

[19] Generally, the wider the district magnitude, the more proportional the PR is.

together, are stronger at fighting corruption. This can be clearly seen in figure 1 starting from the *GI*=8; the Corruption index begins to grow as the *GI* rises up to the value of about 20 which maximises the Corruption index. After reaching its maximum, the Corruption index decreases again. It is interesting to underline that in the increasing section of the Corruption index in figure 1 (which corresponds to the interval of *GI* [8-20]), the small reduction in the proportionality degree of mixed rule implies that the marginal substitution between the monitoring power of opponents in favour of the monitoring power of voters is beneficial in fighting corruption. While considering mixed electoral rules with a proportionality degree always lower (*GI*>20), the same marginal substitution leads to a corruption increase: this happens because the monitoring power of opponents almost disappears. As figure 1 shows, we can find a value of the *GI* which maximises the Corruption index (meaning minimising the level of corruption). This suggests that the "best" proportionality degree that a mixed system should have must almost equally balance the voters' and the opponents' monitoring power in order to maintain their independence and re-enforce each other.
This result remains robust with the introduction of all the control variables that we listed above, as shown in table 7.

Where significant, *Lngdp* is positive as expected, meaning that a greater level of economic development is correlated to less perceived corruption. *Pop,* instead, is never significant. Starting from column (b) we introduce *gov_stab*: it is always significant (except in specification (i)) and positive, as expected - the higher the quality of government, the lower the corruption. The same happens for *dem*, from specification (c): it is always positive and significant (except in (i)) - the greater the level of democracy of a country, the lower the level of corruption. *Law_order* controls for the rule of law: in specification (d) it is treated as exogenous and its sign is positive and significant - a stronger rule of law reduces the likelihood of corruption. In order to take into account the issue of causality of this variable, in specification (e) we treat it as endogenous - the result does not change. Columns (f) and (i) show that *women* and *lnschool* are not significant. Public consumption spending shows a positive and significant coefficient in (g) - the larger the relative size of public sector, the lower the likelihood of corruption; this coefficient becomes insignificant if *G* is treated as endogenous as in (h).

The estimation of the parametric model (1) provided us with a peculiar non-linear relationship between the Gallagher disproportionality index and the Corruption index. We conducted a semi-parametric in order to confirm this particular functional form. As in the parametric model, the semi-parametric one considers the variable of interest *GI* entering the regression equation as exogenous. However, we depart from that econometric specification by including in the linear component of the model only those variables that can be considered exogenous, on the basis of the results of the

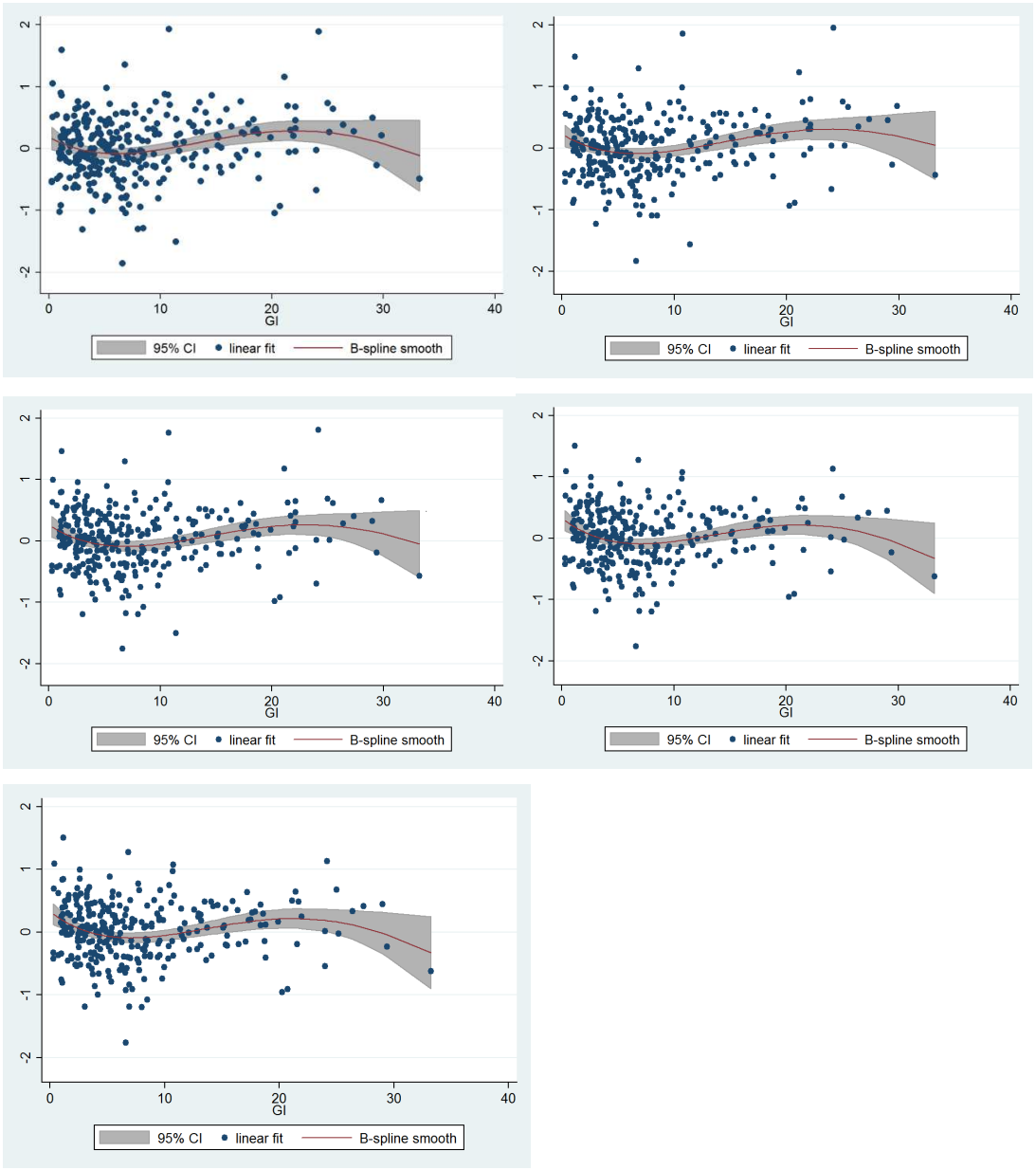
theoretical and applied literature. In particular, this is the case of democratic accountability (*dem*), government stability (*gov_stab*), proportion of seats held by women in national parliaments (*wom*), and the population (*pop*). Table 8 (Appendix) presents the results of the estimation of five specifications of the model. All the specifications include time dummies to account for shifts in the relationships over the period 1984-2010. As Desbordes and Verardi (2012) have done, we use B-splines both as base functions $p^k(GI)$ and to estimate $g(GI_{i,t})$.[20]

In the baseline estimates (a'), the linear regressors are time dummies. Other regressions see the addition of one variable at a time. Estimates confirm that democratic accountability and government stability are significant explanatory variables of corruption.

Figure (2) shows the plot of the non-parametric estimate of $g(GI_{i,t})$ for each of the five specifications of the parametric component of the model. In particular, each panel displays the plot of the relation between *Corr* and *GI* net of the fixed effects and the linear part of the regression equation.[21] In each graph the shaded area displays confidence intervals at 95% level of confidence. The five plots of the estimate of the function $g(GI_{i,t})$ show almost the same shape: a U followed by an inverted U. Hence, we find a substantial confirmation of the main result of the parametric analysis. As the graphs display, the results are confirmed not only by their shape, but also by their values. That is, the min and max of the Corruption index in the semi-parametric analysis fall approximately at a *GI*=8 and a *GI*=20 respectively, similar to the findings of the parametric analysis. This emphasises even more the robustness of the relationship that we found between the proportionality degree of electoral rules and corruption.

[20] Computations were made using the STATA command *xtsemipar* by François Libois and Vincenzo Verardi (2013).
[21] The variable on the vertical axis is re-centered around its mean value.

Figure 2: Non-parametric fit of the relationship between corruption and the Gallagher Index. Partial residuals centred around the mean.



5. Concluding remarks

This work offers a parametric and semi-parametric analysis of the relationship between the proportionality degree of an electoral system and corruption. The use of the Gallagher disproportionality index as a measure of the proportionality degree of an electoral rule has allowed us to properly consider mixed electoral systems alongside the two traditional ones, PR and plurality. Given that mixed rules are becoming the preferred choice of more and more governors, it seems very important and interesting to consider the effect that they have on corruption and, thus filling

the gap empirical literature has in this field. Results confirm our theoretical framework and show that the relationship between the proportionality degree and corruption is not linear. Graphically, this relationship appears as a sine curve, with the Corruption index reaching its minimum at low values of *GI*, and its maximum at high values of *GI*. The policy implications of this result are newsworthy. Even though PR allow their proportionality degree to be modified through the variation of the electoral formula or the introduction of some thresholds, the reduction of the proportionality degree within the same PR is not beneficial in fighting corruption. Indeed, this kind of system weakens the monitoring power of opponents (because the representativeness reduces) without the introduction of the voters' monitoring. On the contrary, the contamination of the PR with plurality elements (therefore, the switch to mixed rules), allows both monitors to exercise their power to induce politicians to avoid corrupt behaviour. Increasing plurality elements into mixed systems is beneficial only up to certain proportionality degrees; after this the corresponding level of corruption begins to grow. For governors who want to adopt mixed electoral systems, their choice of proportionality degree becomes, therefore, fundamental. Further studies are needed in helping governors to make this choice.

Appendix

Table 1: Statistics

Variable	Mean		Std. Dev.	Min	Max	Observations
corr	3.39	overall	1.42	0	6	N = 2160
		between	1.19			n = 85
		within	0.77			T = 25
GI	7.64	overall	6.54	0.26	33.25	N = 1975
		between	5.46			n = 85
		within	3.67			T = 23
lngdp	8.26	overall	1.46	4.9	10.9	N = 2566
		between	1.44			n = 83
		within	0.22			T = 31
pop	3.97e+07	overall	1.14e+08	210600	1.24e+09	N = 2688
		between	1.13e+08			n = 84
		within	1.89e+07			T = 32
gov_stab	7.63	overall	2.01	1	11.5	N = 2153
		between	0.89			n = 85
		within	1.81			T = 25
dem	4.92	overall	1.79	0	11.5	N = 2153
		between	1.43			n = 85
		within	1.05			T = 25
law_order	3.93	overall	1.53	0	6	N = 2153
		between	1.32			n = 85
		within	0.74			T = 25
wom	14.4	overall	10.1	0	47.3	N = 2347
		between	7.5			n = 84
		within	6.9			T = 28
G	0.18	overall	0.08	0.03	1.55	N = 2502
		between	0.06			n = 81
		within	0.05			T = 31
lnschool	4.48	overall	0.2	2.9	4.6	N = 1494
		between	0.18			n = 81
		within	0.08			T = 18

Table 2: Distribution of countries according to their electoral system, 1980-2011

PR	Mixed	Plurality
Argentina, Austria, Belgium, Costa Rica, Denmark, Ecuador El Salvator (since 1998), Finland, Guinea-Bissau (Since 2007), Guyana, Iceland, Indonesia, Ireland, Israel, Italy (since 1980 to 1993), Luxembourg, Malta, Moldova (since 1994), Mongolia 2009, Mozambique (since 1995), Namibia (since 1989), Netherlands, Nicaragua (since 1987), Norway, Paraguay, Peru (since 1981), Poland (since 1990 to 2006), Portugal, Luxembourg, Malta, Moldova (since 1994), Mongolia 2009, Mozambique (since 1995), Namibia (since 1989), Netherlands, Nicaragua (since 1987), Norway, Paraguay, Peru (since 1981), Poland (since 1990 to 2006), Portugal, Romania (since 1991 to 2006), Slovakia (since 1993), Slovenia (since 1992), South Africa, Sri Lanka, Suriname (since 1988), Sweden, Turkey (since 1984), Ukraine (since 2007), Uruguay (since 1985).	Albania (since 1992), Australia, Bolivia (since 1983), Brazil, Croatia (since 1993), Czech Rep. (since 1991), Dom. Rep., El Salvador (since 1983 to 1997), Germany, Greece, Guatemala (since 1986), Honduras (since 1982), Hungary (since 1991), India, Italy (since 1994), Japan, Lithuania (since 1993), Mozambique (in 1994), New Zealand (since 1993), Philippines (since 1999), Poland (since 2007), Romania (since 2007), Senegal, South Korea, Spain, Suriname (1980), Switzerland, Taiwan (since 1992), Ukraine (since 1998 to 2003)	Bahamas, Bangladesh, Botswana, Canada, Chile (since 1990), France, Jamaica, Mongolia (since 1993 to 2008), New Zealand (since 1980 to 1992), P. N. Guinea, Philippines (since 1988 to 1997), Thailand, Trinidad-Tobago, Ukraine (since 1994 to 1997), UK, USA, Zambia (since 1992)

Source: Database of Political Institutions 2012. Mixed systems are those in which both PR and plurality elements coexist. Our Elaboration.

Table 3: list of countries, in decades, from their first democratic election

1980-2001	1990-2011	2000-2011
Argentina, Australia, Austria, Bahamas, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Canada, Chile, Costa Rica, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, France, Germany, Greece, Guyana, Honduras, Iceland, India, Ireland, Israel, Italy, Jamaica, Japan, South Korea, Luxembourg, Malaysia, Malta, Namibia, Netherlands, New Zealand, Norway, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Senegal, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Taiwan, Thailand, Trinidad & Tobago, Turkey, United Kingdom, United States, Uruguay	Bangladesh, Czech Republic, Guatemala, Guinea-Bissau, Indonesia, Hungary, Indonesia, Lituania, Moldova, Mongolia, Myanmar, Mozambique, Nicaragua, Poland, Romania, Russia, Slovakia, Slovenia, South-Africa, Ukraine, Zambia	Albania, Croatia

Table 4: *GI* statistics according to electoral systems, 1980-2011

PR				MIXED				PLURALITY			
Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
4.6	4.4	0.26	29.4	7.8	4.9	0.91	30.2	14.4	7.5	1.3	33.25

Table 5: Variables description

Corr	Corruption Index. Source: ICRG, 1984-2010.
GI	Gallagher Disproportionality index. Source: Gallagher Electoral Disproportionality Data, 1945-2011http://www.tcd.ie/Political_Science/staff/michael_gallagher/ElSystems/Docts/ElectionIndices.pdf.
lngdp	Natural logarithm of gross domestic product at constant price 2000 US. Source: World Bank, 1980-2011.
pop	Urban population refers to people living in urban areas as defined by national statistical offices. Source: World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects, 1980-2011.
gov_stab	Government stability. It is an assessment both of the government's ability to carry out its declared program(s), and its ability to stay in office. The risk rating assigned is the sum of three subcomponents (Government Unity, Legislative Strength, Popular Support), each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk. This index ranges in the interval (0, 12). Source: ICRG, 1984-2010.
dem	Democratic accountability. Measure of how responsive a government is to its people, meaning the more responsive it is, the more likely it is that the government will fall peacefully, in a democratic society, but possibly violently in a non-democratic one. The points in this component are awarded on the basis of the type of governance the country in question has. This index ranges in the interval (0, 6). Source: ICRG, 1984-2010.
law_order	Law and Order is composed of two sub-components which range from zero to three points. . The Law sub-component is an assessment of the strength and impartiality of the legal system, while the Order sub-component is an assessment of popular observance of the law. Thus, a country can enjoy a high rating – 3 – in terms of its judicial system, but a low rating – 1 – if it suffers from a very high crime rate or if the law is routinely ignored without effective sanction (for example, widespread illegal strikes). This index ranges in the interval (0, 6). Source: ICRG, 1984-2010.
wom	Proportion of seats held by women in national parliaments (%). The data refer to Unicameral assembly or lower chamber of bicameral assembly. These data are comparable with United Nations Women's Indicators and Statistics Database – Wistat published by World Bank. Source: PARLIA database, 1980-2011. http://www.ipu.org/wmn-e/classif-arc.htm, http://www.ipu.org/parline-e/parlinesearch.asp, http://databank.worldbank.org/data/views/reports/tableview.aspx
G	General government final consumption expenditure (% of GDP). Source: Penn World Table, 1980- 2011.
lnschool	Natural log of the net enrolment primary rate. It is the ratio between the number of children enrolled in primary schools and the total number of children of official primary school age. Source: World Development Indicators http://data.worldbank.org/indicator/SE.PRM.NENR, 1980-2011.

Table 6: Correlations

	GI	*lngdp*	*pop*	*gov_stab*	*dem*	*law_order*	*wom*	*G*	*lnschool*
GI	1								
lngdp	-0.22								
pop	-0.009	-0.12	1						
gov_stab	0.02	0.11	-0.009	1					
dem	-0.24	0.39	0.04	0.20	1				
law_order	-0.15	0.66	-0.06	0.17	0.46	1			
wom	-0.35	0.31	-0.14	0.16	0.26	0.30	1		
G	0.08	-0.11	-0.07	-0.03	0.06	0.04	-0.03	1	
lnschool	-0.13	0.53	-0.02	-0.06	0.34	0.27	0.12	0.09	1

Table 7: Estimations

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
corr(-1)	1.02***	1.00***	0.9***	0.9***	0.9***	1.0***	0.9***	0.9***	0.9***
	(17)	(15)	(13)	(13)	(18)	(15)	(12)	(13)	(12)
corr(-2)	-0.25***	-0.23***	-0.23***	-0.24***	-0.22***	-0.24***	-0.22***	-0.22***	-0.22***
	(-6)	(-5)	(-5)	(-6)	(-6)	(-6)	(-5)	(-5)	(-5)
GI	-0.19***	-0.21***	-0.22***	-0.21***	-0.09**	-0.13**	-0.30***	-0.30***	-0.2**
	(-2.3)	(-2.4)	(-2.5)	(-2.5)	(-2.06)	(-2.2)	(-2.45)	(-2.6)	(-2.05)
GI^2	0.017**	0.018**	0.02**	0.018**	0.007*	0.01**	0.02**	0.02**	0.01**
	(2.2)	(2.3)	(2.4)	(2.3)	(1.8)	(2)	(2.3)	(2.5)	(1.97)
GI^3	-0.0003**	-0.0004**	-0.0004**	-0.0004**	-0.0001*	-0.0002*	-0.0006**	-0.0006**	-0.0004*
	(-2.1)	(-2.2)	(-2.2)	(-2.2)	(-1.7)	(-1.8)	(-2.13)	(-2.3)	(-1.8)
lngdp	0.13***	0.13***	0.125***	0.05	0.02	0.09**	0.14***	0.15***	0.02
	(3.2)	(3.1)	(2.9)	(1.07)	(0.7)	(2.3)	(3)	(2.6)	(0.35)
pop	1.79e-10	1.90e-10	1.72e-10	7.39e-11	4.76e-11	6.47e-11	2.32e-10	2.55e-10	4.09e-11
	(1.2)	(1.4)	(1.3)	(0.6)	(0.5)	(0.5)	(1.6)	(1.3)	(0.3)
gov_stab		0.04**	0.03***	0.02**	0.03**	0.04***	0.05***	0.05**	-0.002
		(2.3)	(1.9)	(1.9)	(2.37)	(3.3)	(2.9)	(2.44)	(-0.08)
dem			0.05**	0.03*	0.03*	0.04**	0.05**	0.05**	0.03
			(2.1)	(1.85)	(1.8)	(1.98)	(2.3)	(2.2)	(1.35)
law_order				0.1**	0.1**				0.14**
				(2.3)	(2.08)				(2.1)
wom						-0.002			
						(-0.7)			
G							0.92**	1.48	
							(2.17)	(0.5)	
lnschool									-0.1
									(-0.2)
N. obs.	1374	1342	1342	1340	1404	1299	1294	1294	945
Chi^2 (p-value) Hansen test	35 (0.9)	33 (0.9)	34 (0.9)	34 (0.9)	45 (0.9)	33 (0.9)	32 (0.9)	32 (0.9)	41 (0.98
p-value 2nd order autocorrelation	0.2	0.2	0.2	0.4	0.6	0.2	0.13	0.12	0.6

Notes. All regressions contain calendar year dummies (results not reported); the time span is 1984-2010. The dependent variable is *corr*. Standardised normal z-test values are in parentheses; robust standard errors. In column (e) and (h) *law_order* and *G* respectively are treated as endogenous. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table 8: Semi-parametric Fixed Effects Estimation

	(a')	(b')	(c')	(d')	(e')
dem		0.128***	0.101***	0.113***	0.113***
		(3.62)	(2.67)	(2.82)	(2.80)
gov_stab			0.060*	0.065**	0.064*
			(1.92)	(1.97)	(1.89)
wom				0.022	0.019
				(0.22)	(0.19)
pop					0.188
					(0.24)
Times dummies	yes	yes	yes	yes	yes
R^2	0.328	0.359	0.368	0.378	0.378
N. obs.	272	270	270	260	260

Notes. The dependent variable is *corr*. All regressions contain a non-parametric function of the Gallagher Disproportionality Index and time dummies for each five-year period (results not reported); the time span is 1984-2010. Standardised normal z-test values are in parentheses; robust standard errors. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

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