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# Democracy, education and the quality of government

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**Abstract** This paper looks at how the interaction between democracy and education affects the quality of government. Using various cross-sectional and dynamic panel data specifications, we show that the success of democratic institutions is closely related to the educational attainment of the population. Democratic elections do not foster the quality of government in countries with low average levels of education. Education, in turn, has a positive effect on the quality of government only in consolidated democracies.

**Keywords** Education · Democracy · Quality of government · Corruption · Elections · Institutions

**JEL Classification** D72 · D73 · H11 · O43

*You know the way in which dyers first prepare the white ground and then lay on the dye of purple or of any other colour. Colours dyed in this way become fixed, and no soap or lye will ever wash them out. Now the ground is education, and the laws are the colours; and if the ground is properly laid, neither the soap of pleasure nor the lye of pain or fear will ever wash them out.*

(Benjamin Jowett (1941), summary analysis of Plato, The Republic, Book IV)

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## 1 Introduction

The concluding sentence of Abraham Lincoln's Gettysburg address contains one of the most widely cited definition of democracy: " government of the people, by the people, and for the people." By empowering the people, the right to take part to periodic, free, and genuinely contested elections, together with a system of norms and institutions that support that right and make it meaningful, should ensure the implementation of policies that favor the population as a whole rather than specific (political or economic) constituencies. Liberal democracies, the standard argument goes, with written constitutions, separation of powers, bills of rights, check and balances, regular elections and competitive parties, allow people to control and discipline the elected officials and give them voice to oust out inept and corrupt individuals from power (Sen 2000; Rivera-Batiz 2002). However, there is limited empirical evidence that, by itself, the extension of democratic liberties leads to improvements in the quality of government.

In this paper, we suggest that the performance of democratic institutions depends on the level of education of the electorate. Our hypothesis is that education enhances political engagement and participation and increases citizens' ability to make good (*ex ante*) electoral choices and to evaluate (*ex post*) the actions of elected officials.[1]

We take this idea to the data and show that the correlation between democracy and the quality of government is not statistically significant in countries with low levels of education and is positive and statistically significant in countries with high levels of education. We also find a positive and often statistically significant marginal effect of education on the quality of government in democratic countries and no significant effect of education in non-democratic countries. This ancillary result suggests that democracy is of critical importance to channel the political benefits of education into government performance.

In discussing our findings, we acknowledge that causality is hard to establish because our explanatory variables are likely to be endogenous and we do not have good external instruments for education and democracy. While we use difference and system-GMM estimations that use lagged values and changes of the dependent and explanatory variables as internal instruments, we recognize that such internal instruments cannot fully address endogeneity concerns. We deal with this issue by running a set of Monte Carlo simulations aimed at testing the robustness of our results and show that even the presence of extreme endogeneity would not reverse our findings.

By showing that education and democracy complement each other in promoting good governance, our paper reconciles the results of the literature on the relative merits of democracy and education. In particular, our results are consistent with the work of Acemoglu et al. (2001, 2008), Persson and Tabellini (2006, 2008, 2009), and Besley and Persson (2011) who emphasize the importance of inclusive political institutions in explaining cross-country differences in income per capita.[2] However, our findings are also consistent with the literature

[1] According to Almond and Verba (1989 [1963], p. 316): " the uneducated man or the man with limited education is a different political actor from the man who has achieved a higher level of education." An earlier version of this paper develops a theoretical model that formalizes this idea (Fortunato and Panizza 2011).

[2] Empirical papers that find that transitions to democracy are positively correlated with economic growth include Rodrik and Wacziarg (2005) and Papaioannou and Siouraounis (2008). Cervellati et al. (2014), instead, distinguish peaceful from violent democratizations and find that the level of violence during the transition has persistent effects on the quality of emerging democracies. In related contributions Cervellati et al. (2008) and Sunde et al. (2008) predict and document that in unequal societies democracy is negatively correlated with the rule of law. In the political science literature, the effects of democratization on development are still debated (Carbone 2009).

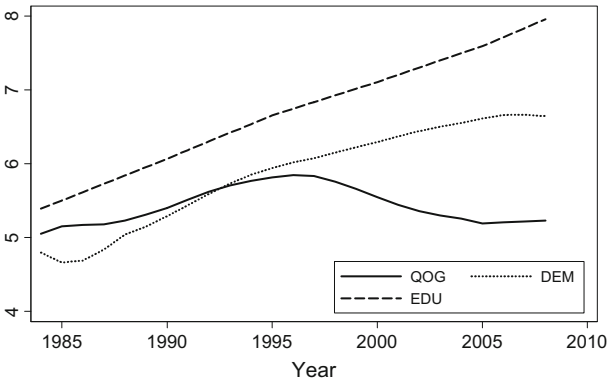


**Fig. 1** Evolution of democracy, education, and quality of government

that looks at human capital accumulation as a basic source of economic growth (Glaeser et al. 2004).

Given that a measure of institutional quality similar to our quality of government variable has been shown to be associated with economic growth (Hall and Jones 1999), our results can also explain why studies that do not allow for heterogeneity do not find evidence of an impact of democracy on growth (Barro 1996, 2000; Przeworski et al. 2000).

The paper is organized as follows. Section 2 discusses the economic and political science literatures on the links between democratic institutions and governance. Section 3 presents our empirical investigation. Section 4 discusses endogeneity. Section 5 concludes and uses a simple calibration exercises to show the implications of our results for economic growth.

## 2 Democratic governance and education

There is no clear correlation between democratization and the quality of government. The last 30 years were characterized by a process of rapid democratization. The cross-country average of a commonly used index of democracy that ranges between 0 and 10 went from 4.7 in the mid-1980s to 6.7 in 2008 (this is the dotted line in Fig. 1). Over the same period, however, a commonly used index of the quality of government did not show a clear trend and remained more or less constant, oscillating between 5 and 5.7 (this is the solid line of Fig. 1).[3] Figure 1 also shows that the cross-country average number of years of education attained by the adult population increased from 5.4 to 8.0 (this is the dashed line in Fig. 1). This should clarify that quality of government is not driven by education alone either.[4]

In this paper we ask why the increase in education and the rapid diffusion of democratic institutions documented in Fig. 1 did not lead to improvements in the quality of government.

[3] For details on the indexes of democracy and quality of government, see Sect. 3 below. The index of quality of government used in this paper ranges between 0 and 100, in Fig. 1, we rescaled it to 0–10 and used moving averages of the three indexes to smooth annual fluctuations.

[4] Note that the sharp increase of the cross-country average years of schooling might not accurately represent actual educational gains. Pritchett (2013) argues that increases in years of schooling for students in poor countries may not translate into gains in education, learning, or achievement as they do in developed economies. This is in part due, according to the author, to the excessive centralization of educational systems in developing countries that imitate systems that were successful elsewhere without taking adequately into account the characteristics of the local environment.

Almond and Verba's (1963) seminal study on civic culture attributed cross-country variations in the performance of democratically elected governments to differences in political engagement and participation. Building on this work, Putnam (1993) showed that the regional governments introduced in Italy in the early 1970s were successful only in regions which had preexisting vibrant networks and norms of civic engagement. Regions with a fragmented social life and a diffuse culture of distrust, in turn, developed executive bodies which were less responsive to public demands and more subject to political patronage. Putnam concluded that an active and public-spirited citizenry populated by trustful (and trustworthy) individuals willing to cooperate with each other is instrumental for the correct functioning of democratic institutions.[5] Putnam's finding that democracy requires social capital is consistent with Banfield's (1958) idea of *amoral familism*. In his study of a poor small town in southern Italy, Banfield suggested that backwardness was the outcome of a social equilibrium in which people care exclusively about their nuclear family and, by disregarding common goods, prevent the development of well-functioning political institutions.

While the political science literature emphasizes the interaction between democracy and social capital, the economic literature has traditionally examined democratic governance by focusing on the distortions brought about by the presence of asymmetric information and the resulting moral hazard and rent-seeking problems (Barro 1973; Ferejohn 1986).[6] In this set-up, self-interested elected officials have strong incentives to appropriate rents if voters cannot monitor their behavior.[7] Another strand of the economic literature concentrates on adverse selection problems in the recruitment of politicians and studies how the quality of government is affected by politicians' talent and preferences (Besley and Coate 1997; Poutvaara and Takalo 2007). This literature concludes that the likelihood of selecting bad politicians is greater when formal returns to politics are low and information is limited (Caselli and Morelli 2004 and Besley et al. 2005).

Although the political science and the economic literatures provide different explanations for the success or failure of democratic institutions (the former focuses on social capital and the latter on the availability of information), both explanations are likely to be correlated with the same underlying factor: education. Education is essential for social capital because, by promoting social interaction and reducing uncertainty about the behavior of others, it strengthens trust and civic norms. Education also trains people to behave cooperatively, emphasizes the benefits of social and political participation (Knack and Keefer 1997; Glaeser et al. 2006), and is the strongest predictor of political engagement (e.g., Shields and Goidel 1997; Verba et al. 1995; Wolfinger and Rosenstone 1980).[8]

[5] Rice and Sumberg (1997) and John et al. (2010) corroborate Putnam's findings by using more recent and disaggregated data.

[6] More recently, also the economic literature has recognized the importance of social norms and civic culture and its effects on economic performance (e.g., Tabellini 2010).

[7] This view is consistent with empirical studies showing that rent-seeking declines when information on the actions of policymakers increases (Adserà et al. 2003). Along similar lines, there is evidence on the role of the media as a source of discovery and dissemination of information, suggesting that increased media presence improves electoral accountability (e.g., Besley and Burgess 2002; Djankov et al. 2003; Besley and Prat 2006). Also, Djankov et al. (2010) find a negative association between corruption and public access to information about politicians' finances and business activities. Panizza (2001) discusses the links between electoral laws and the quality of government.

[8] Chong and Gradstein (2009) use micro data from the World Values Surveys and find a positive association between education and pro-democracy attitudes, even after controlling for a variety of personal characteristics. Education is also generally associated with low levels of clientelism (Huntington and Nelson 1976; Finan and Schecter 2009)

Education is also necessary for increasing information flows and developing the cognitive skills that are necessary to effectively participate in a representative democracy. As more educated citizens are more likely to understand the issues upon which they vote and recognize corrupted public officials, they are also more likely to select good politicians (Milligan et al. 2004; Ostrom 2006).

In synthesis, education is " the best proxy for both information and civic virtues" (Alesina and Giuliano 2011, p. 8), and it can improve the functioning of democratic institutions by both fostering social capital and reducing informational asymmetries.

In this paper we take this hypothesis to the data. In particular, we test for heterogeneity by looking at the how democracy, education, and their interaction affect the quality of government.

## 3 Data and empirical analysis

In this section we check whether the partial correlations between the quality of government and each of education and democracy are consistent with our hypothesis. In the next section, we investigate the endogeneity problem and show that our results are robust to allowing for some endogeneity.

### 3.1 The data

As it is standard in the in the literature, we measure the quality of government with an aggregate index that jointly considers corruption and competency indicators. In particular, our quality of government index ($QOG$) is the simple average of the International Country Risk Guide (ICRG) variables "Control of Corruption," "Law and Order," and "Bureaucratic Quality" (corruption and bureaucratic quality are highly correlated in the data).[9]

Hall and Jones (1999) show that an index of anti-diversion policies which includes the three variables used in our $QOG$ index is the key driver of cross-country differences in productivity.[10]

$QOG$ ranges between 0 and 100, with higher values being associated with higher quality of government. The average value of the index was approximately 52 in the 1980s, 58 in the 1990s, and 55 in the 2000s (Table 1). The index is fairly stable over time, and most of its variance comes from cross-country variations (the " between" standard deviation of the index is about 20 and the " within" standard deviation is approximately 7, Table 2).

We measure democracy using an average of the Polity and Freedom House indexes of democracy (the results are robust to just using Freedom House or Polity indexes). Our measure of democracy ranges between 0 and 10 (again, with higher values associated with greater levels of democracy). The average value of the index increased from 4.8 in the 1980s to 7.1 in the 2000s and the dispersion of the index decreased markedly, with the cross-country standard deviation going from 3.5 in the 1980s to 2.8 in the 2000s (Table 1). Also in this case, the cross-country variance of the index is much larger than the within-country variance (the " between" standard deviation of the index is about 1.2 and the " within" standard deviation is approximately 0.25, Table 2).

[9] The correlation between the ICRG index of bureaucratic quality and that of control of corruption is 0.63 (the coefficient is statistically significant at the one percent confidence level). A regression of the index of control of corruption over that of bureaucratic quality yields a coefficient of 0.8 and a t-statistics of 11.8.

[10] Besides the variables included in $QOG$, Hall and Jones's (1999) anti-diversion index also includes a measure of expropriation risk and a measure of government repudiation of contracts.

**Table 1** Summary statistics for cross-country estimates

| | Obs | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| *1980s* | | | | | |
| QOG | 109 | 51.65 | 25.02 | 5.56 | 100 |
| Democ. | 109 | 4.79 | 3.49 | 0.25 | 10 |
| Educ. | 88 | 5.15 | 2.85 | 0.5 | 12.04 |
| Open | 109 | 64.77 | 44.57 | 13.11 | 359.98 |
| ln(GDP PC) | 109 | 8.54 | 1.1 | 6.34 | 10.85 |
| *1990s* | | | | | |
| QOG | 127 | 57.9 | 20.96 | 10.65 | 100 |
| Democ. | 127 | 6.07 | 3.03 | 0.08 | 10 |
| Educ. | 127 | 6.47 | 2.83 | 0.44 | 12.36 |
| Open | 127 | 72.4 | 41.5 | 2.95 | 337.88 |
| ln(GDP PC) | 127 | 8.62 | 1.15 | 5.73 | 10.59 |
| *2000s* | | | | | |
| QOG | 106 | 55.48 | 20.28 | 11.11 | 100 |
| Democ. | 106 | 7.11 | 2.83 | 0.19 | 10 |
| Educ. | 106 | 7.70 | 2.73 | 0.98 | 12.73 |
| Open | 106 | 86.24 | 47.39 | 25.14 | 407.64 |
| ln(GDP PC) | 106 | 8.98 | 1.15 | 5.89 | 10.7 |
| *Variables with no time variation* | | | | | |
| ELF | 127 | 0.47 | 0.27 | 0 | 1 |
| Common law | 127 | 0.3 | 0.46 | 0 | 1 |
| French law | 127 | 0.45 | 0.5 | 0 | 1 |
| German law | 127 | 0.05 | 0.21 | 0 | 1 |
| Scand. law | 127 | 0.03 | 0.18 | 0 | 1 |
| Catholic | 127 | 31.25 | 36.1 | 0 | 96.9 |
| Protestant | 127 | 11.69 | 20.31 | 0 | 97.8 |
| Muslim | 127 | 24.17 | 36.56 | 0 | 99.8 |
| abs(latitude) | 127 | 0.3 | 0.19 | 0 | 0.71 |

For our third variable of interest we rely on the Barro and Lee (2010) dataset on educational attainment. We measure education with the average number of years of education attained by the adult population. In the data, this variable ranges between 2.8 and 13. Its average value increased from 5.2 in the 1980s to 7.5 in the 2000s. Its standard deviation, instead, remained constant at approximately 2.8. Also in this case, the cross-country variance is larger than the within-country variance (the " between" standard deviation is about 2.9 and the " within" standard deviation is approximately 0.9, Table 2).

In estimating the relationship between quality of government and our explanatory variables, we follow La Porta et al. (1999) and control for the log of GDP per capita, legal origin (Common law, French law, German law, Scandinavian law, the excluded variable is Socialist legal origin) religion (share of Catholics, share of Protestants, and share of Muslims, the excluded variable is other religions), ethno-linguistic fractionalization (capturing the probability that two randomly selected individuals belong to different ethnic or linguistic groups),

**Table 2** Summary statistics for panel data

| Variable | Mean | SD | Min | Max | Observations |
|---|---|---|---|---|---|
| 10-year panel | | | | | |
| QOG | | | | | |
| Overall | 57.36 | 21.8 | 9.1 | 100 | N = 304 |
| Between | | 20.38 | 12.13 | 99.85 | n = 109 |
| Within | | 7.29 | 35.52 | 83.44 | T-bar = 2.79 |
| Democ. | | | | | |
| Overall | 6.38 | 3.17 | 0.08 | 10 | N = 304 |
| Between | | 2.85 | 0.24 | 10 | n = 109 |
| Within | | 1.29 | 1.15 | 9.68 | T-bar = 2.79 |
| Educ. | | | | | |
| Overall | 6.5 | 2.97 | 0.44 | 12.73 | N = 304 |
| Between | | 2.87 | 0.82 | 12.38 | n = 109 |
| Within | | 0.91 | 4.37 | 8.72 | T-bar = 2.79 |
| Open | | | | | |
| Overall | 75.63 | 44.92 | 13.11 | 407.64 | N = 304 |
| Between | | 42.54 | 19.98 | 368.5 | n = 109 |
| Within | | 12.34 | 22.24 | 120.2 | T-bar = 2.79 |
| ln(GDP PC) | | | | | |
| Overall | 8.88 | 1.1 | 5.89 | 11.13 | N = 304 |
| Between | | 1.09 | 6.02 | 10.94 | n = 109 |
| Within | | 0.19 | 8.2 | 9.56 | T-bar = 2.79 |
| 5-year panel | | | | | |
| QOG | | | | | |
| Overall | 58.13 | 21.61 | 9.81 | 100 | N = 496 |
| Between | | 20.02 | 12.5 | 99.82 | n = 109 |
| Within | | 7.27 | 34.99 | 89.38 | T-bar = 4.55 |
| Democ. | | | | | |
| Overall | 6.6 | 3.11 | 0 | 10 | N = 496 |
| Between | | 2.87 | 0.2 | 10 | n = 109 |
| Within | | 1.17 | 0.31 | 10.15 | T-bar = 4.55 |
| Educ. | | | | | |
| Overall | 6.76 | 2.94 | 0.28 | 13.09 | N = 496 |
| Between | | 2.87 | 0.88 | 12.47 | n = 109 |
| Within | | 0.79 | 4.56 | 8.95 | T-bar = 4.55 |
| Open | | | | | |
| Overall | 76.75 | 45.69 | 12.63 | 443.23 | N = 496 |
| Between | | 42.87 | 20.27 | 369.47 | n = 109 |
| Within | | 13.34 | 15.55 | 150.52 | T-bar = 4.55 |
| ln(GDP PC) | | | | | |
| Overall | 8.9 | 1.12 | 5.87 | 11.03 | N = 496 |
| Between | | 1.1 | 6 | 10.82 | n = 109 |
| Within | | 0.18 | 8.18 | 9.63 | T-bar = 4.55 |

and the absolute value of latitude. Following Ades and Tella (1999), we also control for trade openness (measured as imports plus exports over GDP).[11]

### 3.2 Cross-country estimates

We start by studying the cross-country correlation between the quality of government and each of democracy and education, and run three separate regressions for each decade in our sample (1980s, 1990s, and 2000s). Columns 1, 3 and 5 of Table 3 show that education is never significantly correlated with $QOG$ and that democracy is positively but not always significantly correlated with $QOG$.

These preliminary estimates assume that the effects of democracy and education on the quality of government are independent of each other. Our working hypothesis, instead, suggests a positive interaction between these variables. We, therefore, expect a positive correlation between democracy and quality of government only in countries with high average levels of education.

We test for the presence of an interaction between education and democracy by estimating the following model:

$$QOG_i = \alpha + \beta(D_i - \overline{D}) + \gamma(E_i - \overline{E}) + \delta(D_i - \overline{D})(E_i - \overline{E}) + X_i\Psi + \varepsilon_i, \quad (1)$$

where $\overline{D}$ and $\overline{E}$ indicate the average levels of democracy and education.

Within this set up, $\frac{\partial QOG}{\partial D} = \beta + \delta(E_i - \overline{E})$, with $\beta$ measuring the relationship between democracy and the quality of government for the country with average level of education and $\delta$ measuring how the level of education affects the relationship between democracy and the quality of government. Similarly, $\frac{\partial QOG}{\partial E} = \gamma + \delta(D_i - \overline{D})$, with $\gamma$ measuring the relationship between education and the quality of government for the country with average level of democracy and $\delta$ measuring how the level of democracy affects the relationship between education and the quality of government ($\delta = \partial\left(\frac{\partial QOG}{\partial E}\right)/\partial D = \partial\left(\frac{\partial QOG}{\partial D}\right)/\partial E$).[12]

Columns 2, 4, and 6 of Table 3 show that $\beta$ is always positive and statistically significant, indicating that there is a positive relationship between democracy and the quality of government for the country with the average level of education (in the year 2000, the group of countries with a level of education around the cross-country average of 7.5 included Ecuador, South Africa, Mexico, and Jordan). They also show that $\gamma$ is never statistically significant, indicating that there is no robust relationship between education and the quality of government for the country with the average level of democracy (in the year 2000, the group of countries with a level of democracy around the cross-country average of 7.1 included Thailand, Colombia, and Turkey). Finally, Table 3 shows that $\delta$ is always positive and statistically significant, supporting the idea of a positive interaction between democracy and education for the quality of government.

Figure 2 plots the partial correlation between the interaction of democracy and education and $QOG$ for each of the three sub-periods studied in Table 3, and for all the sub-periods pooled together. It suggests that the the point estimates of Table 3 are not driven by outliers.

Figure 3 uses the results of the regressions in Table 3 to plot the correlations between quality of government and democracy at different levels of education for the 1980s, the 1990s,

[11] Our control variables and their sources are described in Table 10.

[12] While demeaning allows to interpret the coefficients of the main effects as being evaluated at the mean of the other variable, it does not affect the estimated parameter of the interacted coefficient. Therefore, estimating $QOG_i = \alpha + \beta D_i + \gamma E_i + \delta(D_i \times E_i) + X_i\lambda + \varepsilon_i$ would yield the same value of $\delta$ reported in Table 3. For details, see Ozer Balli and Sørensen (2013).

**Table 3** Cross-country OLS regressions

| | (1) 1980s | (2) 1980s | (3) 1990s | (4) 1990s | (5) 2000s | (6) 2000s |
|---|---|---|---|---|---|---|
| Democ. | 2.587*** | 3.048*** | 1.122 | 1.890*** | 1.321** | 1.783*** |
| | (0.755) | (0.763) | (0.799) | (0.706) | (0.663) | (0.657) |
| Educ. | −1.071 | −2.171 | 0.130 | −0.744 | 0.565 | 0.410 |
| | (1.404) | (1.386) | (0.858) | (0.782) | (0.730) | (0.722) |
| Dem.*educ. | | 0.745*** | | 0.824*** | | 0.556*** |
| | | (0.247) | | (0.161) | | (0.157) |
| Open | 0.0476 | 0.0572 | 0.0247 | 0.0375 | 0.0570* | 0.0583** |
| | (0.0473) | (0.0409) | (0.0299) | (0.0267) | (0.0293) | (0.0288) |
| ln(GDP PC) | 11.27*** | 12.08*** | 7.695*** | 9.129*** | 5.859*** | 6.866*** |
| | (2.864) | (3.037) | (1.934) | (1.850) | (1.614) | (1.673) |
| ELF | 23.83** | 21.65*** | 1.722 | 2.819 | 4.642 | 6.028 |
| | (9.266) | (8.150) | (6.516) | (5.520) | (5.041) | (4.732) |
| Common law | 5.569 | −7.206 | 13.55*** | 8.388* | 22.47*** | 19.44*** |
| | (16.22) | (12.47) | (4.593) | (4.301) | (4.018) | (4.131) |
| French law | 2.555 | −12.08 | 4.320 | −1.992 | 10.43** | 7.678* |
| | (16.86) | (13.20) | (5.668) | (4.982) | (4.316) | (4.278) |
| German law | 15.27 | 4.189 | 15.03*** | 9.798** | 22.51*** | 18.63*** |
| | (16.64) | (12.82) | (5.428) | (4.552) | (4.438) | (4.391) |
| Scand. law | 4.406 | 2.358 | 10.33 | 8.122 | 30.83*** | 30.51*** |
| | (23.43) | (18.65) | (8.417) | (7.272) | (7.508) | (7.267) |
| Catholic | −0.144* | −0.118* | −0.0290 | −0.0172 | 0.0498 | 0.0425 |
| | (0.0747) | (0.0685) | (0.0408) | (0.0354) | (0.0383) | (0.0380) |
| Protestant | 0.0816 | −0.0880 | 0.0723 | 0.000921 | −0.0127 | −0.0603 |
| | (0.191) | (0.178) | (0.0840) | (0.0746) | (0.0728) | (0.0691) |
| Muslim | −0.108 | −0.113 | −0.00138 | −0.0226 | 0.0673 | 0.0540 |
| | (0.0783) | (0.0718) | (0.0687) | (0.0589) | (0.0575) | (0.0552) |
| abs(latitude) | 42.23*** | 32.92** | 36.14*** | 29.03*** | 43.69*** | 35.97*** |
| | (15.23) | (14.21) | (10.21) | (9.429) | (8.826) | (9.028) |
| Constant | −67.01*** | −62.04*** | −26.58* | −37.28*** | −33.95*** | −40.41*** |
| | (24.39) | (22.82) | (15.29) | (13.69) | (12.21) | (12.20) |
| Observations | 82 | 82 | 100 | 100 | 102 | 102 |
| R-squared | 0.736 | 0.773 | 0.777 | 0.822 | 0.823 | 0.845 |

This table reports the results of a set of cross-country regressions. The dependent variable is the 10-year average of quality of government and the explanatory variables are 10-year averages of: democracy ($Democ.$), education ($Educ.$) the log of GDP per capita ($ln(GDPPC)$). The regressions also include the following time-invariant controls: ethnolinguistic fractionalization ($ELF$), 4 dummy variables measuring the origin of the legal code (Socialist law is the excluded dummy), 3 variables measuring the religious composition of the population, and the absolute value of latitude ($abs(latitude)$). Columns 1 and 2 estimate the model for the 1980s, columns 3 and 4 for the 1990s, and columns 5 and 6 for the 2000s
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

the 2000s, and the three periods pooled together. The horizontal axes measures variations with respect to the cross-country average number of years of education attained. For all of the three sub-periods, the correlation is positive and statistically significant only for those

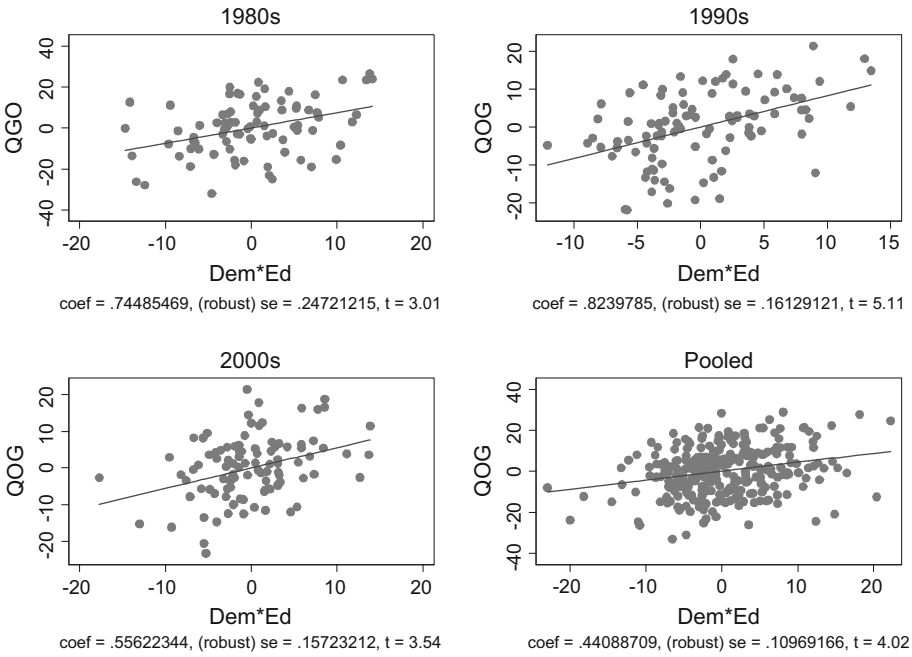


**Fig. 2** Partial correlation plots

countries with relatively high levels of education (for the 1990s and the 2000s the correlation turns positive and significant only when the level of educational attainment lies above the cross-country average). The correlation between democracy and the quality of government is instead negative (and sometimes significant) for countries with low educational attainment.

Analogously, Fig. 4 uses the results of the regressions in Table 3 to plot the marginal effect of education at different levels of democracy. For the 1990s and the 2000s the figure shows that the marginal effect is negative and statistically significant for countries where the democracy index is much lower than the sample average. The marginal effect of education becomes positive and statistically significant for countries where the democracy index is at least three points above the average. [13] If we focus on the 1980s, instead, we confirm a negative and statistically significant marginal effect of education for low levels of democracy. However, the positive effect for high levels of democracy is never statistically significant.

In the first two columns of Table 4 we check whether our results are robust to using an alternative measure of education. In particular, we substitute the Barro and Lee (2010) measure of average years of education with the Vanhanen (2003a, b) index of knowledge distribution computed as the simple average of literates as a percentage of adult population and the number of students at higher education institutions per 100,000 inhabitants (the index

[13] There are 28 countries that in the 2000s had a democracy index below 2.5 (Saudi Arabia; North Korea; Iraq; Turkmenistan; Uzbekistan; Myanmar; Libya; Afghanistan; Cuba; Syria; Qatar; Laos; China; Sudan; Swaziland; Eritrea; Belarus; Vietnam; United Arab Emirates; Equatorial Guinea; Oman; Bhutan; Azerbaijan; Bahrain; Zimbabwe; Cameroon; Kazakhstan; Egypt) and 39 countries that in the 2000s had a democracy index above 9 (Bulgaria; Latvia; South Africa; Panama; Israel; Taiwan; Greece; Estonia; Japan; Chile; Czech Republic; Slovakia; France; Mauritius; Lithuania; Poland; Belgium; Costa Rica; Hungary; Italy; United Kingdom; Slovenia; Germany; Spain; Ireland; New Zealand; Cyprus; Portugal; Uruguay; Austria; Australia; Finland; Sweden; Norway; Netherlands; United States; Switzerland; Denmark; Canada).

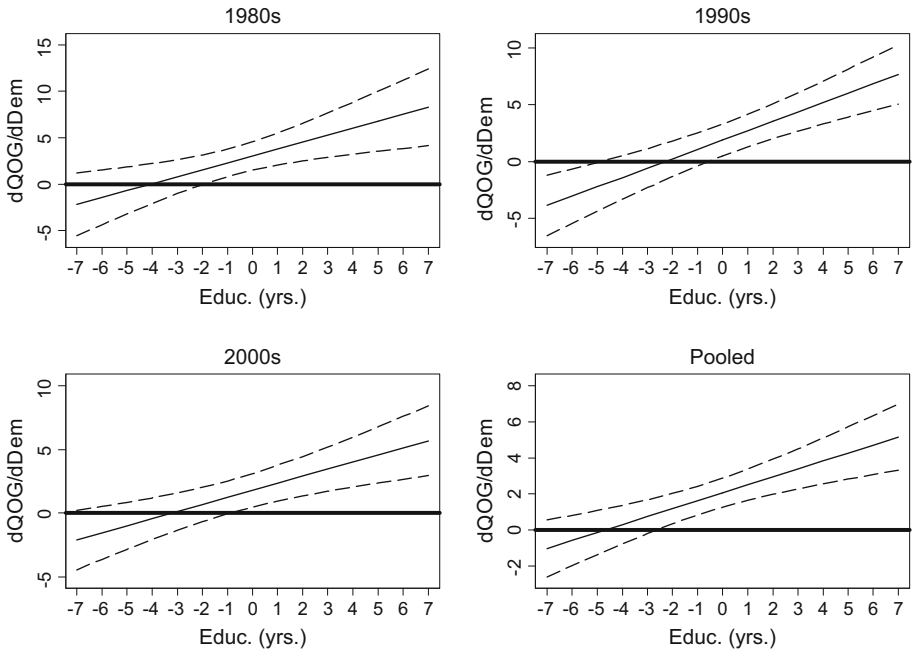


**Fig. 3** Marginal effect of democracy at different levels of education (cross-country regressions)

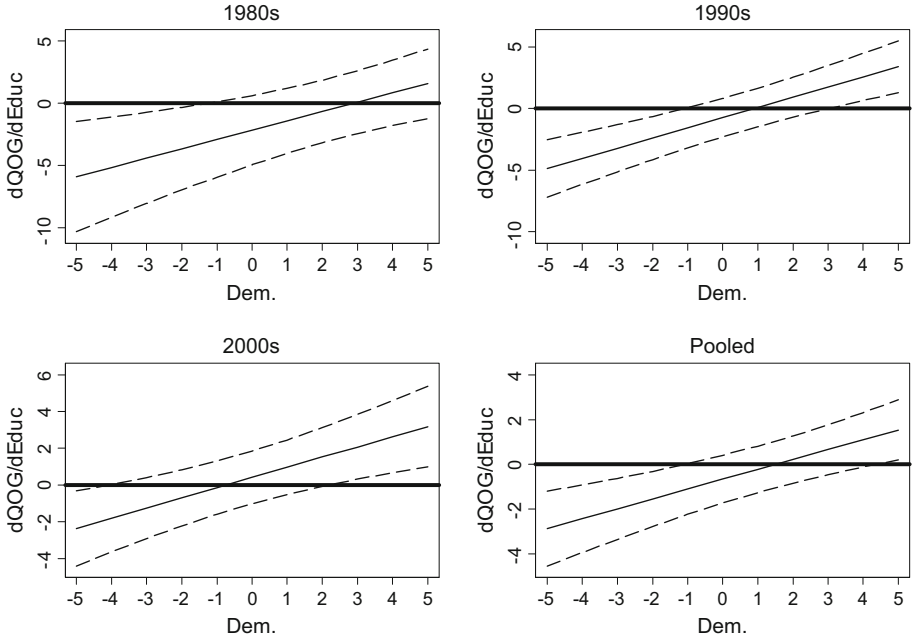


**Fig. 4** Marginal effect of education at different levels of democracy (cross-country regressions)

**Table 4** Cross-country regressions: sensitivity analysis

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Alternative measure of education | | Robust regressions | | |
| | 1980s | 1990s | 1980s | 1990s | 2000s |
| Democ. | 2.888*** | 1.311** | 3.371*** | 1.914*** | 2.293*** |
| | (0.651) | (0.634) | (0.864) | (0.702) | (0.575) |
| Educ. | −0.160 | −0.0219 | −2.559* | −0.892 | 0.583 |
| | (0.117) | (0.0888) | (1.451) | (0.886) | (0.742) |
| Dem*edu | 0.0900*** | 0.0600** | 0.830*** | 0.821*** | 0.518*** |
| | (0.0242) | (0.0231) | (0.259) | (0.194) | (0.168) |
| Open | 0.0518 | 0.0143 | 0.0603 | 0.0433 | 0.0503** |
| | (0.0509) | (0.0289) | (0.0449) | (0.0274) | (0.0212) |
| ln(GDP PC) | 10.45*** | 10.40*** | 12.62*** | 8.758*** | 6.067*** |
| | (2.263) | (1.698) | (3.264) | (1.930) | (1.664) |
| ELF | 20.57** | 0.918 | 21.30** | 1.518 | 8.712* |
| | (8.134) | (5.506) | (8.749) | (5.134) | (4.516) |
| Common law | −18.37** | 3.993 | −9.724 | 8.503* | 20.83*** |
| | (8.356) | (4.394) | (13.45) | (5.073) | (4.314) |
| French law | −19.14** | −1.226 | −14.44 | −1.160 | 8.567* |
| | (8.587) | (4.931) | (13.82) | (5.397) | (4.514) |
| German law | −10.44 | 6.198 | 0.0439 | 9.578 | 20.46*** |
| | (8.025) | (4.875) | (13.63) | (6.176) | (5.300) |
| Scand. law | −17.00 | 0.909 | −0.937 | 6.122 | 32.28*** |
| | (14.58) | (7.489) | (19.78) | (8.958) | (8.048) |
| Catholic | −0.113 | −0.0592* | −0.132 | −0.0202 | 0.0606 |
| | (0.0682) | (0.0354) | (0.0804) | (0.0438) | (0.0386) |
| Protestant | 0.0485 | 0.0914 | −0.0985 | 0.0263 | −0.0579 |
| | (0.147) | (0.0748) | (0.171) | (0.0815) | (0.0736) |
| Mulsim | −0.0940 | −0.0441 | −0.117 | −0.0355 | 0.0977* |
| | (0.0732) | (0.0481) | (0.0901) | (0.0571) | (0.0506) |
| abs(lat) | 28.48** | 17.97 | 30.15* | 29.55*** | 38.17*** |
| | (13.05) | (10.88) | (16.67) | (10.72) | (9.539) |
| Constant | −40.39** | −39.75*** | −62.74** | −33.70** | −36.90*** |
| | (16.62) | (13.45) | (26.84) | (15.06) | (13.22) |
| N. Obs. | 103 | 123 | 82 | 100 | 102 |
| R-squared | 0.731 | 0.784 | 0.728 | 0.791 | 0.837 |

The first two columns of this table estimate the same models of columns 2 and 4 of Table 3 by replacing the Barro and Lee (2010) measure of education with that of Vanhanen (2003a, b). Columns 3–5 estimate the specifications of columns 2, 4, and 6 of Table 3 using Stata's robust regression routine (rreg)
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

is rescaled to range between 0 and 100).[14] While this index is not available for the 2000s and is less commonly used than the Barro and Lee measure of the stock of education, in focusing

[14] In the 1980s the average value of the index was 43, in the 1990s the average value had increased to 51. The cross-country standard deviation of the index is approximately 21 and the within-country standard deviation is about 4.

on both the top (tertiary enrollment) and bottom (basic literacy) parts of the distribution of education outcomes it may do a better job at capturing inequalities in the distribution of education. We find that our results are robust to this alternative measure of educational attainment (this is not surprising since the correlation between the two variables is 0.87).

In the last three columns of Table 4, we re-estimate the models of columns 2, 4, and 6 of Table 3 by using a robust regression method which puts less weight on outliers (in particular, we use the rreg command of Stata) and find results which are basically identical to those of Table 3. This confirms that our findings are not driven by outliers.

### 3.3 Panel regressions

The cross-country correlations of the previous subsection are a useful and transparent way of describing the data. However, these cross-country regressions suffer from an omitted variables bias because they do not allow for the fact that the quality of government is likely to be persistent and correlated to unobservable country-specific factors which are not included in the regressions of Table 3. Moreover, the regressions of Table 3 cannot control for the endogeneity of democracy and education.

This subsection exploits the panel dimension of our data to address some of these issues (especially persistence and unobserved heterogeneity). Section 4 discusses the endogeneity problem in greater detail.

As our measure of education is only available at a 5-year frequency, we start with a non-overlapping panel in which average quality of government over the period $t$ to $t+5$ is regressed over quality of government averaged over the period $t-5$ to $t$ and a set of controls which are either time-invariant (ethno-linguistic fractionalization, law origin, religion, and latitude) or time-variant (democracy, education, the interaction between democracy and education, trade openness, and the log of GDP per capita) and averaged over the period $t-5$ to $t$. All panel regressions control for time fixed effects.

We start with a random effects model (column 1, Table 5) which allows estimating the separate effect of time-invariant country-characteristics. The results show strong persistence and confirm our previous finding of a positive and statistically significant effect of democracy, a positive but not statistically significant effect of education, and a positive and statistically

**Table 5** Panel data regressions: 5-year periods

| | (1) RE | (2) FE | (3) D-GMM | (4) S-GMM | (5) D-GMM | (6) S-GMM |
|---|---|---|---|---|---|---|
| L.QOG | 0.696*** | 0.517*** | 0.417*** | 0.590*** | 0.365*** | 0.550*** |
| | (0.0259) | (0.0491) | (0.0780) | (0.0532) | (0.0826) | (0.0693) |
| Democ. | 0.493** | 0.675 | 0.851 | 0.801** | 1.218** | 0.833** |
| | (0.224) | (0.409) | (0.569) | (0.402) | (0.588) | (0.407) |
| Educ. | 0.206 | −0.0465 | 0.823 | 0.421 | 0.808 | 0.132 |
| | (0.228) | (0.738) | (1.213) | (0.550) | (1.471) | (0.529) |
| Dem*edu | 0.183*** | 0.149* | 0.145 | 0.174** | 0.173 | 0.114* |
| | (0.0483) | (0.0866) | (0.110) | (0.0732) | (0.139) | (0.0690) |
| Open | 0.0130 | −0.0283 | 0.00883 | 0.0361** | 0.0124 | 0.0418** |
| | (0.00918) | (0.0384) | (0.0484) | (0.0148) | (0.0549) | (0.0176) |

**Table 5** continued

| | (1) RE | (2) FE | (3) D-GMM | (4) S-GMM | (5) D-GMM | (6) S-GMM |
|---|---|---|---|---|---|---|
| ln(GDP PC) | 1.447** | 4.444* | −0.222 | 2.689** | −2.946 | 3.820*** |
| | (0.582) | (2.296) | (3.474) | (1.098) | (5.057) | (1.177) |
| ELF | 1.094 | | | 2.074 | | 5.645* |
| | (1.754) | | | (3.161) | | (3.084) |
| Common law | 7.074*** | | | 8.288** | | 9.650*** |
| | (1.601) | | | (3.549) | | (3.145) |
| French law | 3.383* | | | 4.871 | | 5.614* |
| | (1.824) | | | (3.440) | | (3.284) |
| German law | 6.457*** | | | 8.146** | | 9.235*** |
| | (1.697) | | | (3.963) | | (3.355) |
| Scand. law | 11.04*** | | | 11.00 | | 12.35** |
| | (2.564) | | | (10.13) | | (4.924) |
| Catholic | −0.000342 | | | −0.0104 | | −0.0143 |
| | (0.0141) | | | (0.0192) | | (0.0187) |
| Protestant | −0.0510** | | | −0.0334 | | −0.0257 |
| | (0.0228) | | | (0.0812) | | (0.0421) |
| Mulsim | 0.00132 | | | 0.00783 | | 0.00707 |
| | (0.0170) | | | (0.0303) | | (0.0293) |
| abs(lat) | 11.27*** | | | 12.02* | | 19.06* |
| | (2.774) | | | (7.275) | | (10.01) |
| N. obs | 446 | 451 | 344 | 446 | 344 | 446 |
| N. of countries | 102 | 104 | 101 | 102 | 101 | 102 |
| Specification Tests (p values) | | | | | | |
| AR1 | | | 0.024 | 0.00 | 0.072 | 0.002 |
| AR2 | | | 0.022 | 0.014 | 0.029 | 0.013 |
| AR3 | | | 0.145 | 0.097 | 0.168 | 0.114 |
| Hansen J | | | 0.937 | 1.00 | 0.48 | 0.743 |
| Diff−Hansen | | | 55 | 0.864 | | 0.497 |

This table reports the results of a set of panel regressions (random effects in column 1, fixed effects in column 2, DIFF-GMM in columns 3 and 5, and SYS-GMM in colums 4 and 6). The variables are the same of Table 4 but we now introduce a lag of the dependent variable. All regressions control for time fixed effects. In columns 3–6 all time-varying controls are considered as endogenous and the time-invaraint controls of columns 4 and 6 are considered as exogenous. The model are estimated with a two-step estimators and the errors are adjusted with Windmeijer's finite-sample correction. In column 3 the differenced equation is instrumented with all available lags starting with t-2. In column 4 the differenced equation is instrumented with all available lags starting with t-2 and the level equation is instrumented with the first lag of the differenced controls. In column 5 the differenced equation is instrumented with all available lags starting with t-3. In column 6 the differenced equation is instrumented with all available lags starting with t-3 and the level equation is instrumented with the second lag of the differenced controls

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

significant interactive effect. This latter result corroborates our hypothesis that democracy and education complement each other.

While the random effect estimates allow for the persistence of quality of government, they do not control for unobserved heterogeneity. In column 2, we control for unobserved hetero-

geneity by augmenting our model with country fixed effects (a specification that controls for all observable and unobservable country-specific time-invariant factors, but does not allow to estimate the separate effects of these factors). We find that neither education nor democracy are statistically significant. However, the interactive term capturing complementarities between democracy and education remains positive and significant. This is a remarkable result if one considers that in the fixed effects model the limited within-country variance of democracy and education amplifies the downward bias brought about by the presence of measurement error.

As fixed effect estimations of dynamic models are biased, we estimate our baseline model with the difference GMM (DIFF-GMM) estimator of Arellano and Bond (1991) and the system GMM (SYS-GMM) estimator of Blundell and Bond (1998) and Arellano and Bover (1995).[15] Specifically, we start from the following dynamic equation:

$$QOG_{i,t} = \alpha QOG_{i,t-1} + \beta \widetilde{D}_{i,t-1} + \gamma \widetilde{E}_{i,t-1} + \delta \left(\widetilde{D}_{i,t-1} \times \widetilde{E}_{i,t-1}\right) + X_{i,t-1}\Psi + \tau_t + \eta_i + \varepsilon_{i,t}, \quad (2)$$

where $\widetilde{D}$ and $\widetilde{E}$ are demeaned education and democracy (as in Eq. 1 above), $X$ is a matrix of time-variant controls, $\tau$ a set of time fixed effects, and $\eta$ a set of country fixed effects (the SYS-GMM estimations also control for time-invariant country characteristics).

Next, we eliminate the country fixed effects by taking first differences of Eq. 2. While the differenced equation cannot be estimated with OLS (by construction, the differenced errors are correlated with the differenced lagged dependent variable, i.e., $E\left[\Delta QOG_{i,t-1}\Delta\varepsilon_{i,t}\right] \neq 0$), if the errors are not serially correlated ($E\left[\varepsilon_{i,t}\varepsilon_{i,t-s}\right] = 0$, for $s > 1$) and the dependent variable is predetermined ($E\left[QOG_{i,1}\varepsilon_{i,t}\right] = 0$ for $t > 1$), the $1 + s$ lags of the dependent variable can be used as instruments for $\Delta QOG_{i,t-1}$.[16] Therefore, if $E\left[\varepsilon_{i,t}\varepsilon_{i,t-1}\right] = 0$ (i.e., $s = 1$), $QOG_{i,t-2}$ and further lags can be used as instruments for $\Delta QOG_{i,t-1}$. If, instead, $E\left[\varepsilon_{i,t}\varepsilon_{i,t-1}\right] \neq 0$, but $E\left[\varepsilon_{i,t}\varepsilon_{i,t-2}\right] = 0$, the first available instrument for $\Delta QOG_{i,t-1}$ is $QOG_{i,t-3}$ (the same applies for all other control variables). In our discussion below, we will show that our model does indeed have first order serial correlation in the residuals. Therefore, the first available instrument for the differenced equation is the third lag of all explanatory variables.

In estimating Eq. 2, we also need to decide whether to consider our other variables (education, democracy, their interaction, and the set of controls $X$) as endogenous, predetermined or fully exogenous. In the baseline regressions, we will consider all time-varying explanatory variables as endogenous (and therefore we will use the same moment conditions that we use for the lagged dependent variable) and consider the time-invariant explanatory variables as exogenous.[17]

We start by assuming $E\left[\varepsilon_{i,t}\varepsilon_{i,t-1}\right] = 0$ and use all possible moment restrictions to estimate Eq. 2. While we find point estimates which are quantitatively similar to the fixed effects estimate, the interactive term capturing complementarities between democracy and education is no longer statistically significant (column 3, Table 5). There are, however, two problems with the estimations of column 3.

[15] We always use the two-steps estimator with robust (Windmeijer's (2005), finite sample correction) standard errors.

[16] Specifically, Arellano and Bond's (1991) difference estimator uses the moment restrictions $E\left[QOG_{i,t-s-1}\Delta\varepsilon_{i,t}\right] = 0$ (for $t = 3, ..., T$ and $s \geq 1$) and the Generalized Method of Moments to estimate Eq. 2 in first differences.

[17] Our results do not change if we treat all of our explanatory variables as exogenous. Full estimation results are available upon request.

First, a consistent estimate of $\alpha$ needs to lie between the OLS and fixed effects estimates (this is because pooled OLS estimates are biased upwards and, in short panels, fixed effects estimates are biased downwards; for an intuitive discussion, see Bond et al. (2001)).[18] Given that the pooled OLS estimate of $\alpha$ is 0.71 (close to the random effects estimate of column 1), and its fixed effects estimate is 0.52, the DIFF-GMM estimation of $\alpha$ (0.43) does not appear to be unbiased. Bond et al. (2001) suggest that a DIFF-GMM estimation of $\alpha$ that lies below the fixed effects estimations is a sign that biases due to weak instruments can be important.

Second, the specification tests at the bottom of Table 5 suggest that there is second order autocorrelation in the differenced residual (indicating the presence of first order autocorrelation in the original residual of Eq. 2). Therefore, $QOG_{i,t-2}$ is not a good instrument for $\Delta QOG_{i,t-1}$ (the same applies for the second lag of the other explanatory variables).

As an alternative to the DIFF-GMM estimations of column 3, we use the system GMM estimator derived by Besley and Burgess (2002) and Arellano and Bover (1995). This estimator, which is better suited for dynamic panel models with persistent data (Bond et al. (2001)), requires a stationarity restriction on the initial process generating $QOG_{i,1}$ (formally $E(\eta_i \Delta QOG_{i,2} = 0)$) and jointly estimates the differenced equation with a level equation that uses the moment conditions $E(\varepsilon_{i,t} \Delta QOG_{i,t-s})$ for $t = 3, 4, ...T$.[19] Bond et al. (2001) show that condition $E(\eta_i \Delta QOG_{i,2} = 0)$ often holds in models that include time fixed effects. The validity of this assumption can also be tested with an incremental test of overidentifying restriction based on the difference between the OID tests of the system and difference estimators (Blundell and Bond 1998).

The SYS-GMM estimations of column 4 find a positive and significant effect of democracy, a positive but insignificant effect of education, and a positive and statistically significant interactive effect. We also find that the autoregressive coefficient lies between those of the pooled OLS and fixed effects estimates, an indication that SYS-GMM solves (at least in part) the weak instruments problem that affects the DIFF-GMM estimations. [20] The last row of the table shows that the incremental Hansen test for overidentifying restrictions proposed by Blundell and Bond (1998), does not reject the validity of the additional moment conditions $E(\eta_i \Delta QOG_{i,2} = 0)$.

While these results confirm our previous findings, there are two problems with the system GMM estimations of column 4. First, as in the DIFF-GMM estimations, the specification tests reported at the bottom of the table do not reject the presence of second order correlation. Second, the Hansen test yields a value of one, suggesting that we are overfitting our first stage estimates.

To address the first issue, we check for the presence of third order serial correlation of the errors. As we find no evidence in this direction, the third-lag of the dependent variable (and of the other explanatory variables) is potentially a valid instrument for the differenced variables. We thus deal with the presence of second order autocorrelation in the differenced residuals by re-estimating the model using the third and further lags as instruments for the differenced equation. Using the DIFF-GMM estimator, we find coefficients which are similar to those of column 3 (however, the main effect of democracy is now statistically significant). As in

[18] This bounding procedure only applies to the univariate case. In order to apply these results to multivariate models it is necessary to assume that the the only explanatory variable correlated with the fixed effects is the lagged dependent variable and that all other regressors are strictly exogenous with respect to $\varepsilon_{i,t}$.

[19] Given that in the difference equation we use $E\left[QOG_{i,t-s-1} \Delta\varepsilon_{i,t}\right] = 0$ (for $t = 3, \ldots, T$ and $s \geq 1$), the use of further lags beyond $\Delta QOG_{i,t-s}$ is redundant. Also, note that the level equation allows estimating the separate effect of time-invariant controls.

[20] See Bond et al. (2001) for a discussion of this bounding procedure to assess the relative merits of DIFF-GMM and SYS-GMM estimation and Bobba and Coviello (2007) for an application to education and democracy.

column 3, the interactive term is not statistically significant and the estimate of $\alpha$ suggests a large downward bias, possibly associated with the presence of weak instruments.

Finally, we deal with the presence of second order autocorrelation in the differenced residual by estimating the model with the SYS-GMM using the third and further lags as instruments for the differenced equation and the second lag of the differenced variables for the level equation. The sixth column of Table 5 reports the results and shows that democracy and the interaction between democracy and education are positively associated with the quality of government. The bottom panel of the table shows that the specification tests support our assumption of no third-order correlation of the differenced residual (consistent with the presence of no second order correlation in the original residuals). Moreover, the Hansen test drops to 0.74, indicating that, while we are not rejecting the model's overidentifying restrictions, we are no longer overfitting the first stage. Again, the incremental Hansen test does not reject the additional moment restrictions required by the system estimator.

While our benchmark estimates use all available lags in the set of instruments for the differenced equation and the first available lag of the differenced variables in the level equation (the first available lag depends on the degree of autocorrelation in the residuals $s$), we also experimented with different lags in the sets of instruments for both equations and found that our results are robust to these different set of instruments.[21]

Figure 5 shows the marginal effects of education and democracy obtained with the estimates of column 6 of Table 5.[22] Panel A of Fig. 5 shows that democracy does not have a statistically significant effect on the quality of government in countries with low levels of education, but that the effect of democracy becomes statistically significant when education is above the cross-country average (normalized to zero in the figure). Panel B of Fig. 5 shows that the marginal effect of education is increasing with the level of democracy but that education is never statistically significant.

If we estimate the models of Table 5 without the interactive effect, we find that education and democracy are never statistically significant.

### 3.4 Robustness checks

In this subsection, we check whether our results are robust to alternative specifications and data.

We start by experimenting with an alternative method to deal with the presence of second order correlation in the residuals. Specifically, we augment our model with one further lag of the dependent variable. The random effects estimations (column 1 of Table 6) yield results which are qualitatively similar to those of Table 5, but in the fixed effects estimation the interactive effect is no longer statistically significant and becomes negative. Fixed effect estimations are however biased. When we estimate the model with system GMM, we find that the interactive effect goes back to being positive and statistically significant (column 3). The specification tests reported in the bottom panel of the Table show that augmenting the model with the second lag of the dependent variable eliminates the problems associated with the presence of second order autocorrelation of the residuals. However, the Hansen test still indicates that we may be overfitting the first stage. We address the overfitting problem

[21] We experimented with 12 possible combinations of lags in the level and differenced equations and found that only in one case the coefficient of the interaction between education and democracy was not statistically significant. Even in this case, the coefficient was very close to being statistically significant at the 10 % confidence level (p = 0.103).

[22] Since this represents our favorite specification, we also use the estimates reported in column 6 to conduct the non-robustness analysis discussed in Sect. 4.

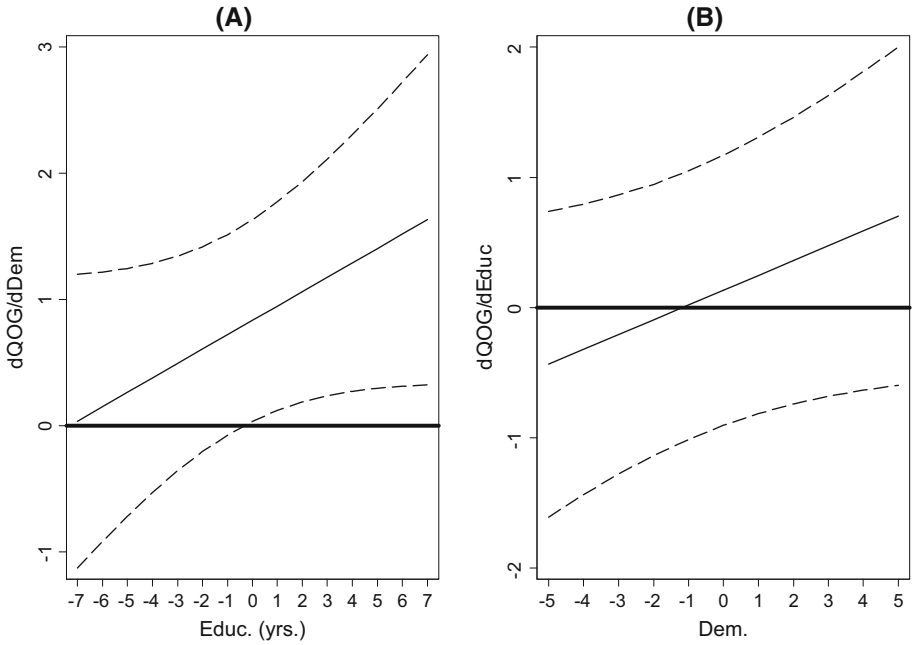


**Fig. 5** Marginal effect of democracy at different levels of education and marginal effect of education at different levels of democracy (panel data)

by following Roodman's (2009) suggestion of collapsing the instruments set.[23] The Hansen tests drops to 0.157 while the estimated coefficient for the interactive term between education and democracy remains positive and statistically significant.

We also check whether our results are robust to moving from a 5-year to a 10-year dynamic panel. Again, we start by considering random effect estimations and find the usual result of a positive and statistically significant effect of the interactive term (column 1, Table 7 ). The effect remains positive but loses its significance in the (biased) fixed effects estimates of column 2. Finally, the system GMM estimations of column 3 confirm our previous result of a positive and statistically significant effect of the interaction between democracy and education. The system-GMM estimations also pass the standard specification tests. The residuals exhibit first order but no second order autocorrelation and the Hansen test indicates that we are not rejecting the overidentifying restrictions and we are not overfitting the first stage.

In Table 8, we split the dependent variable into its 3 components. Specifically, we use our benchmark specification (column 6, Table 5) to run separate regressions for the ICRG variables Control of Corruption, Law and Order, and Bureaucratic Quality. We find that the effect of education is positive (but never statistically significant) only when the dependent variable is Law and Order. Democracy, instead, has a positive and statistically significant effect on Control of Corruption and Bureaucratic Quality but not on Law and Order. Finally, the interactive term is positive and statistically significant only for Control of Corruption.

[23] To collapse the instrument set we impose the same condition for all $t$ and create an instrument for each endogenous variable and lag rather than for each endogenous variable, time period and lag.

**Table 6** Panel data regressions: this table reports the results of a set of panel regressions (random effects in columns 1, fixed effects in columns 2 and system GMM in colums 3 and 4)

| | (1) RE | (2) FE | (3) SYS-GMM | (4) SYS-GMM |
|---|---|---|---|---|
| L.QOG | 0.788*** | 0.489*** | 0.622*** | 0.452*** |
| | (0.0461) | (0.0590) | (0.0674) | (0.123) |
| L2.QOG | −0.127*** | −0.190*** | −0.0686 | 0.0333 |
| | (0.0366) | (0.0440) | (0.0502) | (0.0903) |
| Democ. | 0.279 | −0.0877 | 0.687 | 1.203* |
| | (0.273) | (0.589) | (0.450) | (0.643) |
| Educ. | 0.458* | −0.255 | 0.292 | −1.092 |
| | (0.259) | (0.892) | (0.509) | (1.106) |
| Dem.*educ. | 0.140** | −0.0939 | 0.215** | 0.360** |
| | (0.0672) | (0.137) | (0.0962) | (0.149) |
| Open | 0.0164 | −0.0624 | 0.0428** | 0.0292 |
| | (0.0103) | (0.0430) | (0.0171) | (0.0307) |
| ln(GDP PC) | 1.225** | 5.147 | 2.513** | 6.055*** |
| | (0.624) | (3.260) | (1.135) | (2.280) |
| ELF | 0.614 | | 2.295 | 4.876 |
| | (1.863) | | (2.566) | (3.708) |
| Common law | 9.310*** | | 10.51*** | 7.300* |
| | (1.604) | | (2.524) | (3.785) |
| French law | 5.611*** | | 6.355** | 1.448 |
| | (1.724) | | (2.714) | (4.604) |
| German law | 9.095*** | | 11.39*** | 7.353 |
| | (1.705) | | (3.621) | (4.660) |
| Scand. law | 13.55*** | | 16.81*** | 13.46* |
| | (2.899) | | (4.905) | (7.194) |
| Catholic | 0.00118 | | −0.00811 | −0.00771 |
| | (0.0142) | | (0.0184) | (0.0215) |
| Protestant | −0.0590** | | −0.0711* | −0.0554 |
| | (0.0263) | | (0.0375) | (0.0531) |
| Muslim | −0.00390 | | 0.00283 | −0.00150 |
| | (0.0210) | | (0.0265) | (0.0407) |
| abs(lat) | 16.09*** | | 17.61*** | 15.67* |
| | (3.061) | | (5.241) | (8.473) |
| Constant | −5.609 | −0.0617 | −16.31* | −40.60** |
| | (4.725) | (29.31) | (8.890) | (16.60) |
| Observations | 348 | 351 | 348 | 348 |
| R-squared | | 0.455 | | |
| Number of countries | 101 | 103 | 101 | 101 |
| specifications test (p values) | | | | |
| AR1 | | | 0.003 | 0.162 |

**Table 6** continued

| | (1) RE | (2) FE | (3) SYS-GMM | (4) SYS-GMM |
|---|---|---|---|---|
| AR2 | | | 0.339 | 0.163 |
| Hansen J test | | | 0.998 | 0.157 |

The variables are the same of Table 5 but we now introduce an additional lag of the dependent variable. All regressions control for time fixed effects. In columns 3–4 all time varying controls are considered as endogenous and the time invariant controls are considered as exogenous. The models are estimated with a two-step estimators and the errors are adjusted with Windmeijer's finite-sample correction. In columns 3 the differenced equation is instrumented with all available lags starting with t-2 and the level equation is instrumented with the second lag of the differenced controls. In columns 4, we collapse the set of instruments as suggested by Roodman (2009)
* p < 0.1, ** p < 0.05, *** p < 0.01

**Table 7** Panel data regressions: 10-year periods

| | (1) RE | (2) FE | (3) SYS-GMM |
|---|---|---|---|
| L.QOG | 0.453*** | 0.249*** | 0.297* |
| | (0.0438) | (0.0926) | (0.165) |
| Democ. | 0.527 | −0.634 | 0.787 |
| | (0.384) | (0.889) | (1.129) |
| Educ. | 0.679 | 0.666 | 1.914 |
| | (0.440) | (1.707) | (1.599) |
| Dem.*educ. | 0.265*** | 0.0632 | 0.460** |
| | (0.0938) | (0.207) | (0.221) |
| Open | 0.0286 | −0.0931 | −0.0202 |
| | (0.0176) | (0.0897) | (0.0406) |
| ln(GDP PC) | 1.899* | 5.015 | 5.317* |
| | (1.103) | (5.015) | (2.960) |
| ELF | 1.182 | | 6.823 |
| | (3.025) | | (4.664) |
| Common law | 14.65*** | | 12.33*** |
| | (2.710) | | (4.426) |
| French law | 8.058** | | 5.692 |
| | (3.145) | | (4.933) |
| German law | 13.55*** | | 10.76** |
| | (2.683) | | (5.082) |
| Scand. law | 22.09*** | | 24.14*** |
| | (4.320) | | (7.210) |
| Catholic | 0.00566 | | 0.00724 |
| | (0.0255) | | (0.0350) |
| Protestant | −0.103** | | −0.116* |
| | (0.0399) | | (0.0652) |
| Muslim | −0.00394 | | 0.0414 |
| | (0.0328) | | (0.0640) |

**Table 7** continued

| | (1) RE | (2) FE | (3) SYS-GMM |
|---|---|---|---|
| abs(lat) | 24.99*** | | 13.11 |
| | (5.202) | | (11.52) |
| Constant | −9.977 | 9.914 | −25.98 |
| | (8.092) | (44.16) | (21.91) |
| Observations | 187 | 190 | 187 |
| R-squared | | 0.375 | |
| Number of countries | 102 | 104 | 102 |
| specifications test (p values) | | | |
| AR1 | | | 0.042 |
| AR2 | | | 0.214 |
| Hansen J test | | | 0.393 |

This table reports the results of a set of panel regressions (random and fixed effects in columns 1 and 2 and System GMM in column 3) where the dependent variable is the ten year average of quality of government and the explanatory variables are the same as in Table 4. All regressions control for time fixed effects. In columns 3 all time varying controls are considered as endogenous and the time invariant controls are considered as exogenous. The model is estimated with a two-step estimator and the errors are adjusted with Windmeijer's finite-sample correction. In column 3, the differenced equation is instrumented with all available lags starting with t-2 and the level equation is instrumented with the first lag of the differenced controls
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

**Table 8** Panel data regressions: 5-year periods on the components of ICRG index

| | (1) Control of Corruption | (2) Law & Order | (3) Buroc. Quality |
|---|---|---|---|
| L.DEP | 0.470*** | 0.438*** | 0.512*** |
| | (0.0696) | (0.0817) | (0.0723) |
| Democ. | 0.906** | 0.337 | 1.254*** |
| | (0.455) | (0.586) | (0.429) |
| Educ. | −0.271 | 1.012 | −0.594 |
| | (0.733) | (0.779) | (0.633) |
| Dem.*Educ. | 0.254** | 0.0984 | −0.0149 |
| | (0.115) | (0.131) | (0.0940) |
| Open | 0.0130 | 0.0639** | 0.0322* |
| | (0.0198) | (0.0294) | (0.0192) |
| ln(GDP PC) | 4.534*** | 3.447 | 4.128*** |
| | (1.573) | (2.104) | (1.558) |
| ELF | 4.317 | 4.757 | 5.208** |
| | (3.053) | (3.911) | (2.385) |
| Common Law | 7.153* | 12.44*** | 4.968* |
| | (3.668) | (4.361) | (2.704) |
| French Law | 3.823 | 6.838* | 2.115 |
| | (3.507) | (4.032) | (2.677) |

**Table 8** continued

| | (1) Control of Corruption | (2) Law & Order | (3) Buroc. Quality |
|---|---|---|---|
| German law | 6.308* | 13.37*** | 6.254* |
| | (3.748) | (5.186) | (3.438) |
| Scand. Law | 13.52** | 19.62*** | 3.968 |
| | (6.643) | (6.821) | (4.515) |
| Catholic | −0.0136 | 0.00447 | −0.0297* |
| | (0.0305) | (0.0306) | (0.0163) |
| Protestant | −0.00172 | −0.0820 | 0.0128 |
| | (0.0595) | (0.0639) | (0.0411) |
| Muslim | −0.00886 | 0.0187 | 0.00733 |
| | (0.0348) | (0.0397) | (0.0232) |
| abs(lat) | 15.22* | 25.93*** | 8.979 |
| | (8.530) | (9.950) | (6.292) |
| Constant | −21.68* | −27.08* | −33.05*** |
| | (11.54) | (15.78) | (12.20) |
| Observations | 446 | 446 | 446 |
| Number of countries | 102 | 102 | 102 |
| specifications test (p−values) | | | |
| AR1 | 0.0001 | 0.00701 | 0.0309 |
| AR2 | 0.00672 | 0.0468 | 0.000264 |
| AR3 | 0.283 | 0.121 | 0.822 |
| Hansen J-test | 0.867 | 0.725 | 0.736 |

This table reports the results of a set of panel regressions (all system GMM). We use the same model of Column 6 of Table 5 but we split the dependent variable into its 3 componets (the ICRG variables Control of Corruption, Law and Order, and Bureaucratic Quality) and run separate regressions for each component
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The Control of Corruption component of the governance index seems therefore particularly important for our result on the interaction between education and democracy. This is in line with the literature on social capital and informational asymmetries discussed in Sect. 2 which points mainly to the effect that these variables have on the behavior of elected officials and their degree of responsiveness to public demands.[24]

This result on the primacy of corruption over the other components of governance quality however is not robust to measuring institutional quality with the governance indicators of the World Bank's Worldwide Governance Indicators (Kaufmann et al. 2010). Specifically, we looked at how the interaction of democracy and education affect Rule of Law, Control of Corruption, Government Effectiveness, and Regulatory Quality. [25] In this case, we find that democracy and the interaction between democracy and education is statistically significant for most of these measures of governance (the exception is regulatory quality). However, the

[24] Corruption is often one of the most visible forms of misgovernment and the governance component that seems to have the strongest effect on economic growth (e.g., Mauro 1995).

[25] We would like to thank an anonymous referee for suggesting this robustenss check. Full regression results are available upon request.

Worldwide Governance Indicators start in 1996 and therefore we could only use them in our cross-sectional estimates.

We also experiment with alternative measures of democracy. Specifically, we replace the average of the Freedom House and Polity indexes with just the Freedom House index (computed as the average of the civil liberties and political right indexes) or the Polity democracy index and find results which are essentially identical to those of our benchmark estimates.

In Table 9 we use again the same models of Table 5, but we now employ a discrete version of our two main explanatory variables (democracy and education). Specifically, we split the sample into democratic and non-democratic countries ($Democ = 1$ if the democracy index is greater than 7.2, the median value of democracy in our sample) and educated and non-educated countries ($Educ = 1$ if the average number of years of education attained by the adult population is greater than 6.9, the median value of education in our sample). We use these two dummies to partition our sample into 4 groups: (i) low education/low democracy; (ii) high education/low democracy; (iii) low education/high democracy; and (iv) high education/high democracy and introduce the last three variables in our regression model. Since low education/low democracy is the excluded dummy, our point estimates measure the impact of education (education/no democracy), democracy (no education/democracy) and the joint impact of these two variables (education/democracy). We find that nondemocratic countries with high levels of education and democratic countries with low-levels of education are not significantly different from non-democratic countries with low levels of education. Only educated countries with high levels of education have a level of quality of government which is significantly higher than the benchmark. These results corroborate what we found by using continuous measures of democracy and education (the results of column 3 are, however, problematic because of the presence of second order correlation in the differenced residuals) (Table 9).

We also run a series of horse race regressions to check whether the interaction between democracy and education is the most relevant as compared to other possible alternatives. We start by estimating a model in which we interact democracy with education, income per capita (the log of GDP per capita), and inequality (the Gini index) and find than none of the interacted coefficients is statistically significant (this is probably due to multicollinearity, a regression of one interacted coefficient over the other two yields an R squared of 0.94). While the coefficient of the interactions between democracy and education and democracy and inequality have the expected signs (positive and negative, respectively), the coefficient of the interaction between income per capita and democracy is negative (albeit insignificant) which is the opposite of what one would expect. Next, we use two interactions at a time and find similar results (the coefficients are never statistically significant, the interactions with education and inequality have the expected signs and the interaction between democracy and income per capita has a negative coefficient). Finally, we use just one interaction at a time and find that only the interaction between democracy and education is statistically significant.[26]

## 4 Endogeneity

The main issue with the estimations of Sect. 3 relates to the endogeneity of our variables of interest and of some of our controls. The quality of government is likely to have a direct effect on education and GDP per capita and an either direct or indirect effect on democracy and trade openness. Dynamic panel analysis and different GMM estimators, as we have done

[26] Full regression results are available upon request.

**Table 9** Panel data regressions: 5-year periods with discrete explanatory variables

| | (1) RE | (2) FE | (3) SYS-GMM |
|---|---|---|---|
| L.QOG | 0.726*** | 0.537*** | 0.669*** |
| | (0.0236) | (0.0365) | (0.0614) |
| Educ. & democ. | 3.728*** | 3.703* | 2.894* |
| | (1.177) | (2.140) | (1.491) |
| No educ. & democ. | 1.413 | 2.604 | 1.636 |
| | (0.985) | (1.750) | (1.110) |
| Educ. & no democ. | −0.113 | 1.041 | −0.276 |
| | (1.400) | (1.803) | (1.742) |
| Open | 0.00896 | −0.00298 | 0.0267 |
| | (0.00743) | (0.0292) | (0.0190) |
| ln(GDP PC) | 1.749*** | 4.501** | 2.472** |
| | (0.487) | (1.946) | (1.014) |
| ELF | −0.196 | | 0.716 |
| | (1.429) | | (2.212) |
| Common law | 5.002*** | | 7.035*** |
| | (1.265) | | (2.015) |
| French law | 2.862* | | 4.243** |
| | (1.530) | | (2.080) |
| German law | 4.804*** | | 7.109*** |
| | (1.505) | | (2.461) |
| Scand. law | 8.818*** | | 11.70*** |
| | (2.262) | | (3.481) |
| Catholic | −0.0178 | | −0.0168 |
| | (0.0144) | | (0.0164) |
| Protestant | −0.0364 | | −0.0471 |
| | (0.0227) | | (0.0302) |
| Muslim | −0.0138 | | −0.0184 |
| | (0.0165) | | (0.0176) |
| abs(lat) | 6.778** | | 10.86** |
| | (2.913) | | (4.696) |
| N. obs. | 557 | 589 | 557 |
| N. of countries | 124 | 132 | 124 |
| AR1 | | | 1.71e-05 |
| AR2 | | | 0.000774 |
| AR3 | | | 0.0732 |
| Hansen J | | | 0.732 |

This table reports the results of a set of panel regressions (random effects in columns 1, fixed effects in columns 2 and system GMM in colums 3 and 4). We use the same models of Table 7, but we now employ a discrete version of our two main explanatory variables (democracy and education) and partition the sample in democratic countries with high education, democratic countries with low education, non-democratic countries with high education, and non-democratic countries with low education (this is the excluded category)
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

in Sect. 3, deal with the problem only partially. In the absence of proper instruments there is no solution to the endogeneity problem.[27]

[27] We experimented with an instrument for Democracy (trade-weighted democracy, as in Acemoglu et al. 2008), but we could not find a good instrument for education.

**Table 10** Description of variables

| Variable | Description and sources |
|---|---|
| QOG | ICRG indicator of Quality of Government obtained as the mean value of the ICRG variables " Corruption" , " Law and Order' and " Bureaucracy Quality" , scaled 0-1. Higher values indicate higher quality of government. Downloaded from www.qog.pol.gu.se (the name of the variable in the QOG dataset is QOG) |
| Democ. | Index of democracy obtained as an average of the Polity and Freedom House indexes of democracy. Downloaded from www.qog.pol.gu.se (the name of the variable in the QOG dataset is fh polity2) |
| Educ. | Average numbers of years of education. Source: Barro and Lee (2010) |
| Open | Trade openness (source: Penn World tables) |
| ln(GDP PC) | Log GDP real per capita in PPP (source: Penn World Tables) |
| ELF | Ethnic Fractionalization from Fearon (2003). Downloaded from www.qog.pol.gu.se (the name of the variable in the QOG dataset is fe etfra) |
| Common law | Dummy variable that takes a value of one for countries with a common law legal origin. Source La Porta et al. (1999) |
| French law | Dummy variable that takes a value of one for countries with a French legal origin. Source La Porta et al. (1999) |
| German law | Dummy variable that takes a value of one for countries with a German legal origin. Source La Porta et al. (1999) |
| Scand. law | Dummy variable that takes a value of one for countries with a Scandinavian legal origin. Source La Porta et al. (1999) |
| Soc. law | Dummy variable that takes a value of one for countries with a socialist legal origin. Source La Porta et al. (1999) |
| Catholic | Share of Catholics in the population. Source La Porta et al. (1999) |
| Protestant | Share of Protestant in the population. Source La Porta et al. (1999) |
| Muslim | Share of Muslim in the population. Source La Porta et al. (1999) |
| abs(Latitude) | Absolute value of the latitude of the capital city, divided by 90 (to take values between 0 and 1). Source: La Porta et al. (1999) |
| Rshock | Real external shock. Source: Jaimovich and Panizza (2006) |

We follow Bourguignon et al. (2007) and explore the magnitude of the potential bias in the estimation of our parameters of interest. In a sense, we check how "non-robust" our results are to different assumptions on the severity of the endogeneity problem and plot our estimated coefficients for different values of the correlation between our explanatory variables and the error term (for details, see the Appendix. Altonji et al. (2005) describe an alternative strategy).

Figure 6 shows how different assumptions about the possible correlation between the error term and each of the endogenous variables affect the coefficient associated with the interaction between democracy and education (the solid line plots the average value and the dashed lines plot the values at the 5th and 95th percentile of the distribution).[28]

The figure shows that allowing for a negative correlation would strengthen our result of a positive interactive effect between education and democracy. However, we do not think that this is the likely direction of the bias. It is in fact more likely that our endogenous variables are positively correlated with the error term. The graph shows that the average value of

[28] When we set correlation equal to 0, the whole distribution of the bias collapses to one point. This should clarify the fact that Fig. 6 plots the distribution of the corrected estimators obtained with the Monte Carlo simulation and not the sum of the distributions of each corrected estimator.

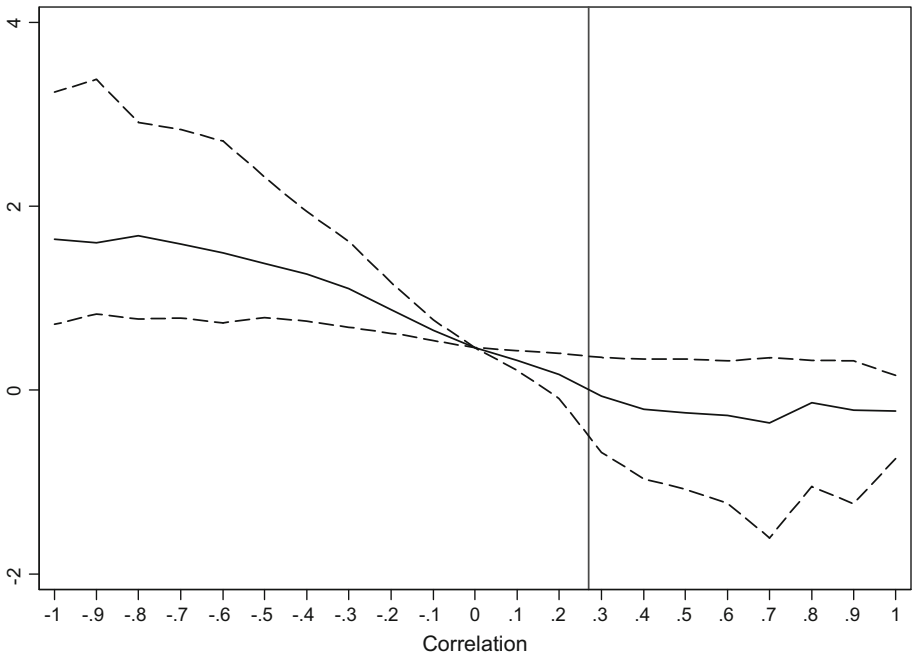


**Fig. 6** Non-robustenss analysis (interaction between democracy and education)

the coefficient for the interaction between democracy and education remains positive if the correlation coefficient is lower than 0.3 and that the coefficient at the bottom 5th percentile of the distribution remains positive if the correlation coefficient is lower than 0.2. Therefore, our results are robust to allowing for a fairly severe endogeneity problem. Moreover, Fig. 6 shows that the coefficient at the 95th percentile of the distribution is always positive, indicating that the relationship between the quality of government and the interaction between democracy and education is non-negative, even if we assume that our estimation suffer from an extreme endogeneity problem.[29]

Summing up, we find that endogeneity would never reverse our results. In the worst case scenario, severe endogeneity would lead to statistically insignificant estimates of our parameters of interest.

## 5 Conclusions

This paper looks at how democracy, education, and their interaction affect the quality of government. In doing so, we synthesize recent research that highlights the importance of political institutions as a fundamental factor explaining cross-country differences in income per capita with work that argues that institutional improvements and development are ultimately driven by social and human capital.

[29] A previous version of this paper also looks at the marginal effects of democracy and education on the quality of government and studies how they are affected by different levels of severity of the endogeneity problem. The findings are analogous to the ones presented here focusing only on the interaction term.

Our results show that: (i) the interaction between democracy and education is always a positively and significantly correlated with the quality of government; (ii) the correlation between democracy and quality of government is statistically significant only in countries with high levels of education; and (iii) the marginal effect of education on quality of government is positive and sometimes statistically significant in countries with high levels of democracy. We also run a set of Monte Carlo simulations which show that our results are robust to mild forms of endogeneity.

These results are important because the quality of government is a crucial determinant of economic growth (e.g., Knack and Keefer 1995; Mauro 1995). It is thus possible to use our estimates to do a back-of-the-envelope calibration aimed at gauging how a joint increase in democracy and education could lead to higher economic growth through their effect on the quality of government.

We start by using the coefficients reported in Table 5 column 6 to measure the impact of our key explanatory variables on the governance index and find that a one-standard deviation increase in democracy and education (3.11 and 2.94 respectively) would increase the governance index by about one fifth of one standard deviation (i.e., about 4 points). Next, we use Rivera-Batiz's (2002) estimates of the impact of governance on growth to assess the growth impact of a joint increase of education and democracy. Given that Rivera-Batiz suggests that a one-standard deviation increase in governance would increase annual GDP growth by 1.2 percentage points, our results indicate that a joint one-standard deviation increase in democracy and education would increase annual GDP growth by approximately one quarter of one percentage point ($0.2*1.2=0.24$).[30]

Our results support the idea that democratic institutions per se do not guarantee effective government and growth and that democracy is more likely to flourish when education is spread through the entire population. However, we are unable to decompose the effect of education into problems of civic culture, selection, or incentives. As the relative importance of these factors is likely to vary across countries, in future research it would be interesting to go deeper into the exploration of the heterogenous effect of democracy on the quality of government and ultimately on economic growth.

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**Compliance with ethical standards**

**Conflicts of Interest** The authors declare that they have no conflict of interest.

[30] This is of course a conservative estimation of the overall impact of democracy and education on economic growth as our calibration considers only the impact mediated through quality of government and does not take into account other direct and indirect channels (e.g., human capital accumulation). Also, Panizza (2009) finds a larger elasticity of growth to governance. His estimates suggest that a joint one-standard deviation increase in democracy and education could increase annual GDP growth by 0.75 percentage points.

## Appendix

Our objective is to estimate the following model:

$$Q_i = \alpha + X_i\beta + W_i\lambda + u_i,$$

where $Q$ is the quality of government, $X$ is a matrix of endogenous variables (democracy, education, the interaction between democracy and education, GDP per capita, and openness) and $W$ is a matrix of exogenous variables (Ethno-linguistic fractionalization, legal origin, religion, and latitude). Because of endogeneity, $X$ and $u$ are not orthogonal and the vector $\widehat{\beta}$ will be a biased estimator of $\beta$ (possibly also causing a bias in $\widehat{\lambda}$).

If we had a set of valid instruments (i.e., a set of variables correlated with $X$ but uncorrelated with $u$), we could use an IV estimator and obtain an unbiased estimator of the vector $\beta$. In the absence of such a set of instruments, we can compute how the correlation between $u$ and $X$ affects the bias of $\widehat{\beta}$.

To see how this can be done let us start by assuming, without loss of generality, that all variables are endogenous and have mean zero.[31] The expected value of the OLS estimator will then be:

$$E\left(\widehat{\beta}\right) = \left(X'X\right)^{-1}X'Q = \beta + \left(X'X\right)^{-1}E\left(X'u\right). \tag{3}$$

As $E\left(X'u\right) = cov(Xu)N$ (where $N$ is the number of observations), we can write the bias of the OLS estimator as $B = E\left(\widehat{\beta}\right) - \beta = \left(X'X\right)^{-1}cov(Xu)N$. By recalling that $\rho_{Xu} = cov(Xu)/(\sigma_x\sigma_u)$, we have,

$$B = N\left(X'X\right)^{-1}\left(\underline{\rho_{Xu}\sigma_x}\right)\sigma_u, \tag{4}$$

where $\sigma_u$ is the standard deviation of $u$ and $\underline{\rho_{Xu}\sigma_x}$ is a $k \times 1$ vector in which each element is the product between the standard deviation of the $k$th variable in $X$ and the correlation between $u$ and the $k$th variable in $X$.[32] In order to evaluate the bias we need a guess about $\sigma_u$ (which can only be estimated if we have an unbiased estimate of $\beta$) and $\rho_{Xu}$. We can instead estimate $\sigma_x$.

Bourguignon et al. (2007) start by observing that:

$$\sigma_u^2 = \frac{E\left(u'u\right)}{N} + \frac{E}{N}\left[\left(\widehat{\beta}-\beta\right)'\left(X'X\right)\left(\widehat{\beta}-\beta\right)\right]$$

and suggest that $\sigma_u^2$ can be proxied by:

$$\sigma_u^2 \cong \widehat{\sigma}_u^2 + \frac{B'X'XB}{N}. \tag{5}$$

By plugging 4 into 5, we can obtain the following estimator for $\sigma_u^2$:

$$\sigma_u^2 \cong \frac{\widehat{\sigma}_u^2}{1 - N\left(\rho_{Xu}\sigma_x\right)'\left(X'X\right)^{-1}\left(\rho_{Xu}\sigma_x\right)} \tag{6}$$

We can now substitute 6 in 4 and have the following expression for the bias:

$$B \cong \frac{N\left(X'X\right)^{-1}\left(\underline{\rho_{Xu}\sigma_x}\right)\widehat{\sigma}_u}{\left(1 - N\left(\rho_{Xu}\sigma_x\right)'\left(X'X\right)^{-1}\left(\rho_{Xu}\sigma_x\right)\right)^{\frac{1}{2}}} \tag{7}$$

[31] The following discussion is close to that in Bourguignon et al. (2007). We repeat it here for ease of reference.

[32] The typical element in this vector is $\rho_{x_k u}\sigma_{x_k}$.

Equation 7 allows us to compute the bias of the OLS estimator for any vector of correlation coefficients $\underline{\rho_{Xu}}$.

Although the correlation coefficients are unknown, they need to range between $-1$ and 1. We can thus build bounds for the coefficients of our variables of interest by randomly drawing a large number of correlation coefficients and applying them to Eq. (7).

In particular, we start with the dynamic system GMM specification of Table 5 column 6 and associate each of our endogenous variables (education, democracy, the interaction between education and democracy, GDP per capita, and trade openness) to a random draw from uniform distribution defined over $(0, c)$, substitute these correlations into Eq. 7, and use $B$ to recover $\beta$. We replicate this exercise 10, 000 times for each value of $c$ allowing $c$ to range between $-1$ and 1, with increments of 0.1 (for a total of 200, 000 simulations). As in Bourguignon et al. (2007), we also impose some restrictions on the values of $\beta$. In particular, we drop all draws for which the impact of GDP per capita, Common law, German law, and latitude is non-positive.[33] We then use the remaining observations to look at how the correlation between the endogenous variables and the error term affects the estimation of our variables of interest.

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[33] The restrictions are never binding when $c$ ranges between $-0.2$ and 0.2, but they exclude most observation when we allow $c$ to take larger values. For instance, when $c = 1$, only 175 draws (out of 10, 000) are retained. We think that these restrictions are reasonable and well grounded in the existing literature. However, the results are basically identical if we do not include these restrictions.

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