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The role of institutions on public debt: A quantile regression approach

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ABSTRACT

The unprecedented rise in debt levels across countries has given rise to the role of institutions on public debt. This study examines the impact of institutions on government debt in a sample of 54 EU and non-EU countries, covering the 2010 to 2022 period, employing the Logistic Quantile Regression (LQR) and Recentered Influence Function (RIF) method, Our results indicate that the effect of institutions varies across the distribution of government debt. The results show that government effectiveness, regulatory quality, voice, and accountability have similar effects in the EU and non-EU countries. However, political stability and the control of corruption have a significant and debt reducing effect only in EU countries. Robustness checks confirm our findings.

1. Introduction

According to the IMF, global debt levels rose to unprecedented levels, reaching $226 trillion in 2020 (Gaspar et al., 2021). This can be attributed primarily to the covid-19 pandemic, and has more recently, been compounded by the Russia-Ukraine war. Several countries including Russia, Egypt, Sri Lanka, Suriname, and Zambia are currently in default (Jones, 2022), with many other countries on the verge of default. Rising debt levels have not only been experienced by the developing, but also developed nations. For example, US public debt as a percentage of GDP currently stands at 115.25%, UK 102.97%, Spain 106.22%, and Italy 146.5% (IMF, 2014c). High debt levels can increase the vulnerability of an economy to macroeconomic shocks, volatility, risk of default, crowd out the private sector, discourage capital accumulation, undermine economic growth, reduce tax revenues and lead to inflation (Burriel et al., 2020; Dimakou, 2015; Sargent & Wallace, 1981; Woo & Kumar, 2015). Addressing debt sustainability issues therefore remain crucial, especially in countries which are in default. These developments give rise to the question of what factors affect public debt ratios. While a number of factors affect a country's debt levels, fiscal discipline cannot be achieved in the absence of strong institutions.

Evidence has shown that strong institutions such as government effectiveness, regulatory quality, the rule of law and the control of corruption are crucial for effective debt management and dealing with financial crises. For example, political unity and good governance in Sweden, were important factors in helping the country to overcome the banking crisis of 1991–1993 (Jonung, 2009). This is further supported by the literature. Van Rijckeghem and Weder (2009) and Cerra et al. (2008), show that political institutions play an important role in explaining international and domestic debt accumulation and defaults. Similarly, Acemoglu et al. (2001) and Acemoglu (2004), highlight the importance of institutions for economic prosperity, Alesina and Tabellini (1990) the influence of

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political conflict on fiscal deficits, Heimberger (2023), the significance of institutions for differentials between bond returns and economic growth, and Woo (2003), the relationship between economic, political, and institutional factors and budget deficits. A large literature shows that the impact of corruption on an economy depends on its institutional environment (Aidt, 2009; De Rosa et al., 2010; La Porta et al., 1999; Méon & Sekkat, 2005; Méon & Weill, 2010; Shleifer & Vishny, 1993). The quality of institutions in a country would, therefore, have an important bearing on budget and debt coordinates and governance.

This gives rise to the question of how institutions affect government debt? If nations exhibit Classical behaviour, then, the government will compete with the private sector for savings, driving up interest rates, and discouraging private sector investment (Yared, 2019). It is likely that this would occur in countries with weak institutions. According to Keynesian models, higher public debt will lead to an increase aggregate demand. While rising debt levels might not matter for countries with strong institutions as they are accompanied by strong fiscal frameworks, it could pose a problem for countries with weak institutions, as debt could reach unsustainable levels.

Strong institutions and fiscal rules can help prevent crises and ensure sustainable growth by reducing the likelihood and impact of fiscal errors, managing revenue, and curbing risks from contingent liabilities (Acemoglu, & JohnsonRobinson, 2005a; 2005b). Strong fiscal frameworks can also lead to lower inflation and ease inflation volatility, and increase tax collection methods, thereby assisting the central bank in achieving its objectives (Kose, & NagleOhnsorgeSugawara, 2020; Woo, 2003). However, these rules will only work when a government is effective and has clearly defined budgetary frameworks (Celik et al., 2020). In countries with strong institutions, debt management is accompanied by other policy measures such as strategic planning to deal with prospective risks and guarantee sustainable fiscal policies (Balibek et al., 2019). Strong institutions, therefore, suggest greater government efficiency, regulatory quality and the control of corruption supporting the better use of fiscal frameworks.

Weak governance and institutions on the other hand, are often linked to debt distress, making institutional capacity and good governance crucial for identifying and managing risks (Lumpkin, 2009). A weak government, fragile regulatory quality and corruption can cause a large proportion of tax revenues to be channeled into unproductive activity, increasing debt levels. Weak institutions can similarly lead to an increase in unofficial activity and tax evasion, reducing tax revenues (Friedman et al., 2000), causing governments to resort to more borrowing to finance expenditure and investment. Countries with poor institutions often have bloated public sectors and high expenditures. Therefore, a weak and inefficient bureaucracy can distort the functionality of the public sector and change the structure of spending, increasing the debt burden of a country (Cooray et al., 2017; Dzhumashev, 2014; Tanzi & Davoodi, 2002). There is further, a greater likelihood for countries with weak institutions to accumulate debt because poor institutions lead to capital flight, which in turn, increases the need for borrowing (Cerra et al., 2008). Countries with weak governance structures, moreover, could find it difficult to separate monetary policy from debt management. Weak institutions can additionally undermine the reporting of debt.

This gives rise to another question. How do institutions affect public debt in countries with and without fiscal rules? Are fiscal rules more likely to be adopted by countries with stronger institutions? Given the recent rise in sovereign debt to alarming levels, an investigation of this issue is imperative. In this respect, the EU nations differ from non-EU nations in that, in addition to their national fiscal rules, they are governed by supranational fiscal rules (Davoodi et al.. 2022). The fiscal policies of the EU countries are coordinated to preserve debt sustainability. The Maastricht Treaty which was signed in 1992 was based on two rules, one, that government fiscal deficits must not exceed 3% of GDP and the other that public debt should not be above 60% of GDP (Regling, 2022). While the pandemic has no doubt affected the debt levels of these nations, higher debt levels do not necessarily mean that the debt in these countries pose sustainability risks (Regling, 2022). It is also well known that the EU countries in general, have stronger institutions (reflected in Table 2 and Fig. 1), permitting these countries to meet debt obligations. This is further supported by Masuch et al. (2017)

Table 1
Data description.

Description	Abr.	Source
General Government Debt (Percent of GDP)	Debt	IMF (2024a)
Government expenditure % of GDP	Gex	IMF (2024b)
Tax Revenue % of GDP	Tax	IMF (2014c)
Population growth (annual %)	Pop	WDI (2024)
GDP per capita (constant 2015 US$)	Pci	WDI (2024)
Inflation, GDP deflator (annual %)	INF	WDI (2024)
Unemployment rate (ILO estimate)[a]	Unp	WDI (2024)
Trade % of GDP[b]	Trade	WDI (2024)
Government effectiveness	GE	WDI (2024)
Rule of Law	RL	WDI (2024)
Regulatory quality	RQ	WDI (2024)
Voice and accountability	VA	WDI (2024)
Political stability	PS	WDI (2024)
Control of corruption	CC	WDI (2024)
Corruption Perceptions Index	CPI	Transparency International (2024)

[a] Inflation, GDP deflator (annual %) and Unemployment of 2022 data for Russian Federation retrieved from https://www.focus-economics.com/countries/russia/.

[b] Trade % of GDP of 2021 and 2022 data for Kyrgyz Republic retrieved from https://wits.worldbank.org/CountryProfile/en/Country/KGZ/StartYear/2017/EndYear/2021/Indicator/NE-TRD-GNFS-ZS and for the Panama retrieved from https://tradingeconomics.com/panama/trade-percent-of-gdp-wb-data.html.

who argue that the quality of institutions is an important factor contributing to the long run growth of European nations. The non-EU countries in contrast, do not have supranational rules that require fiscal policy coordination, and in general, have weaker institutions (see Table 2 and Fig. 2). Masuch et al. (2017) show that initial high levels of government debt together with weak institutional quality below that of the EU average is associated with low long-term economic growth.

Thus, the present study extends upon the existing literature in several respects: (1) we investigate the role of institutions on public debt for two groups of countries: the EU (27 countries) which has supranational fiscal rules and stronger institutions, and non-EU nations (27 countries), which do not have supranational fiscal rules and relatively weaker institutions. The study covers the period 2010 to 2022. (2) we test the model by employing several different methodologies including the Logistic Quantile Regression (LQR) method, the Recentered Influence Function (RIF) regression estimator, the Poisson Pseudo Maximum Likelihood (PPML) method, and the MM estimator (Robust Regression). We use the LQR and RIF as our baseline estimation method, as this methodology has the advantage of enabling the detection of changes in the association at different parts of the distribution of the dependent variable.

Our results suggest that government effectiveness, regulatory quality, the control of corruption, political stability, and voice, and accountability have a significant impact on countries in the EU, while in the non-EU nations, government effectiveness, regulatory quality and voice, and accountability have the highest impact when debt levels are round their median level. Political stability and the control of corruption have a significant and debt reducing effect only in the EU nations.

The rest of the study is structured as follows. Section 2 discusses the literature. Section 3 describes the data, model, and methodology. Section 4 discusses the empirical results, and the final section concludes.

2. Literature review

Despite the importance of institutions for public debt, only limited studies investigate the direct association between public debt and institutions at the country level. Tarek & Ahmed, (2017) in an investigation of whether governance influences public debt accumulation in the MENA countries over 1996 to 2015, find that poor governance leads to higher debt accumulation. Similarly, Cooray et al. (2017) in an empirical study of 126 countries over 1996–2012, find that corruption leads to an increase in public debt. Ben Ali and Al Yahya (2019) in an examination of the effect of governance on public debt in the Gulf nations over the 1996 and 2015 period, find that with the exception of corruption, improvements in all other governance indicators lead to a fall in public debt. In an older literature, Heylen et al. (2013) show that fiscal sustainability is more effective in the presence of a more efficient government in a study of 132 fiscal episodes for 21 OECD countries over 1981 to 2008. According to them, fiscal consolidation policies will be more credible and robust when undertaken by efficient governments as they are usually successful in cutting down on expenditures.

Most studies investigate the debt-institutions relation in the context of economic growth. Abbas and Christensen (2007) in an examination of the role of domestic debt on economic growth in a group of low-income and emerging countries over the 1975–2004 period, find that moderate levels of debt have a positive effect on economic growth through several channels including monetary policy, institutions, savings, and financial intermediation. Masuch et al. (2017) observe that the initial levels of the quality of institutions and public debt explain the long-term growth trajectory of Europe and argue that high initial levels of government debt combined with institutional quality below the EU average, lead to poor growth performance in countries. They find that the adverse effects of high debt levels on long-term economic growth is offset by the existence of strong institutions. In a study of debt and economic growth in low- and middle-income nations over the period 1990–2007, Presbitero (2012) notes that public debt has a negative effect on economic growth until it reaches 90 per cent of GDP. Beyond this threshold, public debt has no effect on economic growth. They attribute this to individual country-specific factors, as excessive debt can impede growth only in countries with macroeconomic stability and strong institutions. Law et al. (2021) similarly, in a study of debt and growth in seventy-one developing countries over 1984 to 2015, find a threshold debt value of 51.65 percent, which is below the value found in the prior literature. They argue that debt

Table 2
Descriptive statistics.

	EU Countries						non-EU Countries					
	Mean	S. D	Min.	Max.	Skew.	Kurt.	Mean	S. D	Min.	Max.	Skew.	Kurt.
DEBT	69.00	38.43	6.16	212.38	1.05	4.13	44.23	19.52	8.60	97.80	0.61	2.82
PCI	31176.6	21606.0	6427.81	110425.9	1.74	6.56	7083.1	5903.4	808.14	33719.3	2.01	8.63
GEX	45.27	7.36	21.22	64.89	−0.024	2.96	27.83	7.65	16.33	49.91	0.71	2.93
TAX	42.50	6.83	22.19	56.36	−0.30	2.74	24.96	7.61	12.46	44.65	0.69	2.73
POP	0.19	0.94	−6.18	3.93	−0.73	10.8	0.95	0.93	−2.21	3.21	−0.53	4.00
INF	2.31	2.57	−2.88	16.56	2.48	12.4	6.25	8.65	−1.28	96.03	6.17	54.64
Unp	8.56	4.61	2.01	27.47	1.59	5.84	6.27	4.55	0.14	28.01	2.25	10.46
Trade	132.7	68.5	51.19	393.1	1.61	5.77	77.49	34.29	22.77	162.48	0.42	2.08
VA	1.07	0.35	0.26	1.69	−0.33	2.33	−0.23	0.75	−1.68	1.15	−0.09	2.10
PS	0.72	0.35	−0.31	1.46	−0.42	2.91	−0.35	0.59	−2.00	1.01	0.06	2.65
GE	1.08	0.56	−0.27	2.23	−0.21	2.40	−0.06	0.59	−1.19	1.40	0.54	2.53
RQ	1.14	0.46	0.14	2.04	0.015	1.89	0.02	0.56	−1.33	1.53	0.45	2.95
RL	1.08	0.59	−0.14	2.12	−0.13	1.99	−0.27	0.61	−1.36	1.34	0.80	3.07
CC	0.967	0.78	−0.38	2.40	0.19	1.80	−0.36	0.55	−1.33	1.54	1.00	4.11
CPI	63.39	15.27	33	94	0.20	1.95	37.81	10.89	19	73	1.01	4.02

Notes: Panels have 351 observations and T: 13, N: 27.

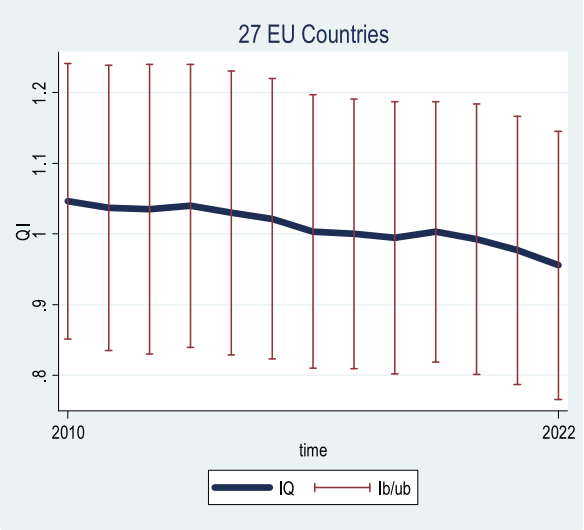

Fig. 1. Institutions EU
Note: Average of the six governance indicators.

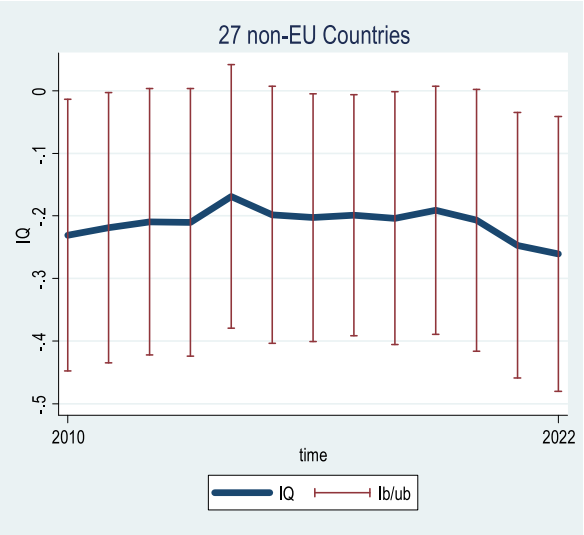

Fig. 2. Institutions non-EU.

has a statistically significant negative effect on economic growth at high levels of debt but an insignificant effect at low levels. The findings also show that stronger institutions reduce the negative impact of public debt on economic growth.

Van Rijckeghem and Weder (2009), find that strong political institutions together with other strong economic fundamentals, such as sufficient foreign exchange reserves, high growth and openness enable countries to avoid debt default in a group of low- and middle-income economies over 1974 to 2000. These arguments are confirmed by Guscina (2008). Guscina (2008) in an investigation of the role of macroeconomic, institutional, and political factors on the structure of government debt in emerging nations, finds that an unstable macroeconomic environment, weak institutions, and political uncertainty adversely affects the expansion of the domestic debt market. In a study of both developing and emerging economies over the 1970–2001 period, Cerra et al. (2008) argue that both institutions and macroeconomic policies affect capital flight. They show that nations with poor institutions are more likely to have higher debt levels as weak institutions lead to capital flight, increasing the need for borrowing.

There are studies which also suggest that larger deficits are associated with countries that have more ministers, greater ideological polarization in the executive, and with a proportional (as opposed to majoritarian) electoral system (see Crivelli et al., 2016; Persson & Tabellini, 2004; Woo, 2003). Studies also show that countries with more rent-seeking, political fragmentation, and political risk will incur larger government deficits, resulting in faster government debt accumulation. These predictions are in line with empirical studies on the determinants of government deficits (for example, Drazen, 2000).

While our study is related to the above literature, we aim to gain a better understanding of how institutions affect public debt in the EU which has supranational debt rules and compare it with a group of non-EU countries which are less encompassing. To the best of our knowledge, the existing literature does not make a clear distinction between the EU and non-EU nations in investigating the relation between institutions and public debt. This study will provide valuable insights into how the institutions-debt relation works in a more extensive rules-based system such as the EU compared to other countries.

3. Data, model and methodology

3.1. Data

The study covers data for 54 countries, 27 EU countries (Panel A) and 27 non-EU countries (Panel B) for the period 2010 to 2022. The non-EU countries were selected on the basis of data availability to obtain a balanced panel. The list of countries is given in the Appendix. We exclude the years of the Global Financial Crisis.

The dependent variable in the study is the ratio of government debt to GDP. Economic institutions, the main independent variables of interest, are measured by government effectiveness (GE), regulatory quality (RQ), and the control of corruption (CC). These variables are sourced from the Kaufmann et al. (2023) World Governance database. We leave out (i) voice and accountability (ii) political stability and (iii) rule of law from our baseline regressions as these variables relate more to democracy. Subsequent estimation includes these variables. These indices range from a −2.5 to +2.5, with higher values denoting stronger institutions. We also replace the control of corruption with the Corruption Perceptions Index (CPI) from Transparency International (TI) in a robustness check. These values range from 0 (totally corrupt) to 100 (not corrupt). We reverse the CPI index and rescale both indices so that they go from 0 to 10, so that higher values on the indices indicate higher levels of corruption for the empirical estimation (see Cooray and Schneider 2016).

A number of control variables are incorporated in the current study. Additional robustness checks are undertaken by incorporating the other governance indicators, the rule of law (RL), voice and accountability (VA), and political stability and absence of violence (PS). Government expenditure (Gex) is employed, as high government expenditure can lead to increased borrowing (Gupta et al., 2001; Tanzi & Davoodi, 2002). Evidence has shown that high tax revenues can reduce borrowing and government debt, therefore we include tax revenue (TAX) as a percentage of GDP in the model. High rates of population growth have implications for government budgets and debt levels (Korwatanasakul et al., 2021). Therefore, population growth (POP) is used as a control variable in our model. GDP per capita (constant 2015 US$) (PCI) in real terms is used as a proxy for the level of development of a country following the previous literature (Cooray et al., 2017; Apergis and Apergis, 2019). We use the GDP deflator (annual %) (INF), as higher inflation can increase interest payments on debt, leading to further increases in debt levels, or alternatively, reduce the real value of the debt stock (Reinhart & Rogoff, 2010). We use the unemployment rate (UN) to control for unemployment (Vogler & Rotte, 2000), because higher unemployment rates can lead to higher levels of borrowing. Trade as a % of GDP (Trade) is employed (Woo & Kumar, 2015) as, if exports exceed imports, debt levels can fall and if imports exceed exports, debt levels could increase.

Table 1 presents the variables, abbreviations, and sources.

Table 2 presents descriptive statistics for the data employed in the study. The results indicate that mean values of government effectiveness (GE), regulatory quality (RQ), rule of law (RL) and the control of corruption (CC) and the TI corruption perceptions index (CPI) in the EU sample are higher than in the non-EU countries. On the other hand, the standard deviations of GE and RQ are lower in the EU compared to non-EU countries. The skewness of GE, and RL in the EU are negative, while in the non-EU countries, they are positive. The values for kurtosis show that the CC and CPI are leptokurtic distributions in the non-EU countries and platykurtic distributions in the EU. Accordingly, the CC and CPI in the non-EU countries are farther away from the normal distribution compared to the EU.

Table 3 shows the partial correlations between government debt and the institutional variables, GE, RQ, CC. The results show that GE and RQ are significantly correlated with public debt in the EU. Government effectiveness has a positive significant correlation with government debt, while regulatory quality has a negative significant correlation with government debt in the EU. CC is insignificant in the EU countries. For the non-EU nations, RQ has a negative significant correlation with public debt, while government effectiveness and the control of corruption are positively and significantly correlated. These correlations suggest the need for further exploration to uncover greater understanding of the relation between government debt and the institutional variables.

3.2. Methodology and model

Following from the discussion above, our model takes the general form:

Table 3
Partial correlations of institutional variables with government debt.

	EU Countries		non-EU Countries	
Variables	Partial Corr.	Significance Value	Partial Corr.	Significance Value
GE	0.3483	0.0000	0.1511	0.0047
RQ	−0.5391	0.0000	−0.2307	0.0000
CC	0.0532	0.3213	0.0990	0.0648

$$y_i = x_i\beta + u_i$$

where y is government debt. x_i is a vector which includes all independent variables including our main variables of interest, the institutional variables, and u_i is a random error term.

We use several different methodologies to test our models. Our key estimator is the Logistic Quantile Regression (LQR) methodology of Bottai, and CaiMcKeown (2010) and Orsini and Bottai (2011).

When assuming a sample of n observations on the continuous outcome variable $y_i, i = 1, \ldots n$ and vector of covariates $x_i = (x_{1,i}, \ldots, x_{s,i})^T$. the quantile model is as follows.

$$y_i = x_i^T \delta_p + \mu_i \tag{1}$$

where the $\delta_p = (\delta_{p1}, \delta_{p2} \ldots, \delta_{pn})^T$ infer unknown regression parameters. The p quantile of the conditional distribution of y_i given x_i is defined as:

$$\theta_y(p) = x_i^T \delta_p \tag{2}$$

If $p = 0.5$, θ_y (0.5) is the conditional median, the value that splits the conditional distribution of the outcome variable into two parts with equal probability. In addition to this, the regression residual μ_i does not require any assumptions. Orsini and Bottai (2011) assume that for any quantile p there exists a fixed set of parameters δ_p and the nondecreasing function h from the interval (y_{min}, y_{max}) to the real line (many times referred to as a link), as follows:

$$h\left(Q_y(p)\right) = x_i^T \delta_p \tag{3}$$

Because a continuous outcome bounded within the unit interval resembles a probability, among a variety of suitable options for the link function h, the logistic transformation is:

$$h(y_i) = log\left(\frac{y_i - y_{min}}{y_{max} - y_i}\right) = logit(y_i) \tag{4}$$

When integrating Equation (3) and Equation (4), the inverse transform is:

$$Q_y(p) = \frac{Exp\ \left(x_i^T \delta_p\right) y_{\max}\ + y_{min}}{1 + \exp\ \left(x_i^T \delta_p\right)} \tag{5}$$

The regression coefficients can be estimated via quantile regression by the transformed outcome $h(y_i)$ on x. The logistic regression is:

$$\theta_{h(y_i)}(p) = Q_{logit(y_i)}(p) = x_i^T \delta_p \tag{6}$$

Bootstrapping standard errors in inference about δ_p in quantile regression outperform asymptotic ones (Orsini & Bottai, 2011).

We estimate the logistic quantile for 4 different quantiles (0.10, 0.30, 0.70, 0.90). The advantage of using the quantile regression method is that it allows for analysing relationships between variables outside the mean of the data. This methodology provides for an understanding of outcomes that are non-normally distributed and have nonlinear associations with independent variables. The LQR method is effective for interval data of the dependent variables (Orsini & Bottai, 2011) and is also more robust to outliers. We normalize debt, by employing the natural logarithm of debt. This new series (lnDebt) is situated within an interval.

Figs. 3 and 4 show averages of a single outcome measured at several points over time. Fig. 3 illustrates the range of normalized Debt values for the EU countries, which fall within the average interval of 3.7–4.4. Fig. 4 illustrates the range of normalized Debt values for

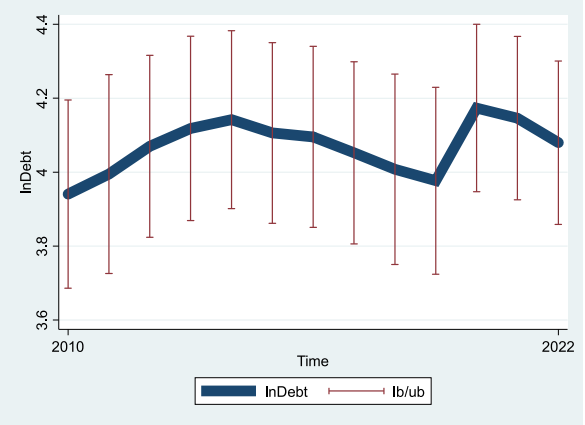

Fig. 3. Average lnDebt for the EU.

non-EU countries which fall within the average interval of 3.1–4.1.

In order to check the robustness of the results we also employ the Poisson Pseudo Maximum Likelihood (PPML) method developed by Silva and Tenreyro (2011). The PPML method is robust to heteroskedasticity in the error terms. It also has the advantage of producing unbiased estimates of the original nonlinear model in the presence of a large number of zeros in the dependent variable (Silva & Tenreyro, 2010).

We also employ the MM estimator (Robust Regression) adapted to Stata by Verardi and Croux (2009) to ensure that the estimates are robust to outliers. The MM robust estimator proposed by Yohai (1987), has the highest potential breakdown point, 0.5, and high efficiency under normality. We report results for two points (MM 0.70 and MM 0.90).

One may argue that LQR is not suitable when the outcome variable is continuous Therefore, we utilize the Recentered Influence Function (RIF) regression methodology proposed by Firpo et al. (2009) to investigate the unconditional partial effects on quantiles within a regression analysis framework. Unconditional quantile regression (UQR) or RIF on quantiles is particularly useful when the dependent variable is continuous with outliers (Araki, 2023). The RIF regression method is highly resistant to the impact of outliers or other distortions on regression results, which enhances its reliability and robustness. This regression approach combines parametric and non-parametric models and does not require specific assumptions about the distribution of the error term or the dependent variable. It is suitable for continuous outcomes with significant mean effect estimates (Rios-Avila, 2020).

4. Empirical findings

Table 4 presents the LQR findings in the Quantiles column, the PPML results in the column labeled PPML and robust regression estimation in the columns labeled Robust Regression. We carry out 100 bootstrap replications in the LQR method. The estimation is carried out for both EU and non-EU nations. First, let's look at the findings for the EU. The quantile logit regression model suggests that the estimated coefficients for government effectiveness (GE) are positive and significant at the 1% level in the 10th and 30th quantiles and 10% level in the 70th quantile, implying that when debt levels are low, that government effectiveness is high. This is reasonable as these nations have debt rules, and low debt levels suggesting greater fiscal discipline. This is consistent with the arguments of Bergman et al. (2016) who find that fiscal rules and government effectiveness are substitutes in advancing fiscal sustainability, and that the effect decreases as government efficiency rises. Regulatory quality (RQ) has a negative significant impact on debt at the 1% level in all quantiles, reaching a peak at medium levels, suggesting that when public debt is at the median, the impact of regulatory quality is high. This is consistent with the findings of Berggren and Bjørnskov (2019) who show that regulatory freedom, especially access to greater credit, reduces the accumulation of debt. The control of corruption (CC) has a negative significant effect on public debt with a coefficient of −0.52 in the 10th quantile, implying that the control of corruption has a higher impact in countries with lower levels of debt.

Taking a look at the results for non-EU countries, the estimates for GE are positive and significant at the 1% level in the 30th and 70th quantiles, suggesting that when public debt is at medium levels, the impact of government effectiveness is high. RQ is negative and significant in the last three quantiles, implying that medium levels of debt are associated with a higher effect of regulatory quality. It is possible that as government debt rises from low to medium levels, that the effects of regulation and government policies are felt. The CC is not statistically significant, indicating that the control of corruption has no impact for high and low debt countries in the non-EU group.

4.1. Robustness checks

4.1.1. Different methodologies

We undertake a number of robustness checks which are also reported in Table 4. First, we re-estimate the model by employing a

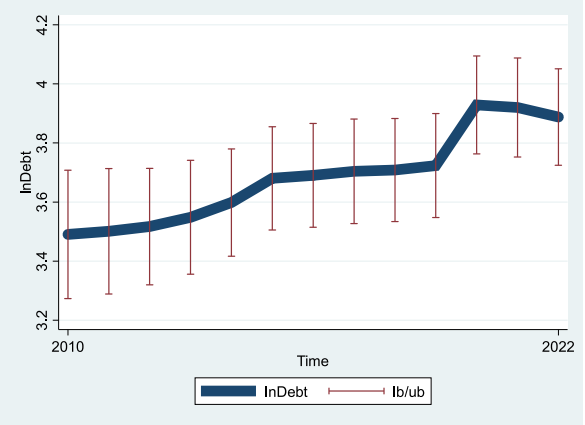

Fig. 4. Average lnDebt for non-EU Countries.

Table 4
Logistic quantile, PPML FE and Robust Regression results.

Dependent variable lnDebt	EU Countries							non-EU Countries						
	Quantiles				PPML FE	Robust Regression		Quantiles				PPML FE	Robust Regression	
	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90
GE	1.90[a]	1.13[a]	0.68[c]	−0.33	0.23[a]	0.60[a]	0.69[a]	−0.32	0.41[a]	0.79[a]	0.89	0.06[a]	0.35[a]	0.28[a]
RQ	−1.89[a]	−1.66[a]	−2.36[a]	−1.49[a]	−0.39[a]	−1.31[a]	−1.38[a]	−0.46	−0.63[a]	−0.85[b]	−1.72[a]	−0.09[a]	−0.40[a]	−0.37[a]
CC	−0.52[a]	0.05	0.69[a]	0.43[b]	0.02	0.43[c]	0.26[a]	0.56	0.19	0.04	0.72	0.03	0.07	0.13
Constant	0.43[b]	0.90[a]	2.29[a]	3.18[a]	1.57[a]	4.55[a]	4.69[a]	−0.20	0.26[a]	1.14[a]	2.35[a]	1.32[a]	3.79[a]	3.80[a]
Mean VIF	8.16							3.51						
Q (p)-stat	15.27 [0.000]							17.23 [0.000]						
LM (k)-stat	3.93 [0.0000]							4.15 [0.000]						
HR-stat	0.59 [0.553]							−1.54 [0.123]						
lnDebt Bounded Outcome	(1.818156, 5.3584152)							(2.1526138, 4.5829278)						

Notes: "( )" parentheses indicate that open interval. [a] and [b] indicate statistical significance at 1% and 5% respectively. We estimated standard possion regression and vce robust version then we robustness checked these findings with the heterogeneous fixed effect version on iterations developed by Correia et al. (2020, 2021), and we reported Ppml FE version.

number of additional econometric techniques. The PPML estimation is undertaken as stated above, to account for heteroskedasticity in the error terms and the presence of zeros in the dependent variable (Silva & Tenreyro, 2010). The PPML fixed effect estimation for the EU for the GE and RQ variables is consistent with the LQR findings. The coefficient on GE is consistent with the quantile regression results for the 10th and 70th quantiles. The coefficient is positive and significant at the 1% level, suggesting that an increase in government effectiveness leads to an increase in public debt. Similarly, the results for RQ exhibit a negative significant effect on public debt at the 1% level. The control of corruption is not statistically significant.

Taking a look at the Robust Regression results, the findings for GE for the EU are consistent with the PPML fixed effect and LQR for the 10th and 30th quantiles. GE is positive and significant at both the 70 and 90 breakpoints. The robust regression coefficients are also consistent for regulatory quality, negative and statistically significant at the 1% level, suggesting that the conditional distribution of public debt will fall with an increase in RQ. Consistent with the LQR and PPML fixed effect results, the coefficient on the CC is statistically significant.

Next, let's take a look at the estimates for the non-EU countries. The coefficient on the PPML fixed effect estimation and the robust regression coefficients are positive and significant for GE, as in the 30th and 70th quantiles of the LQR estimation. The coefficients on RQ are negative and significant under both the PPML fixed effect and robust regression methods, consistent with the LQR findings. The control of corruption is not statistically significant under both methods.

We report model specification tests for serial correlation in the model, heteroskedasticity and model bias (i.e. model bias-corrected). We employ the Q (p)-stat, LM (k)-stat and HR test developed by Born and Breitung (2016). The tests suggest that the model is correctly specified.

We also carry out robustness checks on our LQR findings with Recentered Influence Function (RIF) which is reported in Table 5. The RIF regression findings for the EU show that government effectiveness (GE) is positive and significant at the 1% level in the 10th, 30th and 70th quantiles, respectively. Regulatory quality (RQ) has a negative significant impact on debt at the 1% level in all quantiles. The control of corruption (CC) has a significant negative effect on public debt in the 10th quantile, but this effect is positive in the 70th quantile, consistent with our previous results. Findings for the non-EU countries show that the estimates for GE are positive and significant at the 1% level in the 30th and 70th quantiles. RQ is negative and significant also in the last three quantiles. The CC is positive and significant at the 5% level in the 30th quantile, suggesting that the control of corruption has an increasing effect on debt. The RIF and LQR findings are consistent except in the case of the CC for the non-EU group.

Graphical representation can be useful as the results for the quantiles can be presented in a graph. The x axis in Fig. 5 shows the quantiles ordered from 0.10 to 100 and the vertical axes shows the effects of the different institutional variables, GE, RQ, CC for the EU on the left-hand side and non-EU countries on the right-hand side, based on the estimation in Table 5. The red and blue line in the figures show the movement in institutional variables from the 10th through to the 100th quantile and the grey area shows the 95% confidence bands for the regressions calculated by bootstrapping with 100 replications. All the figures exhibit the unconditional quantile estimates, shown by the black line. The figures show that the quantile regression model provides more in-depth information, as the coefficient estimates are not constant across the quantiles (see Fig. 6).

The coefficient on GE for the EU is positive up to about the 95th percentile, and negative at higher quantiles. The coefficient is largest at lower quantiles, suggesting that GE has the greatest impact in countries with lower debt levels in the EU. In non-EU countries, a negative association with government debt is shown at the lower quantiles, positive in the middle and high quantiles, implying that GE has the greatest impact on debt at medium levels. RQ is negative and significant in the EU in all quantiles. There is not much of a variation in RQ across the quantiles in the non-EU group. The coefficient on CC for the EU is negative at the 10th quantile, then positive at higher quantiles. The CC keeps rising as debt levels increase in EU nations, while in non-EU nations, it remains relatively constant and then decreases.

4.1.2. Replacing the corruption index

Next, we replace the control of corruption in the World Bank governance indicators, with the Transparency International corruption index. The results are reported in Table 6. These findings are broadly consistent with what we obtained in Table 4 for the two groups, except in the case of the control of corruption for the non-EU nations. The CC has a positive significant effect on debt levels across the quantiles. It is possible that in countries with weak institutions that the control of corruption has no effect or increasing effect on public debt.

Table 5
RIF Regression results.

Dependent variable lnDebt	EU Countries				non-EU Countries			
	Quantiles				Quantiles			
	0.10	0.30	0.70	0.90	0.10	0.30	0.70	0.90
GE	1.2[a]	0.98[a]	0.66[a]	0.02	−0.01	0.27[a]	0.44[a]	0.10
RQ	−1.1[a]	−1.6[a]	−1.7[a]	−1.0[a]	−0.25	−0.43[a]	−0.35[a]	−0.36[a]
CC	−0.41[b]	0.22	0.39[a]	0.25	0.21	0.23[b]	0.05	0.18
Constant	3.76[a]	4.36[a]	5.26[a]	5.66[a]	3.21[a]	3.59[a]	4.04[a]	4.34[a]
Sample Mean RIF	3.4553	3.7552	4.3945	4.7916	3.1344	3.4778	3.9843	4.2585

Notes: [a], [b] indicate statistical significance at 1%, and 5% respectively.

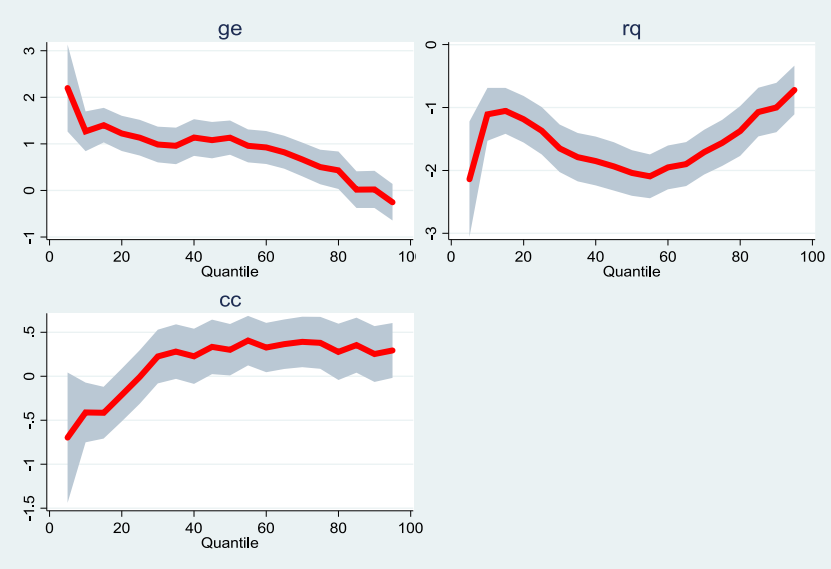

Fig. 5. RIF quantile coefficient for EU

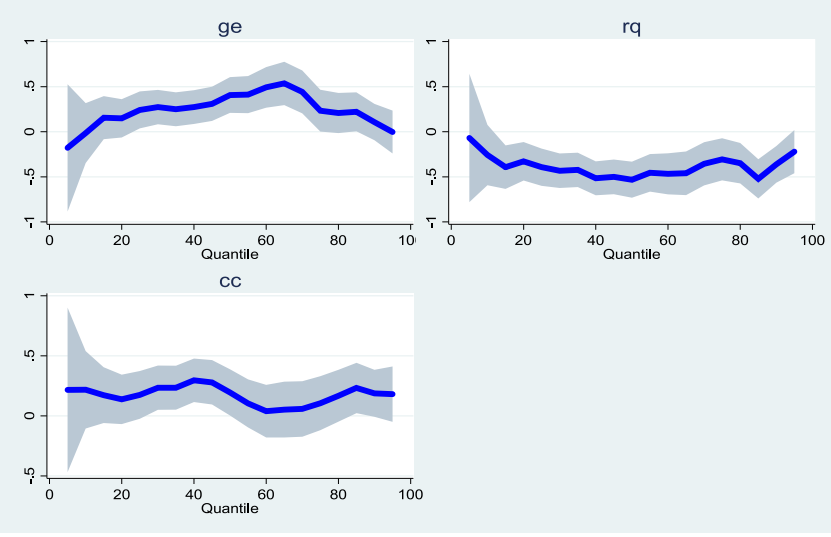

Fig. 6. RIF quantile coefficient for non-EU countries.

4.1.3. Additional control variables

We incorporate a number of additional control variables into the model and re-estimate it. The results are reported in Table 7.

In the EU, GE continues to have a positive and significant effect in all quantiles under the LQR method. The coefficient is positive and significant also under the PPML fixed effect and robust regression techniques, suggesting that the conditional distribution of public debt will benefit from an increase in government effectiveness. The estimates for RQ are consistent and have a negative and significant effect under all three estimation techniques. The coefficients on CC gain statistical significance, reflecting that the control of corruption leads to a fall in public debt across the distribution.

Taking a look at the regression coefficients on the control variables, per capita GDP (PCI) is positive and significant in all quantiles including the PPML fixed effects and robust regression techniques, suggesting that PCI has a significant impact on debt in the EU in all high debt and low debt countries. Similarly, the regression coefficients on government expenditure (Gex) are significant and positive in all quantiles, and also under the PPML fixed effects method, suggesting that Gex has a significant positive impact on public debt levels. If government expenditure is debt financed, then it would lead to an increase in government debt. Alesina and Tabellini (1990) argue that disagreement between policy makers can lead to greater deficits and government debt. The majority of countries in the EU sample have coalition governments, and policy differences are more likely to occur in countries with coalition governments (Roubini & Sachs,

Table 6
Robustness check with lnCPI.

Dependent variable ln	EU Countries							non-EU Countries						
	Quantiles				PPML FE	Robust Regression		Quantiles				PPML FE	Robust Regression	
	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90
GE	1.9[a]	1.1[a]	0.81[b]	−0.10	0.24[a]	0.62[a]	0.68[a]	−0.41	0.27	0.34	−0.10	0.038[b]	0.30[a]	0.22[a]
RQ	−1.9[a]	−1.6[a]	−2.0[a]	−1.1[a]	−0.38[a]	−1.2[a]	−1.3[a]	−0.55[b]	−0.68[a]	−1.18[a]	−1.26[b]	−0.11[a]	−0.44[a]	−0.41[a]
lnCPI	−1.7[b]	0.16	0.6	0.27	0.02	1.27[a]	0.88[a]	1.83[b]	0.86[a]	1.72[a]	3.17[a]	0.18[a]	0.37[a]	0.51[a]
Constant	6.99[a]	0.25	−4.3	1.9	1.46[a]	−0.34	1.29	−6.96[b]	−2.88[a]	−5.01[b]	−9.49[a]	0.65[a]	2.43[a]	1.91[a]
Mean VIF	6.51							3.47						
Q (p)-stat	13.90 [0.000]							17.65 [0.000]						
LM (k)-stat	3.5 [0.000]							4.20 [0.000]						
HR-stat	1.30 [0.193]							−1.56 [0.119]						

Notes: [a] and [b] indicate statistical significance at 1% and 5% respectively. LQR have Bootstrap (100). We estimated standard possion regression and vce robust version then we robustness checked these findings with the heterogeneous fixed effect version on iterations developed by Correia et al. (2020, 2021), and we reported Ppml FE version.

Table 7
Robustness checks with additional control variables.

Dependent variable lnDebt	EU Countries							non-EU Countries						
	Quantiles				PPML FE	Robust Regression		Quantiles				PPML FE	Robust Regression	
	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90
lnPCI	1.1[a]	0.88[a]	1.0[a]	1.5[a]	0.17[a]	0.79[a]	0.83[a]	−0.71[a]	−0.41[a]	−0.28[a]	0.04	−0.04[a]	−0.11[a]	−0.15[b]
lnGEX	2.2[a]	2.3[a]	2.0[b]	1.9[b]	0.41[a]	0.73[a]	1.0[a]	2.5[a]	3.8[a]	4.7[a]	5.4[a]	0.62[a]	1.9[a]	2.0[a]
lnTAX	−1.2[b]	−0.96[b]	−1.0	−0.76	−0.27[a]	0.13	−0.27	−3.0[a]	−2.9[a]	−3.1[a]	−3.9[a]	−0.45[a]	−1.0[a]	−1.2[a]
POP	−0.005	−0.02	−0.01	−0.09	−0.008	−0.008	−0.01	−0.17	−0.001	0.11[b]	−0.004	0.007	0.11[a]	0.06[a]
INF	−0.002	−0.008	−0.05[b]	−0.04	−0.005[a]	−0.03[a]	−0.03[a]	−0.02	−0.02	−0.002	0.001	−0.001	−0.001	−0.002
lnUN	−0.12	−0.13[b]	−0.12	−0.03	−0.02[a]	−0.03	−0.06[c]	0.51[a]	0.23[a]	0.107[b]	0.17[a]	0.02[a]	0.05[b]	0.04
lnTrade	−0.89[a]	−0.72[a]	−0.20	−0.20	−0.09[a]	−0.08	−0.07	1.1[a]	0.44[a]	0.03	−0.48[b]	0.04[a]	0.02	0.03
GE	1.0[a]	0.77[a]	0.26	0.72[b]	0.17[a]	−0.01	0.14	1.5[a]	1.2[a]	0.81[a]	0.38	0.11[a]	0.44[a]	0.42[a]
RQ	−0.96[a]	−0.86[a]	−0.99[a]	−1.2[a]	−0.20[a]	−0.73[a]	−0.76[a]	−1.3[a]	−0.68[a]	−0.23	0.18	−0.05[a]	−0.14[a]	−0.13[a]
CC	−1.1[a]	−0.92[a]	−0.46[b]	−1.2[a]	−0.15[a]	−0.12	−0.29[a]	0.20	−0.12	0.09	−0.48	0.01	0.09	0.12
Constant	−9.34[a]	−9.30[a]	−11.1[a]	−15.5[a]	−0.23	−5.65[a]	−5.89[a]	2.16	−1.43	−2.59[a]	−2.63	0.86[a]	1.43[a]	1.86[a]
Mean VIF	5.69							3.73						
Q (p)-stat	15.05 [0.000]							19.39 [0.000]						
LM (k)-stat	3.93 [0.000]							4.44 [0.000]						
HR-stat	1.70 [0.089]							−3.37 [0.713]						

Notes: [a] and [b] indicate statistical significance at 1% and 5% respectively. LQR Bootstrap (100). We estimated the standard possion regression and checked these findings with the heterogeneous fixed effect version on iterations developed by Correia et al. (2020, 2021).

1989). The impact of tax revenues (TAX) is significant at the lower end of the debt distribution, implying that countries with lower debt levels experience the largest tax revenues. The regression coefficients on population growth (POP) are insignificant under all three estimation techniques. The coefficients on inflation (INF) are negative and significant under the LQR and PPML fixed effects method, implying that countries facing debt tend to experience higher inflation rates (Reinhart & Rogoff, 2010). The coefficient on unemployment (UN) are negative and significant in the lower quantiles under the LQR, suggesting that countries with higher debt levels face lower unemployment rates. The results suggest that Trade leads to a fall in public debt. An increase in exports can lead to a fall in public debt.

Taking the non-EU countries, GE continues to be positive and statistically significant from the 10th through to the 70th quantile. The coefficient on GE is also positive statistically significant under the PPML fixed effects and robust regression methods. RQ is similarly negative and significant from the 10th through to the 30th quantile and is also negative and significant under the PPML fixed effects and robust regression techniques. The control of corruption is not statistically significant, under the LQR method, and robust regression estimation.

The regression coefficients on per capita GDP (PCI) are negative and statistically significant, indicating that counties with higher levels of debt tend to face lower PCI levels in the non-EU economies, as opposed to the EU countries. The regression coefficients of government expenditure are positive and significant under all methods and in all quantiles, implying that Gex leads to an increase in debt. The coefficients on Gex are smaller for the EU, compared to the non-EU nations, suggesting that increases in government expenditure lead to greater increases in public debt in the non-EU countries. The regression coefficients on tax revenue (TAX) in all quantiles and under all methods are negative, suggesting that an increase in tax revenues lead to a fall in public debt in the non-EU countries. These findings are stronger than that for the EU countries. The regression coefficient on population growth is positive and significant in the 70th quantile under the LQR method, and under the robust regression technique, unlike for the EU. As non-EU countries have a relatively higher population growth rate compared to the EU countries, these results are convincing. For inflation, the regression coefficients are insignificant under the LQR method. The regression coefficient on unemployment is significant all quantile and decrease on public debt under the all estimators. These findings may indicate a crowding-out effect for non-EU countries with relatively high unemployment rates. The regression coefficient on trade is positive and significant in the 10th and 20th quantile and negative and significant in the 90th quantile. This result suggests that increases in trade is met with an increase in debt, probably due to a higher volume of imports.

4.1.4. Political and social institutions

Finally, we re-estimate the models employing the political and social institutional variables which include political stability (PS) and voice and accountability (VA), and rule of law (RL) from the Worldwide Governance Indicators. The results are broadly consistent with what we obtained in Table 8 for the EU and non-EU countries.

Table 8 presents findings for the EU and non-EU nations. For the EU, political stability has a negative significant effect on debt in the 70th and 90th quantile, and it is significant only 10th quantile in the non-EU countries. Voice and accountability has a positive and statistically significant effect on debt in the higher quantiles under the LQR estimation technique suggesting that the impact of voice and accountability increase as debt levels increase. This is probably because increased voice and accountability hold a government accountable for their actions, and demand greater transparency, requiring the disclosure of public debt. In the non-EU countries too, the results for the control variables are consistent with previous findings. As in the EU group, VA is positive and significant in the higher quantiles. Evidence has shown that high levels of public debt has led to protests among citizens in a number of countries including Turkey, Brazil, Egypt among others demanding greater accountability and transparency. The rule of law (RL) is insignificant.

In the EU, GE continues to have a positive and significant effect. The estimates for RQ are consistent and have a negative and significant effect under all three estimation techniques. The CC is negative and significant reflecting that it leads to a fall in public debt across the distribution. The coefficient estimates on the control variables are broadly consistent with the results in Table 8.

5. Conclusion

In this study we investigate the effect of institutions on public debt in two groups of countries, namely, the EU and non-EU nations. Our findings show that government effectiveness, regulatory quality, voice, and accountability have similar effects in the EU and non-EU countries. However, political stability and the control of corruption have a significant and debt reducing effect only in the EU countries.

The findings reveal some interesting conclusions. We find that in general, that all institutional variables, government effectiveness, the control of corruption, political stability, regulatory quality and voice and accountability have a significant impact on debt in the EU nations which have supranational debt rules, while in the non-EU nations with no supranational debt rules, government effectiveness, regulatory quality and voice and accountability have the highest impact when debt levels are round their median level. The results suggest that strong institutions effectively help contain debt in the EU. Strong institutions in these countries would support strong fiscal frameworks and budgetary sustainability. In the non-EU group with weaker institutions, the control of corruption and political stability has no significant impact on debt levels. In fact, in some estimations, the control of corruption had a positive effect on debt levels. It is possible that in this group, that political instability and corruption have made it difficult for governments to make credible commitments to reducing debt.

Looking at the control variables, a notable finding is that GDP per capita growth has a significant increasing impact on debt levels in the EU, while in the non-EU group, countries with higher levels of debt have lower PCI growth rates. Similarly, results show that government expenditure has a stronger positive impact on public debt in the non-EU group as opposed to the EU group. Tax revenues

Table 8
Robustness checks with additional political and social institutions control variables.

Dependent variable LnDEBT	EU Countries							non-EU Countries						
	Quantiles				PPML FE	Robust Regression		Quantiles				PPML FE	Robust Regression	
	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90	0.10	0.30	0.70	0.90		MM 0.70	MM 0.90
lnPCI	1.2[a]	0.62[a]	0.65[a]	0.77[a]	0.15[a]	0.66[a]	0.66[a]	−0.35	−0.24[b]	−0.21	0.10	−0.03[a]	−0.07[b]	−0.10
lnGEX	1.9[a]	2.2[a]	1.23[b]	1.3	0.37[a]	0.76[a]	0.95[a]	2.9[a]	3.6[a]	4.5[a]	6.3[a]	0.61[a]	1.8[a]	1.9[a]
lnTAX	−0.91	−0.54	0.16	−0.86	−0.23[a]	0.19	−0.07	−3.1[a]	−2.2[a]	−2.9[a]	−4.7[a]	−0.41[a]	−0.88[a]	−1.0[a]
POP	−0.01	−0.02	−0.03	−0.25[a]	−0.009	0.002	−0.01	−0.02	0.05	0.13[b]	−0.04	0.01[a]	0.13[a]	0.06[b]
INF	−0.007	−0.003	−0.03[b]	−0.06[a]	−0.005[b]	−0.02	−0.03[a]	−0.04[b]	−0.02	−0.004	−0.004	−0.001	−0.001	−0.001
lnUN	−0.11	−0.17[a]	−0.08	−0.21	−0.02[a]	−0.04	−0.06	0.42[a]	0.08	0.10[b]	0.09	0.01	0.04[b]	0.02
lnTrade	−0.93[a]	−0.62[a]	−0.01	0.15	−0.07[a]	0.0004	0.01	1.4[a]	0.36[b]	0.01	−0.17	0.04[a]	0.03	0.03
GE	0.99[a]	0.58[b]	0.17	0.54[b]	0.15[a]	0.092	0.15	1.08[a]	1.28[a]	0.84[a]	0.72	0.13[a]	0.42[a]	0.54[a]
RQ	−1.1[a]	−1.03[a]	−1.3[a]	−1.5[a]	−0.23[a]	−0.78[a]	−0.86[a]	−1.4[a]	−1.23[a]	−0.78[a]	−1.0[b]	−0.14[a]	−0.36[a]	−0.44[a]
CC	−1.4[a]	−0.96[a]	−0.60[b]	−1.11[a]	−0.17[a]	−0.17	−0.33[a]	−0.29	−0.27	−0.13	−0.81	−0.02	−0.05	−0.04
RL	0.50	0.06	0.21	0.55	0.05	−0.07	0.03	0.56	0.10	0.30	0.38	0.02	0.23[a]	0.04
PS	0.06	−0.22	−0.56[a]	−0.95[a]	−0.04[b]	−0.26[a]	−0.25[a]	−0.29[b]	0.06	0.07	0.21	0.008	−0.02	0.05
VA	−0.19	0.91[b]	1.3[a]	1.6[a]	0.08	0.42	0.51[a]	0.40	0.47[a]	0.25[b]	0.55[a]	0.05[a]	0.07[b]	0.17[b]
Constant	−10.3[a]	−8.5[a]	−10.0[a]	−7.86	−0.13	−5.30[a]	−5.06	−3.07	−3.79[a]	−2.93	−4.12	0.64	1.01[a]	1.49[a]
Mean VIF	7.94							4.67						
Q (p)-stat	12.63 [0.000]							20.36 [0.000]						
LM (k)-stat	3.56 [0.000]							4.55 [0.000]						
HR-stat	1.21 [0.227]							−0.34 [0.737]						

Notes: [a] and [b] indicate statistical significance at 1% and 5% respectively. LQR ootstrap (100). We estimated the standard possion regression and robustness-checked these findings with the heterogeneous fixed effect version on iterations developed by Correia et al. (2020, 2021).

on the contrary, have a stronger negative effect on government debt in the non-EU economies, while inflation has a stronger negative effect on debt in the EU. Trade has a stronger impact on debt in the EU compared to the non-EU nations.

In non-EU countries, most of the institutional variables are not statistically significant at the higher and lower quantiles, suggesting that low and high levels of debt in this group are associated with a lower impact of institutions. The results suggest the need for non-EU nations to increase political stability. The results also suggest the need for more stringent measures for controlling corruption to reduce public debt levels in this group.

As high levels of public debt require cutting down on expenditure and increasing tax revenues, it can adversely affect private investment, increase budget deficits, reduce welfare payments, and reduce a governments' capacity to undertake reforms. But when government expenditure on social welfare is reduced and taxes increased, it can negatively impact upon lower income groups, increasing poverty and unemployment in non-EU nations.

This gives rise to the debate of whether indebted countries should focus on growth first, even if it means fiscal expansion, or, whether they should they reduce debt first, even if it means lower growth, and this debate, continues to date. Stronger institutions can lead to lower levels of public debt and an environment that is conducive to growth.

Author statement

This is to declare that we have no competing interests.
Arusha Cooray and Ibrahim Özmen.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

Data will be made available on request.

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Appendix. The country List

EU countries		Non-EU Countries	
Austria	Bulgaria	Belarus	Kyrgyz Republic
Belgium	Czech Republic	Bosnia and Herzegovina	Moldova
Cyprus	Croatia	Brazil	Nicaragua
Denmark	Greece	Cambodia	Panama
Estonia	Hungary	China, People's Republic of	Philippines
Finland	Italy	Colombia	Peru
France	Latvia	Egypt	Russian Federation
Germany	Lithuania	El Salvador	Tanzania
Ireland	Luxembourg	Honduras	Thailand
Malta	Poland	Indonesia	Chile
Netherlands	Romania	India	Costa Rica
Portugal	Slovakia	Kazakhstan	Malaysia
Sweden	Slovenia	Korea, Republic of	
	Spain	Mauritius	
		Türkiye, Republic of	
27 countries, Time:13 (N:27, T:13), Obs: 351		27 countries, Time:13 (N:27, T:13), Obs: 351	

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