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# EXTERNAL DEBT AND GROWTH IN HIGHLY LEVERAGED MENA COUNTRIES WHEN INTEREST RATES ARE FALLING

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SUSTAINABLE DEVELOPMENT GOALS
AND EXTERNAL SHOCKS IN THE MENA REGION:

FROM RESILIENCE TO CHANGE IN THE WAKE OF COVID-19

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# External Debt and Growth in Highly Leveraged MENA Countries When Interest Rates Are Falling

## ERF-1

**Abstract:** Due to the outbreak of the COVID-19 pandemic, external debt of developing countries and economies in transition accumulated debt that that is worth US$9.9 trillion. This is the greatest level on record given the time period and is more than twice the level of the US$4.4 trillion debt registered in the aftermath of the 2008-2009 global financial crisis. Fueled by a policy of Central Bank quantitative easing, a clear declining trend in interest rates has emerged in world markets. Both yields on government bonds and interbank offer rates dropped precipitously in many European countries including Japan and have recently turned negative. A combination of lower interest rates and sluggish economic growth in developing countries has translated into a sharp rise in the ratio of external debt to income from an average of 61% in 2015 to 82% in 2019 in six highly leveraged countries in MENA. Using a panel quantile regression technique, we explore the relationship between external debt and economic growth by delving into the experiences of highly indebted countries in the MENA region (Bahrain, Egypt, Jordan, Lebanon, Morocco and Tunisia) during 2006-2019. Our findings provide a support for the hypothesis that high debt reduces economic growth, underscoring that these countries failed to utilize the external debt wisely and prudently. While this effect seems not homogeneous across the various quantile levels, it is necessary to take into account the economic circumstances of countries when accumulating debt. Our result remain robust after controlling for endogeneity.

**Keywords:** External debt to GDP; economic growth; Panel quantile regression; Endogeneity bias.

## 1. Introduction

Countries, whether developed or developing, recourse to debt financing for different reasons. They may borrow money to feed this budget deficits when their government revenues cannot keep up with their domestic expenditures. They may also use debt to enhance their infrastructure to promote economic growth, particularly in an environment of low interest rates. This second strategy may be or may be not the right one for six Arab countries that are highly indebted, which has motivated us to embark on this project. The literature is also divided on the impact of debt on economic growth which gives room for this study (Raham et al., 2019).

The main objective of this study is to examine whether the debt-to-GDP ratio has a negative or positive impact on different quantiles of economic growth for the six countries in the MENA region during a period when the trend in interest rates worldwide was generally declining and recently negative (Figure 1). In this regard, does it make sense to incur debt to promote economic growth when growth is low or high? Another objective of this study is to investigate the impacts of other variables including gross capital investment, military expenditures, open trade, global geopolitical risk and global economic uncertainty index on the quantiles of economic growth.

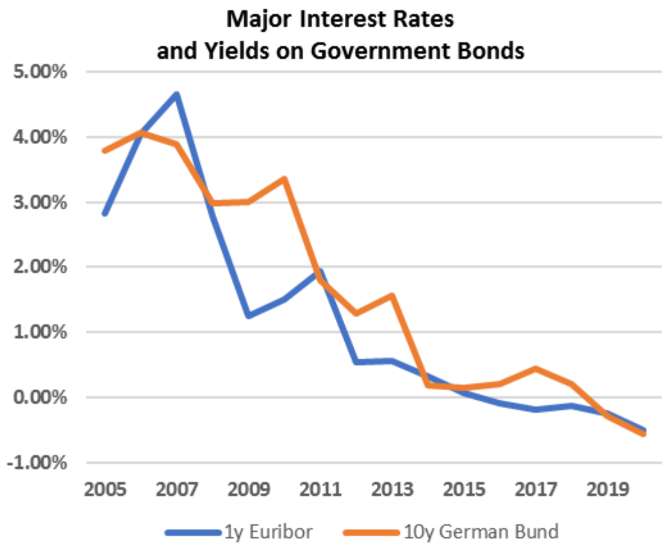

*Figure 1*

The contribution of this study to the literature is three-fold:

(i) Unlike research in the existing literature dealing with on the focal issue, our research utilizes the quantile regressions to investigate the impact of the independent variables on economic growth for highly indebted developing countries. More specifically, this study uses a panel quantile regression approach to explore, from a new perspective, the relationship between external debt and economic growth. One of the most appealing characteristics of this econometric tool is its ability to estimate specific effects that precisely describe the effect of covariates not solely on the center or the mean effect but also on the tails of the distribution. Whilst the mean effect provides far-reaching summary statistics of the effect of a covariate, it fails to fully depict the distributional impact of the independent variable on the dependent variable. One of the main characteristics of the quantile regression technique is its capability to enable the estimated slope parameter to fluctuate with varying quantile levels of the dependent variables (i.e., the economic growth). This would in turn help to offer fresh and accurate insights on the impacts of external indebtness on economic growth, depending on various economic conditions including favorable (high economic growth) and unfavorable (low economic growth).

(ii) Our study focuses on the impact of the debt-GDP ratio in the MENA region on different quantiles of their economic growth. This contribution is important in light of the historic low interest rate environment that conquered the world after the 2008 global financial crisis.

(iii) Dealing with endogeneity in conditional quantiles constitutes in this paper is another contribution of the existing literature. Throughout our analysis, we address the potential endogeneity of public debt arising from measurement error, omitted factors, and/or reverse causation.

The results show that debt-GDP ratio has a negative impact on economic growth when the latter is low. This implies that borrowing money and incurring debt does not enhance economic growth in periods of recessions and crises like the global financial crises. Moreover, the sample period does not cover the COVID-19 pandemic because of unavailability of data for 2020; however, the results do not justify enhancing economic growth by incurring debt in a crisis period. Another finding of this study is that capital formation enhances economic growth at all levels of quantiles as expected, while open trade has a detrimental effect on economic growth at the lower quantiles (e.g., recessions and crises). Additionally, military expenditures limit economic growth because they reduce resources targeting increasing production capacity. Finally, higher global geopolitical risks, economic policy uncertainty and oil prices are not conducive to economic growth. Our attempt to include national interest rates produced inconsistent results. We suspect that, while the bond yields for several developed countries (Germany in particular) became negative after 2016, the domestic interest rates in highly indebted countries of the MENA region did not drop significantly. Moreover, the evidence shows that as rates worldwide were declining, highly indebted countries in the MENA region took advantage of lower rates to borrow more (Figure 2) and accumulate additional external debt (relative to their national income). Tunisia is a good example where the external debt to income rose from around 60% in 2015 to over 100% in 2019. Egypt saw an even bigger percentage change, with external debt to income doubling between 2015 and 2019 coinciding with the time period during which the 1y Euribor (the 1 year Euro Offer Rate by Eurozone banks) went into negative territory.

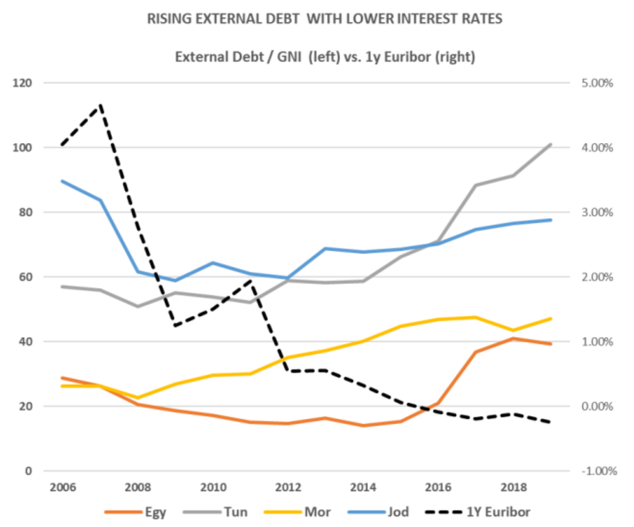


*Figure 2*

The reminder of this paper is organized as follows. Section 2 presents a review of the literature. Section 3 provides the methodology and data description. Section 4 analyzes the main empirical findings.

## 2. Literature review

The literature has examined the relation between debt and economic growth from different angles and used different methodologies but no clear consensus has emerged. Some empirical research provides evidence of a threshold level of debt (see inter alia, Carner et al., 2010; Reinhart and Rogoff, 2010; Minea and Parent, 2012; Wright and Grenade, 2014; Egert, 2015). Carner et al. (2010) investigate the nonlinear linkage between external debt and economic growth by focusing on 101 developed and emerging countries. They show a turning point of debt at 77% for GDP per capita. Besides, Minea and Parent (2012) indicate a collapsing impact of debt on economic growth below the threshold level of 115%. Their results consistently reveal the presence of nonlinearity in the impact of debt on economic growth for the debt-to-GDP ratio above 90%. Égert (2015)'s study suggests a relatively moderate negative nonlinear correlation between public debt and growth. Moreover, Wright and Grenade (2014) assess the same relationship while focusing on 13 Caribbean countries over the period running between 1990 and 2012. They suggest a threshold level of 61% of GDP beyond which the debt had an adverse impact on economic growth.

Rahman et al. (2019) selected 33 articles to review in their study on the effect of public debt on economic growth. They show that there is no consensus on the relationship between public debt and economic growth. The connection can be positive, negative or even non-linear. Moreover, the 90% threshold wrongly calculated in the Reinhart-Rogoff paper does not apply to all countries. Calderón and Fuentes test whether public debt hinders economic growth and whether economic policy can address this adverse effect for a panel of industrial and developing countries. They argue that strong institutions, good quality policy responses and « outward-orienetd » policies partly alleviates this effect.

Ahlborn and Schweickert (2016) emphasize the importance of economic system in addressing the relationship between public debt and economic growth. They identify three distinct economic systems: Liberal (Anglo Saxon), Continental (Core EU members) and Nordic (Scandinavian). They show that different degrees of fiscal uncertainty at similar levels of public debt between those systems can be regarded a major source of heterogeneity in the relationship between debt and growth. Their evidence supports this hypothesis. Continental countries confront more growth-reducing public debt effects than Liberal countries. Public debt exerts neutral or even positive growth effects, while for Nordic countries a non-linear relationship is discovered, with a negative debt effect on economic growth. Sovereign debt can be internal and external. External sovereign debt is a debt that a government borrows from foreign markets in order to cover its deficit. Sen, Kasibhatla, and Stewart (2007) and Presbitero (2012) find evidence to support the negative effect of external debt on economic growth. They also conductd their research on a panel of low- and middle-income countries over the period 1990–2007 and show that public debt has a negative impact on output growth untill it reaches 90 per cent of GDP. Beyond the 90% threshold, the debt effect on growth becomes irrelevant. They also state that the nonlinear effect can be explained by country-specific factors, as debt overhang is a growth constraint only in countries with sound macroeconomic policies and stable institutions. Presbitero (2012) shows that economic growth negatively affected the external debt rates for 114 developing countries over the period 1980–2004. The paper uses an instrumental variable approach to study whether public debt has a causal effect on economic growth in a sample of OECD countries. The results exhibit a negative correlation between debt and economic growth, also indicates that the link between debt and growth disappears once the instrument debt with a variable that captures valuation effects brought about by the interaction between foreign currency debt and exchange rate volatility.

Almahadin and Tuna (2019) show that US interest rates have a spillover effect on the growth of the Turkish banking sector. The US Congressionnel Budget Office (CBO) finds that the higher the national debt, the higher the interest rates are for the central bank for that country. Wen reported that the federal governments in Canada have experienced rapidly rising debt since the 2008–09 recession due to a decrease in the cost of servicing the debt. Globaly, the cost of debt has been at a very low level by historical standards. Walker (2016) postulates that the reason for the decrease in the interest rate since the 2008- 2009 financial crisis is due to the supply and demand income imbalance. He also states that the supply of debt instruments is shrinking relative to the number of debtor who are seeking to lend for retirement income streams. He indicates that interest rates in the 29 economies that make up 90 percent of the world's GDP are low because these economies are experiencing a dearth of borrowers, and hence, resulting in a relatively high saver-to-borrower ratio.

Poghosyan, Tigran (2012) find that government bond yields increase by about 2 basis points in response to a 1 percentage point increase in the government debt-to-GDP ratio and by about 45 basis points in response to a 1 percentage point increase in potentiel growth rate.

Most of the research on the relationship between debt and economic growth uses the standard panel data model. Instead, in this paper we use the quantile panel data model because this model examines the impacts of debt on growth during different states of the economy: recessions, normalcy and booms, which the standard model fails to do. We also handle the endoeneity of the debt in the regression by using a newly developed method which, to our knowledge, the literature on the debt growth relation has not done before.

## 3. Methodology and data

### *3.1. Methodology*

#### *3.1.1. Panel quantile regression with fixed effects*

While the economic impacts of public debt have received tremendous attention, most studies overlook the fact that the consequential impact Debt-to-GDP-ratio (the independent variable) could vary throughout the distribution of economic growth (the dependent variable). A limitation in the current state of the debt literature that must be addressed is the lack of "one-sided" conclusions regarding channels through which public debt significantly affects economic growth. Through such information, policymakers may be able to understand which debt components can serve a mechanism of economic growth. This is not just to control high debt levels in times of crises, but also to appropriately utilize public debt as an effective tool that enables sustainable economic development.

Throughout the present research, we conduct a panel quantile regression (QR) model with fixed effects to address how public debt in the selected MENA countries Bahrain, Egypt, Jordan, Lebanon, and Morocco is significantly linked to variations in economic growth. Such an approach diverges from the standard panel data models which have been largely implemented in the existing debt literature. The QR model also provides information on various economic channels through which debt affects economic growth under different scenarios. In short, this approach makes it possible to get a more complete picture of the distributional relationship between the economic variables of interest. It allows for assessing the empirical linkage among a set of covariates and the distinct parts of the response distribution.

Additionally, what motivates the use of quantile regression is the fact that large deviations from the regression line can exert a significant impact on the fit of ordinary least squares (OLS). Indeed, the standard linear regression models offer information regarding the average link between a set of regressors and the outcome variable based on the conditional mean function $E(\mathrm{Y}|\mathrm{X})$ . This would offer an incomplete picture of the focal relationship, as we might be interested in describing the relationship at different points in the conditional distribution of $Y$. In this context, Koenker (2005) argued that the quantile regression enables one to deal with this problem since the quantile estimators are less affected by the outlying observations in the response variable depending on the covariates.

Furthermore, it appears highly important to stress that the covariates can have an effect on the dispersion of the response variable and its location. In the presence of heteroskedasticity, contrary to the mean regression, the quantile regression is seemingly more flexible in terms of the covariate effects. We should mention that the OLS is inefficient if the errors are non-normal, and thus the quantile regression is more robust to non-normal errors and outliers. The quantile regression accounts for the effect of a covariate on the entire distribution of the variable of interest, and not solely its conditional mean. Overall, by using this technique, we will be able to explore the determinants of economic growth throughout their respective conditional distributions, while considering different economic conditions of the countries under study (i.e., by focusing on countries that have the most and least real GDP per capita growth). In other words, the focus on the mean effects may under- or over-estimate the appropriate coefficient estimates, or may even fail to depict significant relationships (see for instance, Binder and Coad, 2011).

Another major characteristic of the quantile regression estimator is its robustness and less sensitivity to outliers (Koenker and Hallock, 2001). Besides, it is robust to skewness (asymmetry), heteroskedasticity, which are common features of economic and financial data. This technique offers precise information on the average dependence between the time series on the one hand, and the upper and lower tail dependence on the other hand. It consists of analyzing various ranges of changes (i.e., slopes) from the minimum to the maximum responses.

The coefficients of the $\tau^{\text{th}}$ conditional quantile distribution are estimated as follows:

$$\hat{\beta}\ (\tau) = \arg\min \sum_{t=1}^{\tau} (\tau - 1_{\{Y_t \prec X_t \beta(\tau)\}}) \left| Y_t - X_t \beta(\tau) \right| \qquad (1)$$

where the quantile regression coefficient *β(τ)* determines the linkage between the vector *X* (independent variables) and the $\tau^{th}$ conditional quantile of *Y* (the dependent variable). To determine *Y* in a function of specific independent series, the values of the quantile coefficients could be constant where the values of *β(τ)* do not change significantly for the values *τ*. Besides, it should be symmetric (asymmetric) where the values of *β(τ)* are likely to be similar (dissimilar) for upper and bottom quantiles.

Considering a panel quantile regression approach with fixed effects expressed as follows:

$$Q_{Y_{it}}(\tau_k / \alpha_i, X_{it}) = X_{it} \beta(\tau_k) + \alpha_i \qquad (2)$$

The major challenge with using the panel quantile regression with fixed effect is that the inclusion of a large number of fixed effects ($\alpha_i$) may be significantly impacted by an incidental parameters problem (Lancaster, 2000). Accordingly, the estimator will not be the same throughout the distribution when the number of cross-sectional units goes to infinity, whereas the number of observations for each cross-sectional unit is finite (Katoand Galvao, 2010). The standard differencing approaches to overcome the unobserved fixed effects is inappropriate in the quantile regression model. The latter are mainly based on the fact that expectations are linear operators, which is not in line with quantiles properties (see for instance, Canay 2011; You et al., 2015). This can be regarded as one of the major reasons why the empirical literature carrying out panel quantile regression model with fixed effects is very limited. In an attempt to properly deal with this problem, Canay (2011) proposed a simple transformation of the data that prevents the individual fixed effects under the assumption that those effects are constant across the varying quantile levels. In light of this consideration, Canay

(2011) proposed a two-step procedure: (1) estimate the standard fixed effects panel data model at the conditional mean and then use the estimated parameters to find out the individual fixed effect ($\hat{\alpha}_i$); and (2) subtract this component from the dependent variable and estimate, thereafter, the standard quantile regression model ($\hat{Y}_{it} = \hat{\alpha}_i - Y_{it}$). Moreover, the bootstrap technique is conducted to find out the variance–covariance matrix for this estimator. The regression also includes country dummies to effectively deal with any country-specific variation whose omission could prompt inappropriate findings.

### *3.1.2. The endogeneity issue*

The majority of studies on public debt and growth were interested in estimating the impact of the external debt-to-GDP ratio on economic growth. The major challenge in determining this effect is that debt is endogenous and may be significantly impacted by economic growth. The causal negative relationship from public debt to economic growth depends on various crowding-out mechanisms. Public borrowing may lead to rising interest rates, via the crowding-out of private investment or through exchange rate appreciations. Given these considerations, our study conducts a newly econometric tool aimed at testing the presence of endogeneity at each given conditional quantile level separately. While the issue of endogeneity in a quantile regression framework has widely been explored, and various methods to solve this problem have been proposed (for instance, Kim and Muller, 2004; Ma and Koenker, 2006; Kim and Muller, 2013), no study, to our best knowledge, has tested the presence of endogeneity in public debt-growth relationship in conditional quantile models. Some studies indicated that the presence of endogeneity in either the conditional mean or a particular conditional quantile implies that the entire conditional distribution (i.e., all other conditional quantiles) is contaminated by endogeneity (Chen et al., 2003). But it seems more logical to suppose that endogeneity can happen in some parts of the conditional distribution of dependent variable. Although a large empirical literature carried out the Hausman test for testing the presence of endogeneity (for example, Lee and Okui, 2012), however, Kim and Muller (2013) contributed to this issue by developing a newly test allowing one to capture the presence of endogeneity across different quantile levels.

The null hypothesis to be tested is:

*H₀:* There is no endogeneity in the $\tau^{th}$ quantile, which is equivalent to

$$H_0 : E(\psi_0 (\mu_t)/Z_t) = 0 \quad \text{for a given } \tau \qquad (3)$$

where $\mu_t$ is the error term, and $Z_t = [X_t, Y_t]$ is the vector of exogenous variables, $X_t$ and $Y_t$ is the row vector of endogenous variables.

Testing this hypothesis mainly consists of assessing the presence of endogeneity bias at diverse quantile levels.

Equation (3), for a given $\tau$, means that $E\{Y_t(\tau, I_{[\mu_t < 0]}\} = 0$, if it is believable that the only time series possibly prompting an endogeneity problem is $Y_t$. We employed the 10% significance level to reject the null hypothesis that there is no endogeneity depending on varying growth levels (i.e., low, middle or high growth).

### *3.2. Data and descriptive statistics*

In this study, we consider the following regression for the panel of the six relatively highly indebted countries: the growth rate of real GDP per capita (*GDP*) on the external debt-to-GDP ratio (*DEBT*) and a set of relevant control variables commonly considered to be the major determinants of per capita growth in the existing literature, including the real GDP per capita(-1), the capital formation or the net capital accumulation (*CF*), the trade openness

(*OPEN*), the military expenditure (*Mil*), the global geopolitical risk (*GPR*), the global economic policy uncertainty (*GPU*) and change in international crude oil prices (*Oil*).

The time series data for each of the six countries under study are annual and cover the period 2006-2019. We could not include observations for 2020 because they are not yet available. The descriptive statistics for the panel data for those countries are reported in Table 1. The standard deviation values indicate that the growth rate of GDP per capita is volatile, while the debt-to-GDP ratio is likely to be less volatile. The considered variables are negatively skewed, implying that they have longer left tails compared to the normal distribution. All the variables under study seem platykurtic suggesting that their distributions produce fewer extreme outliers than does a normal distribution. The Jarque-Bera (JB) test reveals that all the investigated time series deviate from the normal distribution. The observations have motivated us to look beyond the mean (i.e., to at the quantile regression approach over the ordinary least squares regression).

**Table 1.** Descriptive statistics

| | *GDP* | *DEBT* | *CF* | *OPEN* | *MIL* | *GPR* | *GPU* | *OIL* |
|---|---|---|---|---|---|---|---|---|
| Mean | 0.714423 | 3.980869 | 2.824298 | 4.495204 | -3.416296 | 4.482147 | 4.961376 | 4.222015 |
| Median | 1.001848 | 4.068633 | 3.017225 | 4.511021 | -3.185926 | 4.435035 | 4.941617 | 4.161978 |
| Maximum | 2.212285 | 5.003620 | 3.665844 | 5.256831 | -2.720528 | 5.162498 | 5.635642 | 4.630643 |
| Minimum | -2.996825 | 2.638685 | -3.789323 | 3.409382 | -4.439272 | 3.812203 | 4.068437 | 3.655840 |
| Std. Dev. | 1.120321 | 0.663800 | 1.134432 | 0.392015 | 0.497133 | 0.386580 | 0.421510 | 0.305686 |
| Skewness | -1.511244 | -0.308170 | -4.386104 | -0.587850 | -0.652197 | 0.193096 | -0.139623 | -0.148999 |
| Kurtosis | 5.095365 | 2.235434 | 24.08012 | 3.312617 | 2.056850 | 2.219114 | 2.622882 | 1.865489 |
| Jarque-Bera | 28.17914 | 2.812938 | 1629.134 | 5.118330 | 9.068412 | 2.656247 | 0.770688 | 4.815710 |
| Probability | 0.000001 | 0.245007 | 0.000000 | 0.077369 | 0.010735 | 0.264974 | 0.680217 | 0.090008 |

Notes. *GDP* stands for real GDP per capita, *DEBT* refers to the external debt to GDP ratio, CF stands for gross capital formation, open corresponds to the trade openness, *Mil* refers to the military spending, *GPR* corresponds to the global geopolitical risk, *GPU* stands for the global economic policy uncertainty, *OIL* corresponds to the change in international oil prices. All the variables are in the logarithmic form. Time Period: 2006-19.

# 3. Main empirical findings

## 3.1. Baseline model : External debt and growth

At the outset, the quantile regression technique allows us to investigate the impacts of the independent variables on different quantiles of the growth distributions instead of focusing on the mean of the distribution for the six MENA countries that are highly independent relative to other countries in this region. Throughout our empirical assessment, we report the OLS and the least absolute deviation LAD (i.e., the $50^{th}$ quantile level) regression estimates to justify the usefulness and the efficacy of the quantile regression. Any inconsistency between the conditional median (LAD) and the mean (OLS) estimates can be attributed to the asymmetry of the conditional density and the possible outlier observations in the sample. Such realized different outcomes confirm the effectiveness of the quantile regression analysis. The OLS offers less information than the quantile regression as the latter looks at the impact that the debt-to-GDP ratio, our main independent variable, has on the distribution of the growth of GDP per capita. While OLS can be inefficient if the errors are non-normal, one of the major features of the quantile regression method is its robustness to non-normal errors and outliers.

Table 2 presents the results for the relationship between the growth of GDP per capita and debt-to-ratio to GDP and other relevant control variables for different quantile levels ($\tau$=0.1, .., 0.9). We find that there is a negative effect of debt on per capita growth, where this effect is likely to vary depending on the distribution of the growth of GDP per capita. More specifically, the debt-to-GDP ratio has a negative impact on growth when the economic growth is low (at bottom quantiles; for $\tau$=0.1, 0.2). Overall, our findings reveal that high levels of the public debt-to-GDP ratio are likely to be deleterious for economic growth. An early literature (in particular, Modigliani 1961) claimed that the national debt is a burden for next generations, which comes in the form of a limited flow of income from a decreased stock of private capital. But it must be pointed out at this stage that this relationship is conditional on whether debt finances a productive investment which is a vital input for economic growth.

The Koenker and Xiao (2002) test is used to test if the estimated quantile regression linkages are consistent with the location shift hypothesis which assumes the same slope parameters for all of the conditional quantile functions. The rejection of the null hypothesis implies that the magnitude of the slope coefficient estimated at the several parts of the conditional distribution is distinct, and that this difference is significant, highlighting therefore the efficacy the panel quantile approach over OLS.

Moreover, the coefficients of the potential control variables included in the growth equation for various quantilesare displayed in the same table.Our findings indicate that the capital formation or the net capital accumulation has a positive impact on per capita growth for bottom, middle and upper quantile levels. Not surprisingly, the higher the capital formation of an economy is, the faster an economy can grow its aggregate income. Moreover, the openness to trade has a negative effect on per capita growth at the lower quantiles. In general, trade openness is not conducive to economic growth in countries with low financial development which is important for economic growth. The military spending exerts a negative impact on economic growth, and this seems valid for various quantile levels. The military expenditure may exert a significant influence on the savings-investment equilibrium and limits the resources available for increasing the production capacities (by a crowding-out effect on investment).

The effects of global geopolitical risks and economic policy uncertainty appear to be detrimental to the economic growth. We also note the negative effect of oil prices on the growth of GDP per capita at higher quantiles ($\tau$=0.7, 0.8). Generally speaking, an increase in the oil price would lead to a sharp rise in inflation, reducing in turn the economic growth as inflation is a tax on the economy. We can also add that oil price increases can exert an adverse impact on per capita growth through their effect on the supply and demand for goods other than oil. Higher oil prices mean a transfer of resources from poor oil-consuming countries like Jordan, Lebanon and Morocco to the oil-exporting countries like Kuwait, Saudi Arabia and UAE. Some of the oil proceeds however may be recycled as foreign aïd to the six highly independent countries but this debt does not help with economic growth.

Overall, the rejection of the null hypothesis of the Koenker and Xia (2002) test for the the control variables under consideration can be viewed as supplementary evidence in favor of the panel quantile regression over standard techniques (in particular, OLS).

**Table 2.** Outcome variable: per-capita real GDP growth, the quantile regression estimate (Time Period: 2006-19, 6 countries)

| | $\tau$ | Coefficient | p-value | Koenker and Xiao test: OLS vs. OLS within QR |
|---|---|---|---|---|
| *C* | 0.100 | 1.655369 | 0.6405 | 0.0011$^{**}$ |
| | 0.200 | 1.779959 | 0.4492 | 0.0009$^{***}$ |
| | 0.300 | 0.086686 | 0.9721 | 0.0000$^{***}$ |
| | 0.400 | 1.681156 | 0.4587 | 0.0000$^{***}$ |
| | 0.500 | 1.758356 | 0.4676 | 0.0000$^{***}$ |
| | 0.600 | -0.189774 | 0.9406 | 0.0000$^{***}$ |
| | 0.700 | 0.408947 | 0.8646 | 0.0000$^{***}$ |
| | 0.800 | 2.004852 | 0.3978 | 0.0000$^{***}$ |
| | 0.900 | -0.117269 | 0.9648 | 0.0000$^{***}$ |
| *GDP(-1)* | 0.100 | 0.282702$^{*}$ | **0.0793** | 0.0000$^{***}$ |
| | 0.200 | 0.410737$^{*}$ | **0.0570** | 0.0000$^{***}$ |
| | 0.300 | 0.513717$^{*}$ | **0.0110** | 0.0000$^{***}$ |
| | 0.400 | 0.629278$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| | 0.500 | 0.642902$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| | 0.600 | 0.717803$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| | 0.700 | 0.776799$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| | 0.800 | 0.574894$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| | 0.900 | 0.515327$^{***}$ | **0.0000** | 0.0000$^{***}$ |
| *DEBT* | **0.100** | **-0.018579**$^{*}$ | **0.0758** | 0.0014$^{**}$ |
| | **0.200** | **-0.003313**$^{*}$ | **0.0154** | 0.0000$^{***}$ |
| | 0.300 | -0.004324 | 0.6957 | 0.0003$^{***}$ |
| | 0.400 | 0.003124 | 0.6860 | 0.0011$^{**}$ |
| | 0.500 | -0.000652 | 0.9314 | 0.0009$^{***}$ |
| | 0.600 | -0.000355 | 0.9604 | 0.0000$^{***}$ |
| | 0.700 | 0.001129 | 0.8526 | 0.0000$^{***}$ |
| | 0.800 | 0.009478 | 0.2327 | 0.0000$^{***}$ |
| | 0.900 | 0.011874 | 0.1560 | 0.0000$^{***}$ |
| *CF* | 0.100 | 0.060273$^{**}$ | **0.0027** | 0.0000$^{***}$ |
| | 0.200 | 0.079314 | **0.1187** | 0.0000$^{***}$ |
| | 0.300 | 0.053628$^{*}$ | **0.0574** | 0.0000$^{***}$ |
| | 0.400 | 0.054030$^{*}$ | **0.0168** | 0.0000$^{***}$ |
| | 0.500 | 0.055960$^{*}$ | **0.0106** | 0.0000$^{***}$ |
| | 0.600 | 0.064027$^{**}$ | **0.0030** | 0.0000$^{***}$ |
| | 0.700 | 0.068425$^{**}$ | **0.0011** | 0.0000$^{***}$ |
| | 0.800 | 0.103574$^{***}$ | **0.0002** | 0.0000$^{***}$ |
| | 0.900 | 0.107905$^{***}$ | **0.0001** | 0.0000$^{***}$ |
| *OPEN* | 0.100 | -0.016517 | 0.2116 | 0.0000$^{***}$ |
| | 0.200 | -0.012108 | 0.3399 | 0.0032$^{**}$ |
| | 0.300 | -0.002275 | 0.8241 | 0.0019$^{**}$ |
| | 0.400 | -0.001105 | 0.9037 | 0.0000$^{***}$ |
| | 0.500 | -0.000331 | 0.9707 | 0.0000$^{***}$ |
| | 0.600 | 0.000996 | 0.9182 | 0.0000$^{***}$ |

| | | | | |
|---|---|---|---|---|
| | 0.700 | 0.000369 | 0.9700 | 0.0010** |
| | 0.800 | 0.013530 | 0.1931 | 0.0007*** |
| | 0.900 | 0.011471 | 0.2861 | 0.0004*** |
| *MIL* | 0.100 | -8.518989 | 0.7706 | 0.0001*** |
| | 0.200 | -32.84132* | **0.0787** | 0.0009*** |
| | 0.300 | -34.59874* | **0.0503** | 0.0000*** |
| | 0.400 | -34.01930* | **0.0806** | 0.0000*** |
| | 0.500 | -25.31931 | 0.2467 | 0.0000*** |
| | 0.600 | -23.87467 | 0.3059 | 0.0000*** |
| | 0.700 | -21.20814 | 0.4056 | 0.0018*** |
| | 0.800 | -44.52782 | 0.1501 | 0.0003*** |
| | 0.900 | -45.50231 | **0.0961** | 0.0000*** |
| *GPR* | 0.100 | 0.008520 | 0.5363 | 0.0000*** |
| | 0.200 | -0.002405 | 0.8314 | 0.0000*** |
| | 0.300 | 0.005706 | 0.6349 | 0.0000*** |
| | 0.400 | -0.002179 | 0.8443 | 0.0000*** |
| | 0.500 | -0.000739 | 0.9491 | 0.0000*** |
| | 0.600 | 0.001527 | 0.8949 | 0.0000*** |
| | 0.700 | -0.001089* | **0.0890** | 0.0000*** |
| | 0.800 | -0.008525* | **0.0789** | 0.0000*** |
| | 0.900 | 0.002415 | 0.8477 | 0.0000*** |
| *GPU* | 0.100 | -0.012990* | **0.0656** | 0.0000*** |
| | 0.200 | -0.001203 | 0.7810 | 0.0000*** |
| | 0.300 | -0.001421 | 0.7721 | 0.0008*** |
| | 0.400 | -0.002890 | 0.5766 | 0.0000*** |
| | 0.500 | -0.005644 | 0.2815 | 0.0000*** |
| | 0.600 | -0.000313 | 0.9508 | 0.0002*** |
| | 0.700 | -0.000718 | 0.8806 | 0.0001*** |
| | 0.800 | -0.003013 | 0.6133 | 0.0000*** |
| | 0.900 | -0.005319 | 0.4109 | 0.0000*** |
| *OIL* | 0.100 | -0.004901 | 0.8552 | 0.0000*** |
| | 0.200 | -0.016704 | 0.3523 | 0.0000*** |
| | 0.300 | -0.004257 | 0.8282 | 0.0000*** |
| | 0.400 | -0.014340 | 0.4431 | 0.0000*** |
| | 0.500 | -0.010035 | 0.6084 | 0.0000*** |
| | 0.600 | 0.003144 | 0.8748 | 0.0000*** |
| | 0.700 | -0.001438* | **0.0972** | 0.0006*** |
| | 0.800 | -0.012626* | **0.0158** | 0.0024** |
| | 0.900 | 0.016756 | 0.5205 | 0.0000*** |

Notes.$\tau$: the different quantile levels ranging from lower ($\tau$=0.1, 0.2, 0.3, 0.4), middle ($\tau$=0.5)to upper quantiles ($\tau$= 0.6, 0.7, 0.8, 0.9); The Koenker and Xiao (2002) test assumes the same slope parameters for all of the concerned conditional quantile functions. ***, ** and * imply significance at the 1%, 5% and 10%, respectively.

### 3.2. Control for endogeneity

As claimed at the outset, the usual endogeneity tests based on the mean might fail to appropriately identify a "complex" endogeneity problem. The endogeneity test findings applied to Equation (3) for the two variables of interest (i.e., growth and debt-to-GDP ratio) over the quantile grid from 0.1 to 0.9 are displayed in Table 3, and revealed specific conditional distributions to be significantly impacted by endogeneity bias. More precisely, for the relationship between growth and external debt-to-GDP ratio, the null hypothesis of no endogeneity can be rejected at the 10% when the growth is low (τ= 0.1, 0.2) or middle (τ= 0.5).

**Table 3.** Endogeneity test, outcome variable: per-capita real GDP growth

| | $\tau$ | p-value |
|---|---|---|
| *DEBT* | 0.100 | **0.0198** |
| | 0.200 | **0.0163** |
| | 0.300 | **0.1056** |
| | 0.400 | 0.1342 |
| | 0.500 | **0.0413** |
| | 0.600 | 0.1157 |
| | 0.700 | 0.1832 |
| | 0.800 | 0.1027 |
| | 0.900 | 0.1658 |

(Notes): *DEBT* refers to the external debt to GDP ratio; the null hypothesis tested is $H_0$: There is no endogeneity in the $\tau^{th}$ quantile at the 10% significance level.

Generally, for the standard regression techniques (for instance, OLS), the endogeneity of simultaneous time series may violate the exogeneity assumption of a regression equation. Accordingly, the estimation of asymmetric interdependencies between interdependent variables in the presence of mutually correlated variables is subject to the endogeneity problem (Lütkepohl and Krätzig 2004). It should be remembered that the use of the panel quantile regression does not solve the endogeneity bias. To deal with this problem, there are many econometric tools such as GMM, two-stage least squares (2SLS) and instrumental variable (IV) regressions. Throughout the rest of our analysis, we apply 2SLS for two reasons: (1) the application of GMM necessitates differentiability of the moment functions, whereas the quantile regression consists on nondifferentiable sample moments. This means that the use of GMM within quantile regression can be ineffective; (2) for the instrumental quantile regression, it turns hard to find appropriate instruments with respect to the linkage between public debt and economic growth. To this end, we use all the independent and the lagged dependent variables to calculate the estimated values of the external debt-to-GDP ratio variable. Then, these estimated values are used in place of the actual values of the variable of interest (i.e., Debt-to-GDP ratio).

The use of the endogeneity test (Table 3) revealing that the endogeneity varies significantly across the different quantile levels, which led to the use of 2SLS within quantile regression model in an attempt to control for this problem. The findings generated from the 2SLS with QR model for the growth function are summarized in Table 4. As before accounting for the endogeneity bias, the negative and significant relationship between per capita GDP growth and public debt is also found when the economic growth is low (for τ =0.3, 0.4). Furthermore, the coefficients associated with the control variables do not change fundamentally when we consider the endogeneity problem neither in terms of sign nor magnitude. To ascertain the effectiveness of the instruments used, a test suggested by Stock and Yogo (SY; 2005) was performed in order to identify if there is a problem of weak instruments[1]. The null hypothesis of weak instruments was rejected, and therefore the weakness of instrument is of no concern.

**Table 4.** Outcome variable: per-capita real GDP growth, the quantile regression estimate (Control for endogeneity)

| | $\tau$ | Coefficient | p-value | Koenker and Xiao test: 2SLS vs. 2SLS within QR |
|---|---|---|---|---|
| *C* | 0.100 | 16.91909 | 0.2130 | 0.0000*** |
| | 0.200 | 19.61705* | 0.0870 | 0.0003*** |
| | 0.300 | 14.99264 | 0.1598 | 0.0009*** |
| | 0.400 | 10.04129 | 0.2769 | 0.0000*** |
| | 0.500 | 4.682895 | 0.4952 | 0.0000*** |
| | 0.600 | 2.658049 | 0.9542 | 0.0002*** |
| | 0.700 | 3.273990 | 0.6457 | 0.0000*** |
| | 0.800 | 1.105826 | 0.8711 | 0.0000*** |
| | 0.900 | 1.581371 | 0.8132 | 0.0000*** |
| *GDP(-1)* | 0.100 | 1.751383 | 0.8989 | 0.0000*** |
| | 0.200 | 0.392938** | 0.0088 | 0.0000*** |
| | 0.300 | 0.255752** | 0.0074 | 0.0000*** |
| | 0.400 | 0.235177 | 0.5726 | 0.0000*** |
| | 0.500 | 0.263554* | 0.0331 | 0.0000*** |
| | 0.600 | 0.224296 | 0.5312 | 0.0000*** |
| | 0.700 | 0.219510* | 0.0256 | 0.0000*** |
| | 0.800 | 0.214823* | 0.0903 | 0.0000*** |

[1] If the F-statistic value is greater than the critical value provided by Stock and Yogo (2005), the null hypothesis of weak instruments can be rejected. 10 per cent and 15 per cent critical values of Stock–Yogo weak identification test (SY) are 17.02 and 13.85, respectively.

| | | | | |
|---|---|---|---|---|
| | 0.900 | 0.342490* | 0.0379 | 0.0000*** |
| *DEBT* | 0.100 | 0.237338 | 0.6083 | 0.0000*** |
| | 0.200 | 0.002357 | 0.9957 | 0.0000*** |
| | **0.300** | **-0.110706*** | **0.0736** | 0.0000*** |
| | **0.400** | **-0.094392*** | **0.0997** | 0.0000*** |
| | 0.500 | 0.118480 | 0.6595 | 0.0000*** |
| | 0.600 | 0.229738 | 0.9439 | 0.0000*** |
| | 0.700 | 0.317622 | 0.2081 | 0.0000*** |
| | 0.800 | 0.273430 | 0.2502 | 0.0000*** |
| | 0.900 | 0.018597 | 0.9414 | 0.0000*** |
| *CF* | 0.100 | 0.651016 | 0.0039 | 0.0000*** |
| | 0.200 | 0.426482 | 0.1958 | 0.0000*** |
| | 0.300 | 0.399306 | 0.1762 | 0.0000*** |
| | 0.400 | 0.423042* | 0.0809 | 0.0000*** |
| | 0.500 | 0.540469*** | 0.0007 | 0.0000*** |
| | 0.600 | 0.314235 | 0.9788 | 0.0000*** |
| | 0.700 | 0.100244 | 0.5815 | 0.0000*** |
| | 0.800 | 0.116201 | 0.5033 | 0.0000*** |
| | 0.900 | 0.127744 | 0.4730 | 0.0002*** |
| *OPEN* | 0.100 | -0.055901 | 0.2867 | 0.0000*** |
| | 0.200 | -0.731141 | 0.8110 | 0.0000*** |
| | 0.300 | -0.732594 | 0.7965 | 0.0000*** |
| | 0.400 | -0.806112 | 0.7013 | 0.0000*** |
| | 0.500 | -0.038537* | 0.0395 | 0.0000*** |
| | 0.600 | -1.962237 | 0.7494 | 0.0000*** |
| | 0.700 | -0.072150* | 0.0358 | 0.0000*** |
| | 0.800 | -0.132285* | 0.0276 | 0.0000*** |
| | 0.900 | -0.936021 | 0.2971 | 0.0002*** |
| *MIL* | 0.100 | -2.288346* | 0.0111 | 0.0006*** |
| | 0.200 | 0.116151 | 0.9540 | 0.0000*** |
| | 0.300 | 0.027535 | 0.9877 | 0.0000*** |
| | 0.400 | 0.225129 | 0.8637 | 0.0004*** |
| | 0.500 | -1.046119* | 0.0142 | 0.0000*** |
| | 0.600 | 0.920789 | 0.7001 | 0.0000*** |
| | 0.700 | -6.880194* | 0.0215 | 0.0000*** |
| | 0.800 | -6.849139* | 0.0226 | 0.0000*** |
| | 0.900 | -6.663688* | 0.0721 | 0.0000*** |
| *GPR* | 0.100 | -2.336918 | 0.1267 | 0.0000*** |
| | 0.200 | -2.318131 | 0.0937 | 0.0000*** |
| | 0.300 | -1.812629 | 0.1956 | 0.0000*** |
| | 0.400 | -0.102864* | 0.0951 | 0.0000*** |
| | 0.500 | -0.287882 | 0.7679 | 0.0000*** |
| | 0.600 | -0.168967* | 0.0436 | 0.0000*** |
| | 0.700 | 0.295916 | 0.7707 | 0.0001*** |
| | 0.800 | 0.400721 | 0.6842 | 0.0005*** |
| | 0.900 | -0.212359 | 0.8231 | 0.0000*** |
| *GPU* | 0.100 | -1.914019 | 0.0136 | 0.0000*** |
| | 0.200 | -0.669710 | 0.3521 | 0.0000*** |
| | 0.300 | -0.671746 | 0.3636 | 0.0000*** |
| | 0.400 | -0.565673 | 0.4211 | 0.0000*** |
| | 0.500 | -0.758715 | 0.2211 | 0.0000*** |
| | 0.600 | -0.922974 | 0.5994 | 0.0000*** |
| | 0.700 | -0.090113* | 0.0940 | 0.0000*** |
| | 0.800 | -0.079148* | 0.0884 | 0.0000*** |
| | 0.900 | -0.696597 | 0.2557 | 0.0000*** |
| *OIL* | 0.100 | 1.498037 | 0.2951 | 0.0000*** |
| | 0.200 | -0.093101* | 0.0184 | 0.0000*** |
| | 0.300 | -0.091468* | 0.0371 | 0.0000*** |

| | | | | |
|---|---|---|---|---|
| | 0.400 | -0.135035 | 0.9477 | 0.0000*** |
| | 0.500 | 1.099516 | 0.5053 | 0.0000*** |
| | 0.600 | 1.719575 | 0.6140 | 0.0000*** |
| | 0.700 | 1.934081 | 0.2730 | 0.0000*** |
| | 0.800 | 2.394467 | 0.1636 | 0.0000*** |
| | 0.900 | 1.334718 | 0.4130 | 0.0000*** |
| SY | | | 0.1523 | |

Notes. τ: the different quantile levels ranging from lower (τ=0.1, 0.2, 0.3, 0.4), middle (τ=0.5) to upper quantiles (τ= 0.6, 0.7, 0.8, 0.9); The Koenker and Xiao (2002) test assumes the same slope parameters for all of the concerned conditional quantile functions. ***, ** and * imply significance at the 1%, 5% and 10%, respectively; ST: SarganHansen test; SY: Stock–Yogo weak identification test.

## 4. Conclusion

Many countries, developed and developing, are taking on more debt, particularly influenced by low interest rate environment. The highly leveraged countries in the MENA region are no exception. Some studies have been published on the deleterious impact of debt on economic growth but the overall research shows this impact can be positive or negative or there is no impact. In this study, we examine among other variables the impact of debt on economic growth for six highly indebted Arab countries.These countries are Bahrain, Egypt, Jordan, Lebanon, Morocco and Tunisia. Since most of the research used standard methods, in this paper we use the panel quantile regression with fixed effect to figure out the nature of the impact under different quantiles levels (low, middle and high) since the world economy has experienced low economic growth during the global financial crises. We also included other explanatory variables such as gross capital formation, open trade and military expenditures. We also accounted for global factors including global geopolitical risk, economic uncertainty index and oil prices since those variables affect the economies of those six countries.

Methodologically, the present study goes beyond the existing literature by analyzing the impact of public debt on economic growth, using the panel quantile regression model, which considers the distributional heterogeneity in this linkage. The quantile regression provides fresh and precise insights about the relationships between debt and economic growth that we would not obtain directly from the standard regression model. Even though the mean effects unquestionably are important to be investigated, it is also highly relevant to have accurate information about what happens at the extremes of a distribution. The quantile regression enables us to assess the effects of public debt on economic growth in highly indebted countries throughout the entire growth conditional distribution, with special focus on the economic conditions of the considered countries (i.e., low, middle or high growth). Another prominent contribution of the present research relies on controlling endogeneity within the quantile regression while considering the distributional heterogeneity in the focal relationship. The issue of endogeneity in the within-the-quantile-regression has been largely recognized, and many econometric tools have been proposed to solve this problem. However, no significant attention has been devoted to the issue of testing for the presence of endogeneity in conditional regression models. We believe that such an accurate assessment would have important policy implications as we are able to locate the quantiles where endogeneity is present, and the quantiles where endogeneity can be rejected.

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