BAU Journal - Creative Sustainable Development

Volume 4 | Issue 1
ISSN: 2664-9446

Article 3

November 2022

THE IMPACT OF PUBLIC DEBT ON INFRASTRUCTURE IN ARAB COUNTRIES

Hoda Alaeddine
PhD Candidate, Department of Economics, Faculty of Business Administration, Beirut Arab University, Beirut, Lebanon, hoda_alaeddine@hotmail.com

Follow this and additional works at: https://digitalcommons.bau.edu.lb/csdjournal

 Part of the Business Commons

Public debt, debt-to-gdp, infrastructure indicators, human development index benchmark, panel data analysis.

Recommended Citation

Alaeddine, Hoda (2022) "THE IMPACT OF PUBLIC DEBT ON INFRASTRUCTURE IN ARAB COUNTRIES," *BAU Journal - Creative Sustainable Development*: Vol. 4: Iss. 1, Article 3.
DOI: https://www.doi.org/10.54729/DRSK7970
Available at: https://digitalcommons.bau.edu.lb/csdjournal/vol4/iss1/3

This Article is brought to you for free and open access by Digital Commons @ BAU. It has been accepted for inclusion in BAU Journal - Creative Sustainable Development by an authorized editor of Digital Commons @ BAU. For more information, please contact ibtihal@bau.edu.lb.

THE IMPACT OF PUBLIC DEBT ON INFRASTRUCTURE IN ARAB COUNTRIES

Abstract

The level of public debt as a percentage of GDP (the debt-to-GDP ratio) has expanded in Arab countries as a result of chronically high budget deficits, which undermine the ability of these countries to invest in infrastructure such as healthcare, education, and other productive sectors. This paper uses panel data from 19 Arab countries from 2000 to 2020 to examine the impact of public debt on infrastructure. The Generalized Least Squares regression, in which the Hausman test was used to determine whether the model should follow a random effect or a fixed effect, was employed after the Ordinary Least Squares regression. Two infrastructure indicators that use the old and new Human Development Index as a benchmark have been created. The results showed that debt-to-GDP has a negative impact on the infrastructure index. The fixed-effects results indicated that the infrastructure indicator based on the new human development index was better explained than that based on the old one, supporting the new HDI hypothesis, which has been shown to be a more reliable indicator. Based on the findings, it is recommended to explore how institutional quality affects the relationship between public debt and infrastructure, as strong institutions can properly guide the use of public debt to reduce its negative impact on infrastructure.

Keywords

Public debt, debt-to-gdp, infrastructure indicators, human development index benchmark, panel data analysis.

This article is available in BAU Journal - Creative Sustainable Development: https://digitalcommons.bau.edu.lb/csdjournal/vol4/iss1/3

1. INTRODUCTION

The high level of public debt over the past few decades has become a major concern for most countries around the world, due to its negative impacts on economic growth and infrastructure investment through rising long-term interest rates, the level of inflation, and the high cost of financial system stabilization (Law et al., 2021). Today, as the globe gets ready for a devastating recession and a worldwide health crisis in 2020, the global debt surpassed $226 trillion, the highest level since World War II. Public debt levels were already high prior to the crisis, but governments today face managing a world with record public debt, recent viral tendencies, and rising inflation. According to the International Monetary Fund's Worldwide Debt Database, global debt increased by 28 percentage points in 2020, reaching 256 percent of GDP (Mbaye et al., 2018).

The burden of public debt has increased as a result of recent interest rate adjustments, which have also raised questions about the sustainability of governments in managing them. With central banks raising interest rates to fight inflation, and with rising public debt costs and liabilities, public debt seems to be becoming increasingly important today. Gonzalez-Aguado (2022) asserts that when global interest rates rise, governments, particularly those in developing countries, find it more expensive to borrow money from abroad. High interest rates are one of the main causes of the debt-to-GDP ratio, according to de Soyres et al., (2022). Rising interest rates cast doubt on whether the economy's massive public debt could be sustained.

In contrast, the Global Infrastructure Hub predicts that between 2016 and 2040, the world will invest approximately $3-3.7 trillion per year in both new and existing economic infrastructure, which is 20% higher than the trend in GDP. The infrastructure finance gap has led to an increase in debt levels, which triples when the additional investment required to meet the Sustainable Development Goals is taken into consideration (SDGs). Governments are compelled to take on public debt in order to close the funding gap between what is anticipated to cost $90 trillion by 2030 and what is currently spent on electricity, transportation, water and sanitation, information and communication technology, education, and health services in the Arab world (GI, 2017). They have claimed that borrowing is required to finance infrastructure shortages and stimulate the economy, but opposing viewpoints claim that the debt trajectory is unsustainable and harmful to economic success and progress. Since debt-based sources of financing represent the bulk of infrastructure project financing in the majority of Arab countries, public debt is increasing.

This has an impact on prosperity and economic growth, which in turn has an effect on social progress. Despite some recent social and economic developments in the Arab countries, when debt expansion helped develop capital and productive capacity, public debt continued to shrink the budget space for future growth, and the current state of infrastructure in the region excluded opportunities for expansion, local consolidation, and national comparative advantage. The Global Competitiveness Report lists the following as the most confusing aspects of the business environment: lack of infrastructure, strict business rules, inadequate financial options, and fragile bureaucracy (Schwab, 2019).

The primary objective for the Arab world today is to adequately fund infrastructure while avoiding debt. In the lack of defined laws and methods, governments are forced to borrow heavily to make up for infrastructure underinvestment as well as under tremendous pressure to satisfy debt obligations. This is due to the widening finance gap between infrastructure needs and the budget's capacity to support these improvements. The cost of infrastructure remains a big worry despite the fact that many Arab nations are working on sizable infrastructure projects because the financial system needs to change to accommodate the growing demand for infrastructure across various sectors. Infrastructure must be long-lasting, eco-friendly, and based on a number of considerations, such as feasibility studies, cost-benefit assessments, environmental and social research, among many others (Note, 2016).

Therefore, there is a need to investigate the impact of public debt on infrastructure using infrastructure indicators since there is little empirical research that addresses these issues. This paper intends to investigate the impact of public debt on infrastructure in 19 Arab nations from 2000 to 2020. The rest of this paper is organized as follows: a literature review is presented in the second section and the research methodology is provided in the third. The results are discussed in the fourth section, and the conclusions are discussed in the fifth.

2. LITERATURE REVIEW

This section offers the theoretical and empirical literature on public debt and infrastructure. The theoretical foundations of these two ideas will be examined over time by various scholars in order to answer the research topic.

2.1. Theoretical Background

Theoretical literature on the long-term effects of public debt on economic growth predicts four different effects on economic growth (neutral, negative, positive, and nonlinear). Beginning with the Ricardian equivalence hypothesis (REH) which is based on studies by Barro (1989) and Buchanan (1976) and states that differences in government spending and debt have a similar effect on savings and little or no effect on the real economy. REH states that public debt has no adverse economic effects as long as solvency is not the main concern; thus, it has a neutral impact on economic growth. According to Ricardo (1955), real economics is not related to the government's choice to increase revenue by taxing or issuing debt, and increases in debt caused by expansionary fiscal policies have little effect on macroeconomic efficiency, reinforcing the idea that such policies are ineffective (Pereira & Rodrigues, 2005). That is why this theory does not allow the use of debt as an economic stimulus. Turning to the overhang hypothesis that the negative impacts of government borrowing are necessary to promote economic growth, Myers (1977) initially put forward this effect and claimed that the ability of the private sector to make optimal investment choices in the future is hampered by debt caused by the financial downturn. This negative impact of debt on growth is caused either by unclear macroeconomic expectations or an unstable reaction to consistent and stable macroeconomic policies adopted by economic actors. When debt levels are high, the government cannot implement macroeconomic reforms through stimulus or policies because the money obtained will be used for debt reduction (Clements et al., 2003).

Contrary to the overhang hypothesis, Keynesian views on public debt are usually optimistic because the short-run effect of debt on GDP growth is positive. Keynes criticizes the idea of public debt espoused by classical economics and stresses the necessity of this debt for economic development (Keynes, 1937). According to Keynesian economics, higher public debt leads to higher rates of productive public spending, which automatically stabilizes the economy, as domestic borrowing helps boost domestic financial markets and private savings, which in turn encourages public investment. The latter impact is reflected by the threshold effect theory which depicts a non-linear relationship between public debt and economic growth. According to the theory, economic growth is believed to be positively affected by low levels of public debt and vice versa Reinhart and Rogoff (2010). Krugman (1988) believes that public debt will increase economic growth when higher government spending replaces lower private spending. He claims that debt levels below a certain point will have a negative impact on economic growth because crowding out has a greater effect than crowding in.

Along the theories mentioned above, it is worth noting the post-Keynesians view on debt that c0nsider it a financial mechanism through which the economy operates and expands. They argue that this debt is an economic necessity that has fostered human development and prosperity. As a result, while debt itself is not a problem, having too much can be, especially for private companies, individuals, and subnational governments. The basic idea here is that debt proceeds, whether private or public, should be used for value-adding purposes to avoid becoming a real burden on the economy. In other words, the money should be used for projects that will generate profit (Kravchuk, 2019). For post-

Keynesians, more debt taken on by borrowers stimulates the economy because all the money borrowed is spent. But when more interest payments are required, the pace of the economy slows. Palley (1996) states that a decrease in the equilibrium level of GDP in the economy will result from higher interest rates or an increase in the debt-to-income ratio for borrowers. One of the main schools of post-Keynesian is related to Hyman Minsky and the financial instability hypothesis. Minsky (1995) identified debt cycles as a driver of economic volatility and distinguished three distinct phases: hedge financing, speculative financing, and Ponzi financing.

2.2. Public Debt and Infrastructure

Infrastructure is essential to boost growth and reap economic benefits. The term "infrastructure" refers to a wide range of measurements and indicators, including those related to transportation, roads, health, electricity, education, water and sanitation, etc…It is necessary for development because it promotes economic activity and creates job opportunities and has many other direct benefits such as increased efficiency and safety, reduced environmental impact, increased foreign direct investment, and successful provision of public goods and necessities (Asian Development Bank, 2012).

Public debt has emerged as a significant source of outside funding for infrastructure in many emerging nations, which is driving up infrastructure investment. Although the economy has benefited from this scaling up, worries regarding the sustainability of the debt have surfaced as a result of declining public saving-investment balances and rising debt-to-GDP ratios (Mencinger et al., 2014). For economists, the debt-to-GDP ratio is more important than the actual level of debt since it shows how well a government can pay off its loans. Economic growth can be hampered and infrastructure investment might be stopped by high debt-to-GDP ratios (Reinhart et al., 2012).

Since greater spending increases the amount of public debt and external borrowing, efficient infrastructure investments are likely to pay for themselves in the long run by producing economic and societal returns that are higher than anticipated interest rates. The ability to make money from borrowed money will increase with the development of infrastructure that promotes economic growth. When money is spent on unneeded or badly planned assets or on projects with high construction costs that will have a detrimental impact on their capacity to sustain their financial viability in the future, paying off debt becomes more difficult (Stupak, 2017). In order to be dependable, economically and environmentally efficient, and to meet international standards, infrastructure must make use of the latest technologies available. It should align with the nation's long-term economic development plans in a way that improves service delivery, strengthens community capacity, and encourages employment growth.

Achieving the infrastructure goals requires an additional projected annual spending of about $0.5 trillion for low-income countries, estimated at 15 percent of GDP, and $2.1 trillion for emerging economies, estimated at 4 percent of their GDP. Infrastructure investments should steer clear of debt commitments with impractical repayment schedules, especially when it comes to undertakings that do not boost productive output and increase government revenue required to service debt (Runde et al., 2019).

Infrastructure investment and renovation is one of the primary methods Arab nations use to modernize their economies. It is a successful method to increase growth because it gives people access to high-quality facilities, attracts new business opportunities, strengthens comparative advantage, enables enterprise expansion, and attracts money. The Arab world as a whole has seen an increase in public investment over the past 20 years, but it is clear that this increase has been concentrated in the oil-exporting countries, which have benefited from the rise in gas prices. As a result of their restricted financial resources, oil-importing countries including Egypt, Jordan, Lebanon, Morocco, Palestine, and Tunisia have seen a decrease in their economies (Kabbani and Ben Mimoune, 2021).

Sarangi and Ahmadieh (2017) noted that nine Arab countries—Egypt, Jordan, Lebanon, Libya, Mauritania, Morocco, Sudan, Tunisia, and Yemen—are approaching critical debt levels according to the Global Sovereign Indebtedness Monitor (Sarangi and Ahmadieh, 2017). Recent events have made Lebanon stand out for having the highest debt to GDP ratio in the area, at 169 percent, just behind heavily indebted Greece at 181 percent, as well as a $1.2 billion default on international loans due to the constraints of the global crisis. Growing governmental debt necessitated shifting more expenditures away from infrastructure investment and toward debt service.

2.3. Empirical Review

There is no accepted approach for evaluating infrastructure, and there is no consensus among scholars on the collection of factors that represent infrastructure. According to the literature, infrastructure's contribution to population activities and economic output is measured by the availability of services like energy, transportation, telecommunications, water and sanitation, and proper waste disposal. Theoretical analysis of the impact of public debt on infrastructure and the economy reveals that the main obstacles to achieving quality in infrastructure include difficulties locating additional sources of funding for infrastructure investments in nations that are experiencing population growth, rapid urbanization, economic, and industrial evolution, necessitating the requirement for efficient and high-value infrastructure. Despite the fact that a large body of academic research has concentrated on the debt-growth relationship, it has recently undergone a notable divergence as a result of the significant deterioration of public finances in various sectors, particularly in infrastructure. This has raised a crucial question about the effect of public debt on infrastructure. Despite the resurgence of interest in the connection between public debt and infrastructure, the impact of public debt on infrastructure in the Arab world has not been adequately studied empirically.

The studies listed below have mixed results and conclusions that differ based on the nation, the time period of analysis, and research methodology. They address issues similar to those in this paper. The differentiation between various national coverage and data properties, non-linear and thresholding modeling approaches of the supposed relationship, time horizon of findings, and estimating methodologies can all be learned in accordance with this paper.

Using the non-linear Autoregressive Distributed Lag Model (NARDL) and a multiple structural breaks model, Gaaloul (2022) investigated the asymmetric impact of public debt on economic growth rates in 10 Arab nations. In many countries, short- and long-term results have shown an unbalanced relationship between public debt and economic growth. It showed that in some countries, increases in public debt had a negative relationship with GDP growth rates, indicating that higher public debt slows GDP growth. On the other hand, it has been discovered that negative changes in public debt have a significant impact on economic growth in some countries, which means that lower levels of debt lead to a faster growth rate of GDP. The interaction between debt and growth may not be constant all the time and may change depending on the state of the economy, according to the results. The study indicated that in order to prevent negative consequences caused by changes in the level of public debt, it is necessary to conduct a frequent and systematic examination of the impact of public debt on economic growth.

De Soyres (2022) provided additional empirical data on the effects of unexpected changes in the public debt on real GDP, using forecast errors in the public debt to determine how a change in the debt-to-GDP ratio will affect real GDP. The results showed that the impact of an unexpected increase in public debt on the level of real GDP is often negative and varies depending on other basic factors when looking at the data on the total public debt of 178 countries for the period 1995–2020. In particular, countries with a high debt level or a trajectory of increasing debt over the previous five years are experiencing an unexpected increase in the ratio of public debt to GDP. Alternatively, for countries that (iii) have a lower

income level or (iv) have completed the Heavily Indebted Poor Countries (HIPC) debt relief project, an unexpected increase in public debt increases real GDP.

Using the Generalized Method of Moments (GMM) to identify the point beyond which foreign debt affects the level of infrastructure differently, Kengdo et al. (2020) looked at the effect of external debt on the level of infrastructure in 37 nations in Africa from 2009 to 2017. The findings indicated that external debt had a positive impact on infrastructure, with a potential threshold equal to 36.71% of GDP. It was advised that debt levels be respected in order to avoid reaching the stage of unsustainable debt.

A framework for evaluating the impact of anticipated infrastructure investments on debt-related vulnerabilities in nations along the Belt and Road Initiative's transportation and communication corridors was presented by Bandiera and Tsiropoulos (2019). (BRI). In numerous nations, PPG debt is expected to significantly expand between 2019 and 2023 as a result of Belt and Road loan financing. The findings demonstrate that while the impact of the full expansion of infrastructure connected to the Belt and Road Initiative is not fully understood, investment money for the BRI will be distributed in full. Additionally, he stated that, on the assumption of a sustained negative divergence in interest rate growth and the absence of materialization of the financial risks associated with the Belt and Road Initiative, the impact of the initiative on public debt would improve in the future.

In their analysis of the effects of infrastructure development in Nigeria, Davies et al. (2019) acknowledged that infrastructure predominates as a key element in determining people's quality of life. The findings demonstrated that the government's commitment to providing adequate funding, fiscal responsibility, sound policies, infrastructure services, ensuring value for money, and utilizing creative methods of funding infrastructure are necessary for effective infrastructure development. The review suggested that in order to ensure that sustainable infrastructure projects are more likely to be implemented successfully over time, project evaluation should take initial capital expenditure, maintenance costs, and asset behavior into account.

3. RESEARCH METHODOLOGY

The econometric model to examine the impact of public debt on infrastructure is as following:

$$\mathbf{INFRA}_{it} = \beta 0 + \beta 1 LDEB_{it} + \beta 2\mathbf{GDP}_{it} + \beta 3\mathbf{POP}_{it} + \beta 4\mathbf{TRD} + \varepsilon_{it}$$

INFRA represents the infrastructure index and denotes the dependent variable, while DEB represents the Debt-to-GDP ratio and denotes the independent variable. The control variables (GDP per capita, Annual Population Growth (POP), and Trade Openness (TRD)) are chosen based on previous studies.

The Human Development Index and Infrastructure are closely related, as infrastructure is directly related to the economic growth and development of a country by providing access to necessities such as health care and education and acting as a catalyst for finding solutions to eradicate poverty. The HDI measures the level of development and well-being of a nation. It is widely agreed that improving access to infrastructure services such as energy, water and transportation directly benefits people's lives, as well as the well-being of their communities and businesses. By reducing costs and improving the quality of health and education services, it helps improve the health and education of individuals, which ultimately raises the degree of human development at the local and national levels (Sapkota, 2015).

Based on this relationship, an infrastructure model based on the Human Development Index (HDI) was created to support the aim of this research, which is to examine the effect of public debt on infrastructure in Arab countries (HDI). Over time, HDI evolved into New HDI. The two are different in terms of calculation methodology, but both are based on the same sub-indicators, including the education index, life expectancy index, and income index (Stanton, 2007). The Old HDI and New HDI were used as benchmark indicators in this paper, and a new indicator, named INFRA 1 and INFRA 2, were developed after minor improvements. In light of this, the variables employed in calculations can be separated into two groups: social and traditional indicators. The social indicators include education, health, poverty, and ICT

(individuals using the internet %of population). The traditional indicators include electricity and water.

The methodology steps included:

First: Normalizing all variables using the same HDI method for calculating sub-indicators index:

$$Sub - indicator\ Index\ = \frac{\ln(value) - ln(min)}{ln(Max) - ln(min)}$$

Second: Getting the arithmetic average of electricity and water, so that the traditional indicators are represented in one sub-indicator

The arithmetic mean formula in statistics is defined as the sum of all observations divided by a number of observations.

Arithmetic Mean = $\sum \frac{xi}{n}$

Based on this step, the traditional indicators (water and electricity) are represented in one sub-indicator.

Third: Calculating the INFRA1 and INFRA2.

For INFRA1: is calculated using the arithmetic mean:

$$\frac{1}{5}\text{Education} + \frac{1}{5}\text{ Health} + \frac{1}{5}\text{ Poverty} + \frac{1}{5}\text{ICT} + \frac{1}{5}\text{Traditional Indicator}$$

For INFRA2: is calculated using the geometric mean:

$$\sqrt[5]{\text{Education} + \text{Health} + \text{Poverty} + \text{ICT} + \text{Traditional Indicator}}$$

4. EMPIRICAL RESULTS

A short glance at the statistical summary of all variables is required before starting the estimating technique. Table 1 below shows the means, standard deviations, and number of observations for each variable from 2000 to 2020. It also reflects the properties of these variables. This table shows that each variable has a varied number of observations; so, this data is imbalanced panel data. However, the unequal number of observations had no effect on the regression results because the missing values were skipped and the sample size was adjusted accordingly.

Table 1 shows the summary statistics of the variables used in model one. It reveals the occurrence of heterogeneity within the sample countries, where the debt-to-GDP is negative for one country and a positive large value for another country. This variation is due to different economic growth within the sample countries. For example, Sudan's debt-to-GDP scored 160 in 2017 while it scored -11.93 in Oman in the same year.

The first four variables represent the model independent variables, where GDP and population show a low standard deviation that shows data consistency, in contrast to debt-to-GDP and trade openness, which show a large variation between countries. It is known that the variation magnitude is large for the four variables as it shows between their minimum and maximum values.

Table 1: Descriptive Statistics

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Missing obs.
Debt to GDP	51.2665	45.2835	-50.8690	344.300	54.1420	5
GDP per Capita	0.409032	0.741024	-62.3780	121.779	9.48346	5
Population	2.92519	2.25285	-0.442463	17.5122	2.60612	1
Trade Openness	87.4436	85.6728	0.784631	347.997	46.2805	10
INFRA1	0.624231	0.614751	0.205703	0.956714	0.157601	1
INFRA2	0.478335	0.504212	-0.000768645	0.955253	0.284254	12

Source: Researcher's Calculation

The execution of various diagnostic tests is an essential stage in any type of series modeling. In terms of negative effects on the outcome, the ramifications of utilizing skewed data in regression might be significant. Since this research used panel data, the diagnostic tests used are mostly panel data-related and are detailed below, along with their values and interpretations.

The correlation matrix in Table 2 below depicts the potential relationship among variables and defines the degree and direction of a linear relationship between two variables. At first glance, the only strong correlation that is higher than 0.7 is between two dependent variables that will not be used in the same equation. Hence, no major issues with correlation were discovered. Regarding the correlation between the first dependent variable, INFRA1, and the other independent variables, they all showed a positive relationship except for the debt-to-GDP variable. In particular, INFRA1 has the strongest relationship with interest rate, then with population, and finally with GDP per capita. The second dependent variable, INFRA2, is negatively correlated with debt-to-GDP, then with GDP per capita, and positively correlated with population and interest rate.

Table 2: Correlation Matrix

INFRA1	INFRA2	Debt-to- GDP	GDP Per Capita	Population	Trade Openness	
1.0000	0.8724	-0.2749	0.0211	0.2154	0.2834	INFRA1
	1.0000	-0.3049	-0.0768	0.2477	0.2886	INFRA2
		1.0000	-0.0719	-0.2268	-0.1780	Debt-to- GDP
			1.0000	-0.1165	0.0458	GDP per Capita
				1.0000	0.1415	Population
					1.0000	Trade Openness

Source: Researcher's Calculations

The Breusch-Pagan test is then performed to deduct heteroscedasticity for both dependent variables, INFRA1 and INFRA2. The results are shown in Table 3, which confirms the heteroscedasticity existence. The p-values for INFRA1 and INFRA2 are less than 0.1, leading to null hypothesis rejection that states that the error term is homoscedastic. The heteroscedasticity problem was fixed with a robust standard error performed.

Table 3: Heteroscedasticity Test

BREUSCH-PAGAN / COOK-WEISBERG TEST FOR HETEROSKEDASTICITY HO: CONSTANT VARIANCE VARIABLES: FITTED VALUES OF Debt-to-GDP
CHI2(1) = 8.73 PROB > CHI2 = 0.00625

BREUSCH-PAGAN / COOK-WEISBERG TEST FOR HETEROSKEDASTICITY HO: CONSTANT VARIANCE VARIABLES: FITTED VALUES OF Debt-to-GDP
CHI2(1) = 8.61 PROB > CHI2 = 0.00625

4.1. Panel Data Methods

The first regression was done with only one dependent variable, which is Debt to GDP, as per the following econometric model using standard OLS.

$$\mathbf{INFRA}_{it} = \beta 0 + \beta 1 DEB_{it} + \varepsilon_{it}$$

The results showed that debt-to-GDP is negatively significant at a 5 percent level and at a 1 percent level for INFRA1 and INFRA2, respectively. It is more significant for INFRA2 than INFRA1 with a higher R-squared. So, the impact of debt-to-GDP on INFRA2 is higher than on INFRA1.

Table 4: Model 1, Panel Regression, Pooled OLS: INFRA1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
constant	0.667657	0.0219362	30.4363	<0.00001	***
DEB	−0.00073914	0.000313788	-2.3555	0.01902	**

Mean dependent variable	0.628843	S.D. dependent var	0.155296
Sum squared residual	8.179455	S.E. of regression	0.149493
R-squared	0.175860	Adjusted R-squared	0.173336
F(1, 366)	30.04410	P-value(F)	7.88e-08
Log-likelihood	178.2188	Akaike criterion	−352.4376
Schwarz criterion	−344.6214	Hannan-Quinn	−349.3323
Rho	0.918148	Durbin-Watson	0.167604

Table 5: Model 2, Panel Regression, Pooled OLS, INFRA2

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
constant	0.560865	0.0329192	17.0376	<0.00001	***
Debt-to-GDP	−0.00152397	0.000446356	-3.4143	0.00071	***

Mean dependent variable	0.480989	S.D. dependent var	0.282768
Sum squared residual	26.11950	S.E. of regression	0.268985
R-squared	0.299105	Adjusted R-squared	0.296623
F(1, 361)	39.04600	P-value(F)	1.17e-09
Log-likelihood	−37.41742	Akaike criterion	78.83483
Schwarz criterion	86.62364	Hannan-Quinn	81.93084
Rho	0.789472	Durbin-Watson	0.411818

The pooled OLS method was used as a first step to assess the direct effect of four explanatory factors on INFRA1 and then INFRA2.

$$\mathbf{INFRA}_{it} = \beta 0 + \beta 1 DEB_{it} + \beta 2 \mathbf{GDP}_{it} + \beta 3 \mathbf{POP}_{it} + \beta 4 \mathbf{TRD} + \varepsilon_{it}$$

Based on Table 6, population and trade openness have no significant relationship with INFRA1, therefore they have no direct influence on infrastructure. At 1 percent, debt-to-GDP will reduce the infrastructure index, indicating less infrastructure development, whereas GDP per capita will increase it.

Table 6: Model 3, Panel Regression, Pooled OLS, INFRA1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Constant	0.562678	0.0298256	18.8656	<0.00001	***
Debt-to-GDP	−0.00062111	0.000171951	-3.6121	0.00035	***
GDP per Capita	0.000292967	0.000101176	2.8956	0.00401	***
Population	0.0082619	0.00684523	1.2070	0.22822	
Trade Openness	0.00079823	0.000588827	1.3556	0.17604	

Mean dependent variable	0.624231	S.D. dependent var	0.157601
Sum squared residual	7.821163	S.E. of regression	0.145194
R-squared	0.560309	Adjusted R-squared	0.451256
F(4, 371)	17.70730	P-value(F)	2.58e-13
Log-likelihood	194.5572	Akaike criterion	−379.1144
Schwarz criterion	−359.4665	Hannan-Quinn	−371.3149
Rho	0.835749	Durbin-Watson	0.332491

Based on Table 7, GDP per capita is the only nonsignificant variable with INFRA2, therefore it has no direct influence on the infrastructure index. Debt-to-GDP has a significant negative impact on INFRA2 at 1%, resulting in a lower infrastructure index indicating less development. Both population and trade openness are statistically significant for INFRA2 at the 1% level.

Table 7: Model 4, Panel Regression, Pooled OLS, INFRA2

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	0.375259	0.0369258	10.1625	<0.00001	***
Debt-to-GDP	−0.0012778	0.000251642	-5.0779	<0.00001	***
GDP per Capita	−0.00222481	0.00146746	-1.5161	0.13037	
Population	0.0163307	0.0053544	3.0500	0.00246	***
Trade Openness	0.00139581	0.000295592	4.7221	<0.00001	***

Mean dependent variable	0.478335	S.D. dependent var	0.284254
Sum squared residual	23.91892	S.E. of regression	0.257762
R-squared	0.686742	Adjusted R-squared	0.680314
F(4, 360)	20.66599	P-value(F)	2.40e-15
Log-likelihood	−20.55852	Akaike criterion	51.11704
Schwarz criterion	70.61653	Hannan-Quinn	58.86639
Rho	0.693292	Durbin-Watson	0.602351

The Durbin-Watson statistic is a prominent test for serial correlation. In Tables 6 and 7, the DW result is 0.33 and 0.60, respectively. In both situations, the null hypothesis of uncorrelated regression residuals failed to be rejected and thus autocorrelation occurs. Therefore, a positive correlation occurs since both values are less than 1.5. It is very important to mention that, as per Williams (2015), the serial correlation in OLS will affect the efficiency of its estimators but not their unbiasedness or consistency.

For the model goodness of fit, model 4 results are more comparable to model 3 results due to the higher R-squared, where it is 68 percent in model 4 while it is 56 percent in model 3.

Taking into consideration the obtained results, together with the presence of serial correlation in the model, the OLS technique is typically not highly efficient and could result in inconsistent estimates that are susceptible to incorrect analysis. That's why Generalized Least Squares (GLS) was used as a second step method.

The choice between fixed effects and random effects models is based on the results of the Hausman test. In principle, the null hypothesis assumes that GLS estimates are consistent; where a low p-value counts against the null hypothesis that the random effects model is reliable, and thus favors the fixed effects model for both independent variables. Given that the p-values for the two models in the table below are less than 0.05, the null hypothesis of random effects is rejected, indicating that fixed effects exist in the model and that it is preferable to use.

Table 8: Hausman Test, Dependent Variables, INFRA1 and INFRA2

Dependent Variable INFRA1
Hausman test statistic: H = 13.9888 with p-value = prob(chi-square(4) > 13.9888) = 0.00733078
Dependent Variable INFRA2
Hausman test statistic: H = 16.0953 with p-value = prob(chi-square(4) > 16.0953) = 0.00289391

By applying a fixed effect, model 5 results reveal that GDP per capita lost its significance, and population remained insignificant with INFRA1. At a 5 percent level, debt to GDP is inversely significant, with the INFRA1 having a coefficient of value (0.0007). At a 5 percent level, trade openness is positively significant, with INFRA1 having a coefficient of (0.001). However, model 6 results revealed three significant variables with INFRA2, Debt to GDP with a coefficient of 0.0013, negatively significant at level 5 percent, and GDP per capita with a coefficient of 0.002. At a 1 percent level of significance, trade openness is positively related to INFRA2.

Table 9: Model 5, Fixed-effects, Dependent variable: INFRA1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Constant	0.540804	0.0687661	7.8644	<0.00001	***
Debt-to-GDP	−0.00079631	0.000313971	-2.5363	0.01164	**
GDP per Capita	−0.000801841	0.000867045	-0.9248	0.35572	
Population	−0.00421984	0.00440164	-0.9587	0.33838	
Trade Openness	0.00162647	0.000753396	2.1589	0.03155	**

Mean dependent variable	0.628843	S.D. dependent var	0.155296
Sum squared residual	4.554885	S.E. of regression	0.114902
LSDV R-squared	0.485375	Within R-squared	0.111301
LSDV F(22, 345)	14.79053	P-value(F)	1.16e-37
Log-likelihood	285.9370	Akaike criterion	−525.8741
Schwarz criterion	−435.9882	Hannan-Quinn	−490.1633
Rho	0.810282	Durbin-Watson	0.330761

Table 10: Model 6, Fixed-effects, Dependent variable: INFRA2

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Constant	0.180772	0.122394	1.4770	0.14061	
Debt-to-GDP	−0.00134367	0.000595893	-2.2549	0.02478	**
GDP per Capita	−0.00248968	0.000829225	-3.0024	0.00288	***
Population	0.0074311	0.00920116	0.8076	0.41987	
Trade Openness	0.00399143	0.00137949	2.8934	0.00406	***

Mean dependent variable	0.480989	S.D. dependent var	0.282768
Sum squared residual	17.89107	S.E. of regression	0.229392
LSDV R-squared	0.381886	Within R-squared	0.124312
LSDV F(22, 340)	9.548195	P-value(F)	1.68e-24
Log-likelihood	31.25868	Akaike criterion	−16.51736
Schwarz criterion	73.05391	Hannan-Quinn	19.08679
rho	0.654765	Durbin-Watson	0.629381

It is shown that the fixed effect regression, based on Hausman test results, eliminates the bias from unobservable that change over time but are constant over countries, as it also controls for factors that differ across countries but are constant over time. In other words, it keeps the characteristics of each country since each country has a different culture and economic development level, such as in 2019, the United Arab Emirates, which has a debt-to-GDP that is equal to 27.1 and a GDP per capita of 1.9, while Sudan has a debt-to-GDP of 262.5 and a GDP per capita of 5.09. These two countries are from the sample under study, yet they have a huge gap in economic growth and other indicators. The relationship between the infrastructure indicators (INFRA1 and INFRA2) and the debt-to-GDP is still significant at different significance levels, and the relationship is still negative.

5. CONCLUSIONS

Debt became a crucial issue in Arab countries after witnessing an increase in its levels in the past decade accompanied by its excessive use in financing the infrastructure gap. Although infrastructure investment in the region overall has been strong, there is wide variation across countries in the quality and quantity of infrastructure. Arab countries need a fair number of high-quality infrastructure development projects with large amounts of funds to move their economy forward (Gulf News, 2016). This paper examined the impact of public debt on infrastructure from 2000 to 2020 using panel data from 19 Arab countries. Ordinary Least Squares regression (OLS) was used as a first step, followed by Generalized Least Squares regression (GLS), in which Hausman test was used to assess whether the model should follow a random effect or a fixed effect.

INFRA1 and INFRA2 are the two dependent variables that were constructed based on old and new HDI. Debt-to-GDP was found to have a negative significance for INFRA1 and INFRA2 at levels of 5% and 1%, respectively. With a larger R-squared, INFRA2 is more significant than INFRA1; therefore, INFRA2 is affected by debt-to-GDP more than INFRA1. In more detail, the increase in the debt-to-GDP, which is the government's ability to repay debts, decreased the government’s spending on infrastructure. These results are in line with Reinhart et al., (2012) and Runde et al., (2019), and the negative relationship part can be explained as per Stupak (2017), who found that a government’s debt will be harmful once it is invested in the wrong projects that will fire back on the government, especially on its financial satiability and sustainability.

In order to examine the relationship between debt and infrastructure more closely, control variables were included. Results indicated that population and trade openness have no significant relationship with INFRA1, therefore they have no direct influence on infrastructure. At 1 percent, GDP per capita will increase the infrastructure index, indicating high infrastructure development. For INFRA2, GDP per capita is the only nonsignificant variable, therefore it has no direct influence on the infrastructure index. Both population and trade openness are statistically significant for INFRA2 at the 1percent level. After applying the Hausman test, it was found that the p-values of the two models (INFRA1 and INFRA2) were less than 0.05, rejecting the null hypothesis of the random effect, and indicating that there are fixed effects in the models, where it is preferable to use them. This research came to the conclusion that INFRA2 is more explained than INFRA1, confirming the premise of the new HDI that it has been shown to be a far more trustworthy index than it was at the time it was initially utilized. It also confirmed that debt-to-GDP has a significant negative impact on both INFRA1 and INFRA2 at 1%, resulting in a lower infrastructure index indicating less development.

Regarding the methodology, the researcher suggests, for further studies, adding the interest rate as an additional explanatory variable to test its direct impact on public debt, proceeding from the relationship between debt to GDP and interest rate. Also, as an alternative empirical equation to be used as a robustness check, other proxies for infrastructure can be used other than HDI, such as the Global Competitiveness Index (GCI), since its sub-indicators are similar to HDI. In addition, this paper was conducted using country-level panel data for the 19 Arab countries as a bulk; thus, the researcher can categorize the countries as oil-exporting and non-oil-exporting countries by adding a dummy variable to absorb the effect of the structural differences between the two groups on the results. Rather than discussing public debt in general, the paper can further develop a comparative analysis of internal and external debt in particular.

In an era of economic conflict and debt burden where weak institutions, a lack of governance, and widespread corruption reinforce issues of debt abuse, further research into the effect of institutional quality on the relationship between infrastructure and public debt is recommended, as good institutions can reduce the impact of debt on infrastructure.

REFERENCES

- Asian Development Bank. (2012). *Infrastructure for supporting inclusive growth and poverty reduction in Asia*. Asian Development Bank.
- Bandiera, L., & Tsiropoulos, V. (2019). *A framework to assess debt sustainability and fiscal risks under the Belt and Road Initiative*. The World Bank.
- Barro, R. J. (1989). The Ricardian approach to budget deficits. *Journal of Economic perspectives*, *3*(2), 37-54.
- Buchanan, J. M. (1976). Barro on the Ricardian equivalence theorem. *Journal of political economy*, *84*(2), 337-342.
- Clements, B., Bhattacharya, R., & Nguyen, T. Q. (2003). External debt, public investment, and growth in low-income countries. IMF Working Paper No. 03/249, Available at SSRN: https://ssrn.com/abstract=880959.
- Davies, I. E. E., Nwankwo, C. O., Olofinnade, O. M., & Michaels, T. A. (2019, November). Insight review on impact of infrastructural development in driving the SDGs in developing nations: a case study of Nigeria. In *IOP Conference Series: Materials Science and Engineering* (Vol. 640, No. 1, p. 012112). IOP Publishing.
- de Soyres, C., Kawai, R., & Wang, M. (2022). Public Debt and Real GDP: Revisiting the Impact. *IMF Working Paper No. 2022/076*.
- Gaaloul, S. (2022). Public Debt in the Arab World: Asymmetric Effects on Economic Growth. Arab Monetary Fund No.98-2022.
- GI, H. (2017). Global Infrastructure Outlook, Global Infrastructure Hub.
- Gonzalez-Aguado, E. (2022). Interest Rate Shocks and the Composition of Sovereign Debt. TSE Working Paper, n. 22-1379, Toulouse.

- Gulf News. (2016). “Building bridges: How the world’s terrestrial links stack up”. Accessed April 11, 2016, http://gulfnews.com/news/gulf/ saudi-arabia/building-bridges-how-the-world-s-terrestrial-links-stack-up-1.1708571.
- Kabbani, N., & Ben Mimoune, N. (2021). Economic diversification in the Gulf: time to redouble efforts. *Brookings Doha Center, Briefing Policy, January, Doha, Qatar*.
- Kengdo, A. A. N., Nchofoung, T., & Ntang, P. B. (2020). Effect of external debt on the level of infrastructure in Africa". *Economics Bulletin*, *40*(4), 3349-3366.
- Keynes, J. M. (1937). The general theory of employment. *The quarterly journal of economics*, *51*(2), 209-223.
- Kravchuk, R. S. (2019). Elements of a Post-Keynesian Public Finance: Contributing Concepts from Modern Monetary Theory Concept for a Book.
- Krugman, P. (1988). Financing vs. forgiving a debt overhang. *Journal of development Economics*, *29*(3), 253-268.
- Law, S. H., Ng, C. H., Kutan, A. M., & Law, Z. K. (2021). Public debt and economic growth in developing countries: Nonlinearity and threshold analysis. *Economic Modelling*, *98*, 26-40.
- Mbaye, S., Badia, M. M. M., & Chae, K. (2018). *Global debt database: Methodology and sources*. International Monetary Fund.
- Mencinger, J., Aristovnik, A., & Verbic, M. (2014). The impact of growing public debt on economic growth in the European Union. *Amfiteatru Economic Journal*, *16*(35), 403-414.
- Minsky, H.P., 1995. The Financial Instability Hypothesis: A Restatement. In P. Arestis & T. Skouras, eds. Post Keynesian Economic Theory. Sussex: Wheatsheaf Books, pp. 24–55.
- Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of financial economics*, *5*(2), 147-175.
- Note, A. S. (2016, April). Investment and Growth in the Arab World. In *Annual Meeting of Arab Finance Ministers*.
- Palley, T.I. (1996): Post Keynesian Economics: Debt, Distribution and the Macro Economy, London: Macmillan.
- Pereira, A. M., & Rodrigues, P. G. (2005). Public debt and economic performance. *THE LONG-TERM BUDGET CHALLENGE OF THE G-7 NATIONS: AN INTERNATIONAL PERSPECTIVE, J. Hollifield and D. Ippolito, eds*.
- Reinhart, C. M., & Rogoff, K. S. (2010). Growth in a Time of Debt. *American economic review*, *100*(2), 573-78.
- Reinhart, C. M., Reinhart, V. R., & Rogoff, K. S. (2012). *Debt overhangs: Past and present* (No. w18015). National Bureau of Economic Research.
- Ricardo, D. (1955). *The works and correspondence of David Ricardo: Volume 10, Biographical miscellany* (Vol. 10). Cambridge University Press.
- Runde, D. F., Yayboke, E. K., & Ramanujam, S. R. (2019). Achieving Sustainability through Quality Infrastructure. *Center for Strategic and International Studies*.
- Sapkota, J. B. (2015). Infrastructure Access and Human Development: Cross-Country Evidence and Post-2015 Development Strategies. *Journal of Globalization Studies*.
- Sarangi, N., & El-Ahmadieh, L. (2017). Fiscal policy response to public debt in the Arab region. *Economic and Social Commission for Western Asia (ESCWA)*.
- Schwab k. (2019). The global competitiveness report 2016–2017. World Economic Forum.
- Stanton, E. A. (2007). The human development index: A history. *PERI Working Papers*, 85.
- Stupak, J. M. (2017). Economic impact of infrastructure investment. Federal Publications, 7-2017.
- Williams, R. (2015). Serial Correlation [Optional; Very Brief Overview]. Available at https://www3.nd.edu/~rwilliam/ Last revised January 22, 2015.