GCU Economic Journal, Volume LVIII, 2025, pp. 1-41

Navigating Debt Burden: An analysis of Economic Freedom, Logistics Performance and Foreign Aid using Method of Moments Quantile Regression

*Nimra Usman **Muhammad Omer Chaudhry &
*** Asif Javed

Abstract: Navigating debt burden is important because it helps to manage and reduce the impact of debt effectively. This paper examined the influence of economic freedom (EF), logistic performance (LP) and foreign aid (FA) on debt burden (DEB) in 35 debt-prone economies between 2007 and 2018. The empirical findings based on the Method of Moment Quantile Regression (MMQR) confirm that LP and FA have a significant positive association with DEB across all quantiles. Interestingly, the outcomes also reveal that the relationship between EF and DEB is not straightforward and shows a varying pattern across different levels of debt. The findings suggest a positive relationship for lower quantiles and a negative relationship for higher quantiles, thus highlighting the complexity of the relationship between EF and DEB. The robustness checks of the Pool Mean Group (PMG/ARDL), Fully Modified Ordinary Least Squares (FMOLS), Fixed Effects (FE), and Random Effects (RE) validate and reinforce the results of MMQR. We suggest a tailored and personalized strategy to meet the unique characteristics and nuances of each situation rather than using a one-size-fits-all approach.

Keywords: Economic freedom; Logistic performance; Foreign aid; Debt burden; MMQR

JEL: H63; O57; R41; F35; C14

1. Introduction

The world is abuzz with discussions around debt burden (DEB), economic freedom (EF), logistic performance (LP), and foreign aid (FA). These aspects play a crucial role in shaping the global economic landscape. Research has demonstrated that nations with greater EF achieve better

*School of Economics Bahauddin Zakariya University Multan, Pakistan Nimrakhan2390@gmail.com
**School of Economics Bahauddin Zakariya University, Multan, Pakistan omer@bzu.edu.pk
***Department of Economics studies, University of "Gabriele d'Annunzio" Chieti-Pescara, Italy asif.javed@unich.it

economic results than those with less freedom (Ahmed et al., 2023). In addition, the world economy receives an incredible $12 trillion in contributions from the logistics sector (Annual Report 202 | UNDP). Simultaneously, FA surpasses $204 billion annually in 2022, providing a glimmer of optimism for faltering economies (OECD, 2022). Despite these initiatives, the DEB continues to be a major roadblock to advancement.

Prominent academics, including Smith, Ricardo, and Friedman, contend that an economic system based on private property, competitive markets, and free trade yields good outcomes. Other scholars like Marx and Keynes argue that EF leads to sub-optimal outcomes. Ultimately, whether EF yields positive or negative outcomes is an empirical question. Nations in the top quartile of EF had an average per-capita GDP of $48,251 in 2020, compared to $6,542 for nations in the bottom quartile (Gwartney et al., 2023). EF boosts entrepreneurship, innovation & investment, thus fueling growth, creating jobs & improving well-being (Herrera-Echeverri et al., 2014; Ahmed et al., 2023). The multifaceted nature of EF encompassing multiple factors (ease of doing business, protection of property rights, free market access, minimal government regulations, absence of corruption, international trade, contract enforcement, and a stable legal system) are instrumental in forming a country's economic landscape.

Likewise, logistics services are paramount to bolstering economic progress by secured and prompt delivery from producers to consumers and enhancing the competitiveness of both production processes and export delivery, thereby attracting investments and profits (Yildiz et al., 2017; Gani, 2017; Yeo et al., 2020). Effective logistics help establish robust supply chains, improving coordination and reducing waste (Gani, 2017; Yeo et al., 2020). This increased productivity leads to customer satisfaction & economic efficiency (Partyka et al., 2021). In today's world, logistics are crucial for increasing exports, attracting FDI & fostering an interconnected global economy that enhances a country's revenue generation capacity & reduces its DEB.

Quintessentially, Countries in need of support rely heavily on foreign assistance. Nonetheless, how effective FA is in promoting sustainable

economic growth and reducing DEB is a steaming argument (Saibu et al., 2021). FA serves various purposes, such as improving well-being and growth in recipient countries through infrastructure development, entrepreneurship support & increased productivity (Sethi et al., 2019). It also fosters global unity and cooperation (Swiss, 2020) by building diplomatic connections between nations. Additionally, aid plays a critical role in addressing global challenges like humanitarian crises & natural disasters by providing swift assistance for recovery and rebuilding efforts. However, it is essential to ensure transparency & accountability in aid programs to avoid potential pitfalls like debt-traps & misuse by unscrupulous administrations. Additionally, aid initiatives should be aligned with specific local priorities & needs (Islam et al., 2023; Aluko et al., 2010).

Understanding the impact of DEB is crucial as it significantly influences economic stability & government policy decisions (Swamy, 2019). Accumulating high levels of debt poses numerous challenges for a country. One major consequence is the heavy burden of interest payments, which can lead to low creditworthiness & higher borrowing costs for debt-laden nations. This situation makes it harder for governments to access affordable funding, limiting their ability to invest in vital sectors. Improper debt management can also trigger inflation, currency devaluation, & financial crises (Patri et al., 2022), further destabilizing a country's macroeconomic environment. Governments often resort to structural adjustment programs recommended by IFIs to tackle these issues, but these measures can sometimes exacerbate the socioeconomic challenges faced by debt-ridden nations. Therefore, policymakers must carefully assess the level of debt to make informed decisions.

The real world is intertwined, and thus, a straightforward relationship among the variables mentioned above is far from reality. These variables can influence each other in a myriad of ways. e.g., a country's EF is constricted by escalating debt levels. An indebted country might also struggle to provide essential services to its inhabitants. Conversely, A higher level of EF frequently leads to better LP. Autonomous businesses operate efficiently, establish strong supply chains, enhance transportation networks & optimize logistical processes, fostering smoother trade flows & growth. Additionally, efficient logistics are vital for effective aid distribution. Moreover, EF can impact a country's reliance on FA. Increased

EF attracts more foreign investment, potentially leading to stronger domestic growth & reducing the need for external funding. While FA remains crucial for nations with limited EF, it can also support their long-term development efforts. In its entirety, the global socioeconomic landscape is intricately shaped by interconnected forces and recognizing these interdependencies allows us to navigate the complexities of our intertwined world (Hayaloğlu, 2023).

The primary objective of this study is to examine the empirical and theoretical dimensions regarding the impact of EF, LP and FA on the financial wellness of selected countries, specifically focusing on DEB with a set of macroeconomic indicators (Trade/GDP, GDP growth rate). The study aims to provide a comprehensive analysis of how these factors interplay & influence the economic stability and debt levels of nations. Centred on this core objective, the following hypothesis is postulated by this study: *H1:* There is a compelling and intertwined linkage among EF, LP, FA and DEB. *H2:* Increased levels of EF and GDP growth are anticipated to lessen DEB. Additionally, we foresee that an amplified reliance on FA and enhanced TO will be adverse to the DEB. *H3:* As LP advanced, countries may experience higher levels of debt to support and maintain their logistic operations.

With these considerations in mind, the following are the contributions made by this study: *(i)* Prior studies have largely overlooked the simultaneous consideration of DEB, EF, LP, and FA. An ongoing study is a pioneering endeavour that examines the interplay of these variables within a single comprehensive analysis. This endeavour dug into the intricate relationships and potential synergies between these variables, offering a more nuanced understanding of the complexities surrounding debt accumulation and management. *(ii)* This study narrows the investigation to debt-ridden economies shedding light on the challenges faced by them. Debt-ridden economies are often grappled with high debt burdens, limited financial resources, and complex geopolitical dynamics that impact their economic stability. By delving into the specific challenges and opportunities present in these economies, we offered targeted recommendations & strategies to

address debt sustainability. This customized approach enhances the applicability and relevance of findings, enabling a more impactful contribution to the ongoing discourse on debt management. *(iii)* This study further includes LP as a variable that represents a novel approach in DEB studies. This addition allows us to explore the impact of logistical efficiency on DEB, a facet rarely explored in existing literature. By exploring this aspect, our study fills a significant gap in the literature and provides a more comprehensive view of how logistics can impact debt management strategies. *(iv)* Prior studies used a variety of statistical tools, e.g., GMM, Quantile regression, VAR modelling, ARDL, and OLS, to examine how different factors relate to DEB (Sharma et al., 2023; Mohsin et al., 2021; Sethi et al., 2019). Nevertheless, to the best of the researcher's understanding, MMQR has not been utilized in this specific field. This endeavour seeks to bridge this vacuum by introducing MMQR. This method allowed for exhaustive inquiry across different quantiles to understand the delicate relationship between variables. Further, the study explored the causal relationship between variables using a causality test, which is followed by a robustness check.

The rest of the study is structured as follows: Section 2 renders an overview of existing literature; Section 3 lays out theoretical underpinnings and econometric methodology employed for the study. Section 4 presents the results and a further discussion. Finally, Section 5 capitalizes inferences & policy implications based on findings.

2. Literature Review

This study conducted a literature survey to understand debt dynamics, which highlighted that the relationship of debt with associated factors is not straightforward & may vary across different populations.

2.1 Economic Freedom and Debt: Exploring the Link

Literature has explored the origin & evolution of EF and DEB. Studies have shown an inverse relationship between EF & debt, indicating that countries with strong economic institutions tend to have lower DEB (Vojnovic, 2022; Roychoudhury & Lawson, 2010; Mura et al., 2023). Further, Berggren et al. (2019) found that regulatory autonomy reduces DEB. Khan et al. (2021) highlighted how EF strengthens finance in developing nations, emphasizing

efficient debt management & the impact of structural changes on financial outcomes. Ahmed et al. (2023) demonstrated the positive influence of EF on economic growth in South Asia, with different components of EF & economic crises playing distinct roles. Miraj Ul Haq (2020) identified that stable & democratic economies lead to increased EF, emphasizing that FA, regardless of its form, negatively affects economic freedom in the recipient country.

2.2 Logistic Performance and Debt Management

Contemporary studies found a significant diverging interplay between LP and debt dynamics. One study by (Cheng, 2023) evidenced a considerable negative relationship between LP and the commercial and industrial debt level indicating that with logistical efficiency, financial pressure on firms will reduce. Ye et al. (2024) pointed enhanced stability of logistics is crucial for handling cost of debt thereby highlighting that improve LP leads to favourable debt scenario. Another study noted that supply chain disruptions are negatively correlated to financial leverage. We can infer that firms will increase their financial leverage with the improvement of logistics thus greater reliance on debt (Ginn and Saadaoui, 2024). Another study by (Dzacka, 2024) evidenced a weak negative association between LP and level of debt in Ghana, pinpointing that stable LP does not necessarily reduce debt. This indicates that other elements are more pronounced in driving challenges of debt.

2.3 Foreign Assistance in Debt Management: Impact and Consideration

The engagement and effectiveness of IFIs in regulating & influencing debt has generated considerable debate in academic circles. While some studies advocated a positive impact on debt management & economic stability (Bjerg et al., 2011; Meraj et al., 2024; Bjørnskov and J.H. Schröder, 2013), others expressed concerns about the possible downsides of interventions from IFI (Tombofa et al., 2013; McGillivray and Ouattara, 2005). Studies revealed the diverse impacts of debt relief on economies (Tiruneh & Wamboye, 2017), the consequences of bailouts on borrowing trends (Fink

& Scholl, 2016) and the crucial need to assess financial aid's effectiveness in promoting growth and preventing crises (Stupachev, 2022; GÜNDÜZ et al., 2022). The importance of project size in fund allocation is also underscored (Krahnke, 2020). Studies also investigated the role of the IMF in restructuring public debt over time (Hagan, 2020; Jorra, 2012). Bird & Rowlands (2017) praised IMF programs for boosting growth in LICs. Guzman (2015) criticized the IMF's debt sustainability framework, advocating for changes. Smets and Knack (2014) discussed how IMF involvement impacts countries' debt maturity based on financial strength.

Table 1 Literature Summary

Author(s)	Sample	Time Period	Methodology	Expected Relationship
Magnini &Vojnovic, (2023)	71 countries across 5 continents	1990-2020	GMM	EF→ DEB (-)
Mura et al. (2023)	10 CEE countries	1995-2020	VECM	DEB→ EF (-)
Tombofa et al. (2013)	Nigeria	1981-2010	ECM	FA→ DEB (+)
Bakhtiari et al. (2013)	Asian and LA countries	1991-2010	FRM	FA→ DEB (-)
McGillivray & Ouattara, (2005)	Côte d'Ivoire	1975-1999	FRM	FA→ DEB (+)
Roychoudhury & Lawson, (2010)	93 countries	2000-2006	Regression Analysis	EF→ DEB (-)
Bjørnskov & J.H. Schröder, (2013)	93 countries	1976-2005	GMM	FA→ DEB (-)
Bjerg et al. (2011)	38 LDCs	1960–2000	FEM	FA→ DEB (-)
Ouattara, (2006)	68 countries	1980–2000	FE+RE	FA→ DEB (-)
Meraj et al. (2024)	Pakistan	Survey 2016-17	ECM+ARDL	FA→ DEB (-)

POWELL & Bird, (2010)	42 SSA countries	1988-2006	GMM	FA→ DEB~(T)
			PVAR	GDP→ DEB (-)
Swamy et al. (2015)	252 countries	1960-2009	ARDL	
	Uganda			GDP→ DEB (-)
Ssempala et al. (2020)	Pakistan	1980-2016	ARDL	
			GMM	TO→ DEB (+)
Ahmed et al. (2016)	Türkiye	1970-2012		TO→ DEB (+)
Kızılgöl et al. (2014)		1990-2012		

Note: DEB = Debt Burden, FA = Foreign Aid, EF = Economic Freedom, GDP= GDP growth rate, TO=Trade Openness, (~T) =varies over time, → = represents.

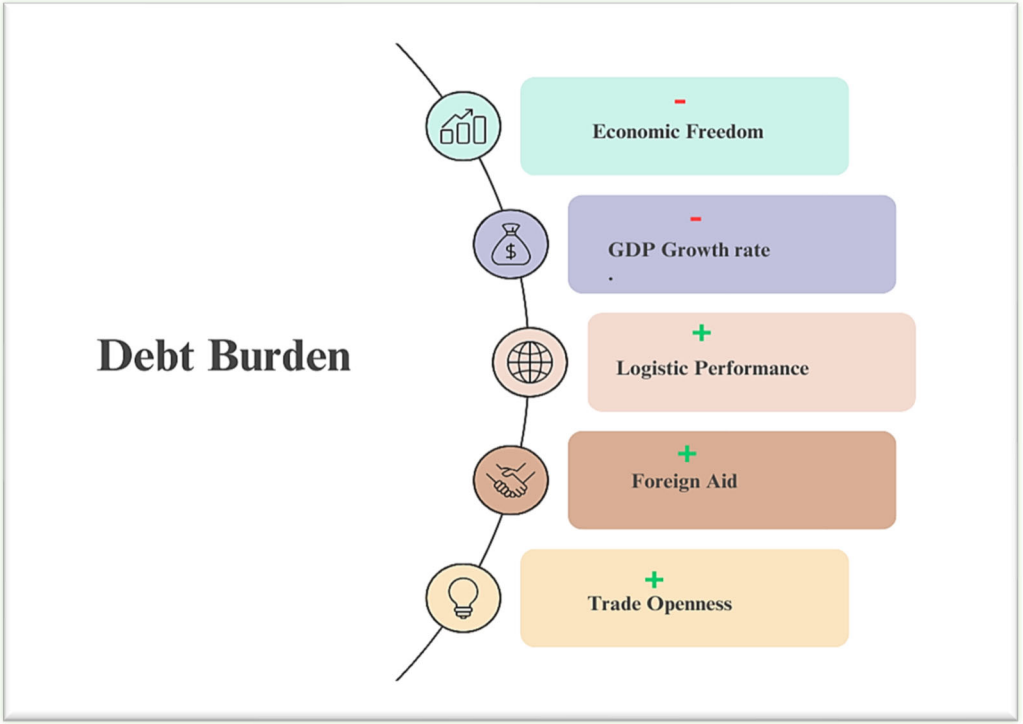

Fig. 5 Anticipated connections between DEB & key variables

Source: Authors own using existing literature

2.5 Literature Gap

It is evident from the literature survey that studies have ignored the interplay of factors in a single setting. Besides, the results from prior studies about the impact of FA on DEB are inconclusive. This shows room for further exploration. This study aims to fill this gap by examining the cumulative effect of LP, FA & EF on DEB of Asian-African countries. This focus provides unique & location-specific findings. With the incorporation of the least explored LP in relation to DEB, this study hopes to expand the scope of existing literature. Furthermore, it employs MMQR, which stands out from traditional approaches because of its reduced vulnerability to outliers & heteroscedasticity. It helps in understanding how the relationship between variables evolves across a spectrum of values. To the best of our

understanding, this novel technique has not been employed to study DEB, thus providing a robust comprehension of debt dynamics.

3. Theoretical Mechanism, Data and Methods

3.1 Theoretical underpinnings and model

Theoretical underpinnings provide a sound base to understand the subject matter & are as follows.

Debt Sustainability Analysis Frameworks: The debt sustainability analysis **(**DSA) framework evaluates a country's debt management capacity, considering factors like debt-to-GDP ratio, sovereign debt servicing capability & external debt risk assessment. This comprehensive approach aids policymakers in making informed decisions to maintain a stable financial footing over time. Studies utilized DSA to comprehend the influence of debt sustainability on EF (Grosu et al., 2022; Ahmed et al., 2023) and suggested that persistent DEB pose debt management risks for a country along with compromise on its EF. Further, how LP impacts DEB is studied by (Bouabdallah et al., 2017) in the eurozone and provided with a comprehensive DSA-based strategy to deal with financial uncertainties. DSA framework is reinforced by (Di Bella, 2008) to understand how FA & DEB impact the sustainability of debt.

Institutional Theory: DiMaggio and Powell (1983) suggested that both formal & informal rules shape economic outcomes & behaviour. It is, therefore, crucial to comprehend how institutional factors impact decisions relating to debt choices. Key ingredients of institutional theory are institutional isomorphism, proactiveness, cognitive abilities and normative dynamics. Hussain et al. (2016) found that improved EF positively influence economic growth, with a significant role played by institutional factors. Herrera-Echeverri et al. (2014) found that institutional quality and EF have a strong positive relationship with business generation in emerging economies. (Glenn et al., 2005) applied institutional theory to forecast

effects on environmental sustainability in reverse logistics monitoring systems. Institutional procedures & legislation also influence debt-relating decisions and affect borrowing costs (Zhang et al., 2016). Thus $\gamma_1 = \frac{DEB_{it}}{EF_{it}} < 0$.

Agency Theory: Agency theory (Meckling et al., 1976) sheds light on the competing interests of agents involved in debt management. Borrowers, lenders & policymakers often have different priorities. Agency theory is instrumental in understanding the principal-agent relationship (Carbonara et al., 2018). Otáhal (2012) used this theory to analyze the impact of agency problems on EF. It provided perspective on how information asymmetry, moral hazard & the alignment of the interest of lender & borrower shape the behaviour & decisions of the actors involved. Studies also used agency theory to gauge how the nexus of principals & agents in organizations impacts the efficiency of logistics (Uyar et al., 2021; Partyka et al., 2021). Further, the association between DEB & FA is investigated by (Winters et al., 2010), who reported that FA performs better with enhanced stakeholder engagement. Thereby, $\gamma_2 = \frac{DEB_{it}}{LP_{it}} > 0$.

Resource Dependence Theory: Resource Dependence Theory (RDT) **(**Pfeffer and Salancik, 1978) argues that organizations & entities are at the mercy of their environment, and this necessitates adaptability to their environment to secure resources. Organizations try to cope with uncertain environments & increase their access to vital resources for their survival as they navigate a complex environment with minimal control due to dependency on multiple external elements such as suppliers, investors or government agencies. Drees et al. (2012) explained that mutual collaboration between two organizations is used as a pivot by organizations to enhance their legitimacy, which then improves their performance. RDT is used to highlight enhancing collaborations between organizations and logistics suppliers (Van et al., 2020; Jiang et al., 2022). Studies employed RDT to warn about over-reliance on external resources that could limit a country's EF, emphasizing the importance of carefully analyzing loan terms to avoid falling into a debt trap (Hailu et al., 2016; Aluko, 2010) Therefore, $\gamma_3 = \frac{DEB_{it}}{FA_{it}} > 0$.

This study developed the following model to establish the direction and magnitude of the relationship between variables.

$$DEB_{it} = f\ (EF_{it}, LP_{it}, FA_{it}, TO_{it}, GDP_{it}) \quad (1)$$

The baseline model for panel data settings can be defined as:

$$DEB_{it} = \gamma_0 + \gamma_1 EF_{it} + \gamma_2 LP_{it} + \gamma_3 FA_{it} + \gamma_4 TO_{it} + \gamma_5 GDP_{it} + \varepsilon_{it} \quad (2)$$

This model represents modelling from country one to thirty-five; hence, subscript I =1,2, 3,…..,35, t=2007,2008,….,2018 showing time period & ε_{it} is the error term. Here, γ_0 represents the intercept term. Other coefficients represent the slope for independent variables. Coefficients facilitate the comprehension of the direction and magnitude of the impact of one variable on another.

3.2 Data

The composition of panel involves 35 economies (See ANNEX-I) and covers years spanning 2007-2018, providing a considerable degree of freedom. The sample ensures a diverse representation of economies whose selection is made upon careful considerations following the subsequent characteristics of policy convergence, availability of data & shared economic challenges. The dependent variable is DEB, which is measured by Gross debt-to-GDP. This proxy indicates the ability of a country to repay its debt relative to its economy's size. While net debt-to-GDP comes up with a more refined picture as it considers adjustments due to the poor availability of its data, gross Debt-to-GDP is the ideal selection for this research, and it is also backed by literature (Horton et al., 2010; Turan 2013). Independent variables are EF measured by EFI (Sharma and Tokas, 2023; İMRE et al., 2020), LP using LPI (Arvis et al., 2014; Semis et al., 2017; Marti et al., 2014) & FA whose magnitude & effectiveness is quantified by NODA (Perveen, 2021; Nicolás et al., 2022). In contrast, this study controlled for TO and GDP. (See Table 2 for description & sources of variables).

Table 2 Description of variables and source

Variables	Symbols	Measurement	Source	References
Debt Burden	**DEB**	Gross debt/GDP	World Economic Outlook (IMF)	Ssempala et al. (2020) Swamy, (2015)
Economic Freedom	**EF**	EFI (comprising 12 indicators that determine the score, indicating the level of effectiveness, with 0 (lowest) and 100 (highest possible) score.	Heritage Foundation	Vojnovic, (2023) Mura & Donath, (2023)
Logistic Performance	**LP**	LPI (comprising 6 key indicators showing level of significance. The score typically ranges between 0 (lowest) and 100 (highest).	World Bank	Yildiz et al. (2017) Karanina et al. (2020)
Foreign Aid	**FA**	NODA (aid + grant)	World Bank	Mazher et al. (2022) Sethi et al. (2019)
Trade Openness	**TO**	Trade/GDP	World Bank	Mohsin et al. (2021) Ahmed et al. (2016)
GDP Growth rate	**GDP**	annual %	World Bank	Swamy et al. (2015) Ssempala et al. (2020)

Note: **EFI=** Economic Freedom Index, LPI= Logistics Performance Index, NODA= Net Official Development Assistance Received

3.3 Estimation Strategy

Panel data demands initially to inquire about the nature & characteristics of data. A series of diagnostic tests are then performed to determine the most appropriate estimation technique to explore the empirical relation of a model. The current study has an econometric strategy involving seven steps (see Fig 6). In the *1st-step* of the estimation process, the parameters' slope coefficient heterogeneity (SHT) is tested by utilizing the Pesaran and Yamagata (2008) test. *2nd-step* involves checking cross-sectional dependency (CSD) using (Pesaran, 2007) test. The stationarity properties of the underlying variables are evaluated in *3rd-step* by performing 2nd-generation LLC (Levin, Lin, and Chu, 2002), Cross-sectionally augmented Dicky-Fuller (CADF) & cross-sectionally augmented Im-Pesaran-Shin (CIPS) (Pesaran, 2007) tests. Long-run cointegration association among the variables is confirmed by employing Persyn and Westerlund (2008) and Pedroni (1999) cointegration tests in the *4th-step*. In the *fifth step*, the long-term connections between variables are observed using the (MMQR) technique. *6th-step* deals with robustness checks by employing FMOLS, PMG, and FE. Causality direction among the variables is investigated by employing (Dumitrescu & Hurlin, 2012) test in a *final step*.

Fig. 6 Flow chart of estimation strategy

Source: Authors own

3.3.1 Slope heterogeneity test

The issue of varying slopes is frequently encountered while modeling data, even in the panels that show CSD. This study takes on (SHT) introduced by Pesaran and Yamagata (2008), to ensure the applicability of the dataset. The purpose of SHT is to find whether the strength or direction of the relationship is the same or different among distinct groups. Here, slope heterogeneity can be expressed as follows:

$$\tilde{\Delta}_{SH} = (N)^{\frac{1}{2}} (2X)^{\frac{1}{2}} \left(\frac{1}{N}\tilde{S} - X\right) \quad (3)$$

$$\tilde{\Delta}_{ASH} = (N)^{\frac{1}{2}} \left(\frac{2X(T-X-1}{T+1}\right)^{-\frac{1}{2}} \left(\frac{1}{N}\tilde{S} - 2X\right) \quad (4)$$

3.3.2 Cross-sectional dependency tests

Owing to the interconnectedness of the real world, CSD are often present in datasets which could overdo outcomes. Possible reasons for CSDs are spillover effects of economic policies, global financial crises, trade agreements, etc. Likewise, countries that receive foreign aid might be subject to certain conditions or policies that can create CSDs. Therefore, this paper has used Pesaran (2004) CD test, Pesaran (2004) scaled LM test and Breusch Pagan (1980) LM test to address this concern. The modified equation for this analysis is as follows:

$$CSD_{TM} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=0}^{N-1} \sum_{j=i+1}^{N-1} \delta_{ij} \quad (5)$$

Where, the correlation of the pair-wise parameters is denoted as δ_{ij}, N is the cross-sections while the period is depicted as T.

3.3.3 Unit root tests

LLC stationarity test by (Levin, Lin, and Chu, 2002) is utilized in this study together with (CIPS) and (CADF) that were put forth by (Pesaran, 2007). Stationarity tests are crucial for determining whether the variables present in the panel exhibit a consistent & uniform trend over time or not. CIPS & CADF are called 2nd-generation stationarity tests because they outperform standard tests of stationarity by taking into account CSD. They also offer reliable results for panels indicating the problem of slope heterogeneity. These tests further detect structural breaks and thwart spurious regression for accurate results. Following is the mathematical expression for the panel unit root test:

$$\Delta Y_{i,t} = \varphi_i + \varphi_i Y_{i,t-1} + \varphi_i \bar{X}_{t-1} + \sum_{i=0}^{v} \varphi_{i,t} \Delta \overline{Y_{t-\iota}} + \sum_{i=1}^{v} \varphi_{i,t} \Delta \overline{Y_{t-\iota}} + \varepsilon_{it} \quad (6)$$

Here, $\bar{X}_{t-1}$ denotes the lagged parameter & the symbol of $\Delta\overline{Y_{t-\iota}}$ Illustrates the first Difference of lagged parameter. Whereas the statistics for CIPS are based on the average statistics of CADF. The expression for CIPS is as follows:

$$\widehat{CIPS} = \frac{1}{N}\sum_{i=1}^{n} CADF_i \quad (7)$$

3.3.4 Cointegration test

The intended purpose of a cointegration test is to ascertain the presence of a long-term relationship between variables. It helps in determining if these variables move together in the long run, despite potential short-term variations. This paper utilizes the studies from (Persyn & Westerlund, 2008) and Pedroni, (1999). Westerlund cointegration is opted for, as it permits CSD in data, while Pedroni cointegration approach considers potential deviation in the cointegrating relationship across different groups in a panel.

3.3.5 MMQR Method

This study adopts an advanced method of moment quantile regression for estimation. The theoretical foundation of MMQR is based on assessing the correlation between variables across different quantiles of distribution. Mainstream statistical techniques have limitations in capturing differences in the impacts of experimental variables over distinct quantiles because of distributional and heterogeneous effects. This oversight is owing to their focus towards calculating single point estimates. This limitation could make the results less precise when substantial variations across quantiles exist. For this purpose, a technique of moment quantile is employed. Computation using this technique exhibits a thorough understanding of how explanatory variables steer response variables across different quantiles. This is contrary to the standard assumption of uniform relationship across all quantiles & thereby gives a precise idea about the varying impact of independent variables across the entire division (Lamarche et al., 2019; Ike et al., 2020; Chen et al., 2021; Javed et al., 2024).

As the real world does not conform to established normalcy standards, MMQR becomes more relevant as it handles skewed distribution. This

flexibility enables us to understand the relationships across a wide range of contexts (Canay, 2011). Results obtained from MMQR are compact and offer a clear explanation for estimated coefficients. Results can further be displayed using quantile plots, providing a handy, graphical & amplified version of communication that helps in better understanding. MMQR is robust to outliers, and extreme values do not sway the results because this method calculates for quantiles instead of estimating average values. It provides a perspective across different segments of distribution because of its consideration for a full spectrum of values for DEB, therefore yielding reliable estimates & fundamental trends in the dataset.

One possible difficulty in the MMQR panel could be the likelihood of unobserved variations across individual units. The underlying reason is that the effects of conditional heterogeneity tend to be centred around a mean value. This potential difficulty could underestimate the ability of independent variables to drive our interested outcomes. Thereby, careful consideration of unobserved heterogeneity is prescribed (Koenker et al., 2004).

A customized version of the location-scale model for MMQR estimation is given below (Machado and Silva, 2019; Adebayo et al., 2022).

$$\Omega DEB\left(\frac{\tau}{X_{it}}\right) = \left(ai + \beta iq(\tau)\right) + X_{it}\varphi + \Upsilon_{it}xq(\tau) \quad (8)$$

Whereas $\Omega DEB\ (\tau/X_{it})$ reflects the distribution of DEB across different quantiles. Explanatory variables are denoted by vector $X_{it}\varphi$, while $ai + \beta iq\ (\tau)$ represents the scalar coefficients for different quantile levels in a dataset. Symbol (i) shows quantile fixed effect and (τ) denotes distributional effects. Υ_{it} is the vector of known differentiable transformations of explanatory variables, where i = 1… k and q (τ) is the (τ-th) quantile produced from the following optimization function:

$$\frac{Min}{q}\ \Sigma_i\Sigma_I\ \rho\ (R_{it} - (\beta i + \Upsilon' itx)q) \quad (9)$$

The estimation function is as follows:

$$\rho\tau\,(A) = [\tau - 1]AI(A \leq 0) + TAI(A \succ 0) \quad (10)$$

3.3.6 Robustness Check

Robustness checks evaluate the responsiveness of inquiry to different approaches and, therefore, strengthen the reliability and validity of a study. Ongoing study employs PMG/ARDL, FMOLS, FE, and RE. Following is the reasoning for employing these checks: The model of PMG/ARDL examines how different variables influence each other over time in group settings, keeping in mind the short and long-term impacts (Pesaran, 1999). FMOLS settles for endogeneity problems and tackles inaccuracies in the measurement of data (Pedroni, 2001). FE reflect individual characteristics of variables that show consistent behaviour over time, while RE captures variability in individual traits across all observations over time. This way, the reliability of results can be assured and timely corrections for the differences can be made (Teachman et al., 2001).

3.3.7 Dumitrescu-Hurlin panel causality

A causal relationship between the variables is figured out by (Dumitrescu & Hurlin, 2012) test. This test inspects for the direction of cause-and-effect linkage. This test is suitable for heterogeneous panels with varied characteristics among individual units. This expanded version of the Granger Causality test (1969) accounts for CSD and can also handle non-linear complex relationships. This improved version has dual predictive powers. While Granger causality focuses on unidirectional causality, this test focuses on the simultaneous influence of two variables on each other, suggesting a bidirectional cause-and-effect relationship. Furthermore, this test assumes that the causal association can differ across countries that are included in the panel in terms of strength and significance, contrary to Granger causality, which presupposes uniform causal linkage across all cross-sections. This leverage provides a good degree of flexibility in capturing causal variations across different group settings. Expression for causal estimation is crafted as follows:

$$X_{i,t} = \vartheta_i + \sum_{j=1}^{p} \varphi_t^i W_{i,t-j} + \sum_j^p \delta\varphi_t^i Q_{i,t-j} \quad (11)$$

Herein, autoregressive parameters are represented by the symbol of φ_t^i & j denotes lag length.

4. Results and Discussion

4.1 Results

The overall pattern and characteristics of data can be understood by the descriptive statistics shown in Table 3. Mean values serve as a reference point that helps us understand the distribution of data. Conversely, the spread of data can be cognized by standard deviation.

Table 1. Summary of descriptive statistics

	DEB	EF	LP	FA	GDP	TO
Mean	36.56381	56.35667	2611815	4.436989	5.091813	67.15974
Median	34.00000	56.20000	2550000	2.951930	5.306690	58.02539
Maximum	129.6000	74.50000	3.775321	37.36543	17.29078	192.4655
Minimum	4.100000	40.30000	1.610000	-0.052359	-14.10000	20.72252
Std. Dev.	18.94742	5.955914	0.355383	5.525697	3.042036	31.94861
Skewness	1.205750	0.063038	0.687784	2.391773	-0.783742	1.299844
Kurtosis	6.001478	3.155543	3.645250	10.86553	7.820593	4.163799
Jarque-Bera	259.4237	0.701557	40.39936	1483.106	449.6646	141.9741
Probability	0.000000	0.704140	0.000000	0.000000	0.000000	0.000000
Sum	15356.80	23669.80	1096.962	1863.535	2138.562	28207.09
Sum Sq. Dev.	150423.0	14863.15	52.91850	12793.46	3877.420	427679.0
Observations	420	420	420	420	420	420

Table 4 provides the findings of CSD tests. Breusch-Pagan LM, Pesaran CD & Pesaran scaled LM tests yielded statistically significant results at a 1% probability level, suggesting the presence of CSD in the overall data.

Table 4. CD-Tests results

Test	Statistics
Breusch-Pagan LM	2759.552***
Pesaran CD	30.91409***
Pesaran scaled LM	62.74724***

Note: Asterisk *** show a 1% level of significance.

The results from SHT (See Table 5) yielded significant results at 1% level. The statistics for delta and $\tilde{\Delta}$adjusted indicate that there is significant variation in the slopes of analyzed variables. This suggests that the relationship between the variables may differ across different groups. The $\tilde{\Delta}$ and $\tilde{\Delta}$adjusted values in SHT are measures of the magnitude of slope heterogeneity of variables. The $\tilde{\Delta}$adjusted takes into account the sample size and other factors to provide a more accurate measure of heterogeneity.

Table 2. Slope heterogeneity

Test	Statistics
$\tilde{\Delta}$	5.350***
$\tilde{\Delta}$adjusted	8.288***

Note: Asterisk *** shows a 1% level of significance**.**

Stationarity tests are computed for both levels and the 1st-difference of variables (See Table 6). LLC, CADF, and CIPS tests show significant results suggesting the presence of unit roots in variables. This means that the variables exhibit a trend over time. While the level results look at the variables in their original form, the 1st-difference results conform to looking at the variables after taking the Difference between consecutive observations. Negative coefficient values indicate that the variables are nonstationary. As for CADF and CIPS, the initial values of variables were not in the range of statistical significance, which led to conduct first difference test.

Table 6 Unit-root tests results

	LLC		CADF		CIPS	
Variables	**Level**	**1st Difference**	**Level**	**1st Difference**	**Level**	**1st Difference**
DEB	-6.1739***	-18.3755***	-2.187***	-2.624***	-2.036*	-3.283***
EF	-2.7685***	-4.1162***	-1.972*	-2.028**	-2.016	-3.307***
LP	-9.0096***	-15.8192***	-3.059***	-3.076***	-1.638	-1.868*
FA	-3.3160***	-8.5368***	-1.670	-2.423***	-2.379***	-3.553***
GDP	-9.4418***	-23.0625***	-2.050**	-2.912***	-2.424***	-3.613***
TO	-5.5045***	-9.9822***	-1.420	-2.136**	-1.513	-2.704***

Note*:* Asterisks ***, ** & * show a 1%, 5% & 10% level of significance, respectively.

This study further applied Westerlund and Pedroni cointegration tests to gauge the presence of cointegration association among variables (See Table 7). Westerlund cointegration test considers CSD and heterogeneity while giving robust results. Variance ratio (VR) shows significant cointegration at a 1% significance level. It measures the extent to which the variables being analyzed are influenced by common factors across the cross-sectional units. Likewise, the Pedroni cointegration test with a common AR (autoregressive) parameter shows significant test statistics at a 1% probability level, indicating interdependencies among countries.

Table 7. Cointegration tests results

	Pedroni test	**Westerlund test**
	Statistics	**Statistics**
VR mod.	-7.5788***	8.0498 ***
PP mod.	6.5973***	
PP	4.0841***	
ADF	5.1146***	

Note: Asterisk *** shows a 1% level of significance**.**

Given the confirmation of the long-run cointegration relationship among the variables, it becomes crucial to estimate the long-run coefficients of each regressor. Therefore, the present paper employed the MMQR approach (See Table 8).

Starting by summarizing the overall findings of MMQR for 0.10-0.90 quantiles, LP shows a consistent pattern of a statistically significant positive association across different levels of DEB. This suggests that as LP improves, DEB increases. The coefficient value in Q.10 (9.943993***) for LP indicates that for every unit increase in LP, the DEB increases by approximately 9.94 units. The p-value of 0.000 suggests a significant relationship that is highly unlikely to occur by chance. This means that LP has a significant impact on DEB. Similarly, the results of LP for the rest of the quantiles can be understood. The standard error values in MMQR results show the average amount of variation in the estimated coefficients of independent variables. A smaller standard error indicates a more precise

estimate, while a larger standard error suggests more uncertainty in the estimated coefficients.

FA and TO also show a consistent and statistically significant positive relationship with DEB. E.g., FA (0.10) shows a coefficient value of (.758). This tells that for every unit increase in FA, DEB increases by 0.759 with a 1% probability level, confirming a strong positive relationship between the explanatory variable FA and DEB. Similar is the interpretation for the rest of the quantiles. Moreover, the positive association of TO with DEB explains that with an increase in trade openness, DEB tends to increase.

Regardless of the quantiles, this study found a negative relationship between GDP growth and DEB. This suggests that as GDP growth increases, DEB tends to decrease across all levels of DEB. These findings indicate a robust and consistent pattern in this study. The relationship of EF seems to vary across different levels of DEB, which is quite interesting to observe. This association gradually drifts from positive to negative as we move from lower to higher quantiles. This gradual shift proposes the consideration that EF impact differently for different debt levels.

MMQR also provide location and scale results where the scale deals with the degree of variability between variables, and the location deals with the average relationship between the studied variables. Small values of scale convey the consistency of relationships across different quantiles and vice versa. Similarly, a larger value of location indicates a comprehensive strong positive relationship for a variable and smaller values of location are associated with an overall negative relationship for a variable against DEB.

Table 8. Method of moment quantile regression results

			Lower Quantile				Middle Quantile			Upper Quantile	
Variables	**Location**	**Scale**	**Q.10**	**Q.20**	**Q.30**	**Q.40**	**Q.50**	**Q.60**	**Q.70**	**Q.80**	**Q.90**
LP	13.6***	2.7	9.9***	10.6***	11.5***	12.2***	13.1**	14.0***	14.8***	16.1***	18.9***
	(2.834)	(1.897)	(2.612)	(2.449)	(2.385)	(2.438)	(2.661)	(2.975)	(3.355)	(4.070)	(5.708)
FA	.9***	.14	.75***	.79***	.84***	.87***	.92***	.97***	1.01***	1.08***	1.22***
	(.198)	(.132)	(.182)	(.171)	(.166)	(.170)	(.186)	(.208)	(.234)	(.284)	(.399)
EF	-.13	-	.30**	.21	.11	.036	-.075	-.175	-.272	-.424*	-.741**
	(.157)	.31***	(.144)	(.136)	(.133)	(.136)	(.149)	(.166)	(.187)	(.230)	(.319)
		(.105)									
GDP	-1.1***	-.43**	-.53**	-.65**	-.79***	-.89***	-	-	-	-	-
	(.303)	(.203)	(.279)	(.262)	(.255)	(.261)	1.05***	1.19***	1.32***	1.53***	1.97***
							(.285)	(.318)	(.359)	(.439)	(.612)
TO	.16***	.014	.144***	.148***	.153***	.157***	.162***	.167***	.171***	.179***	.194***
	(.027)	(.0187)	(.0257)	(.024)	(.023)	(.024)	(.026)	(.029)	(.033)	(.040)	(.056)

Note*:* Asterisks ***, ** & * show a 1%, 5% & 10% level of significance, respectively.

Figure 7 shows a graphical plot of estimated quantiles against independent variables. It visualizes how the relationship between variables changes across different quantiles of DEB. The slope of the line in the plot determines the direction of a relationship. A downward slope line indicates a negative relationship, and an upward slope line indicates a positive relationship between the explanatory variable and DEB. A careful examination gives a negative relationship between EF and GDP with DEB, showing that with improved EF and GDP, the DEB of a country reduces. Likewise, LP, FA, and TO show a positive relationship with DEB, which means that with an increase in aid support foreign funding, improved LP, and increased TO, DEB also increases. Plots for LP, FA, GDP growth, and TO show that the relationship is consistent across different quantiles.

Concerning EF, an assorted linkage has been found that varied along different quantiles. This non-linear relationship points out that myriads of factors are at play in different areas of distribution. Possible explanations can be developed using agency theory for this pattern. For example, lower quantiles show a small part of true data and thus can be interpreted as quantiles with lower EF. This shrunken freedom leads to bad governance and higher costs associated with agencies leading to inefficient allocation of resources and burgeoning DEB.

On the other hand, higher quantiles are associated with higher EF, which, of course, improves governance mechanisms. By this channel of influence, agency costs can be cut down with improved allocation of resources and better management of debt (Solomon et al., 2021; Carbonara et al., 2018). From the lens of institutional theory, a framework of institutions is weaker in countries with poor EF and thereby, they have poorly developed financial markets. These systematic inefficiencies raise the borrowing costs that result in aggravated DEB. So is the case with alternative situations where countries with improved EF have strong institutions, and this strengthens their regulatory frameworks. These countries experience lower rates of borrowing that can ultimately reduce their DEB (Zhang et al., 2016; Echeverri et al., 2014). Discrete lines in Fig 7 express different thresholds of DEB. Whereas the shaded blue area shows the confidence interval.

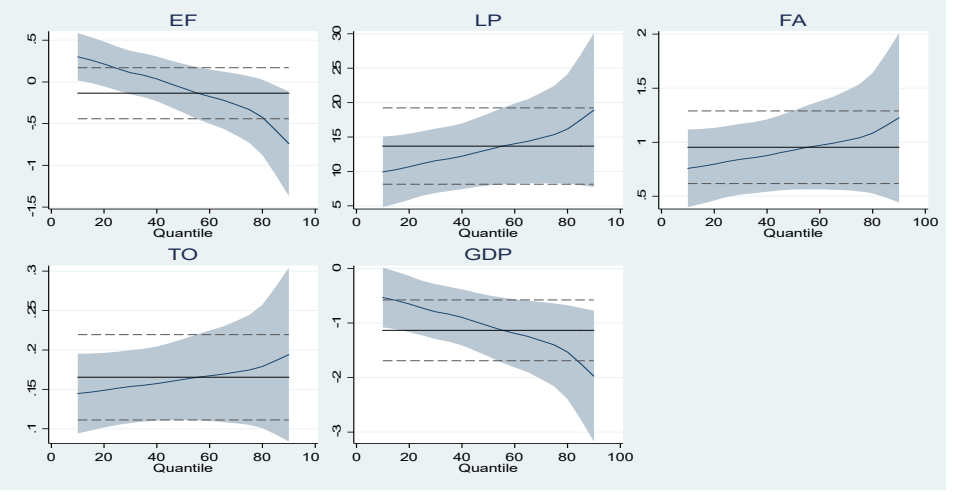

Figure 7 Plot of MMQREG results

The reliability of the results for this analysis is ensured by the employment of regression checks, including FMOLS, FE, RE and PMG/ARDL (Teachman, 2001; Pedroni, 2001; Pesaran, 1999). Results of these tests (See Table 9) confirm a significant association of EF, LP, FA, GDP and TO with DEB in selected countries. (Consult Fig. 8 for projected estimates from adopted methods).

Table 9 Robustness check

Variables	PMG	FMOLS	FE	RE
LP	17.51784***	19.12965***	19.05153***	18.40668***
FA	0.877319***	0.262593***	.3474221	.6029342**
EF	-0.219872**	-0.647921***	-.6750707***	-.4972969**
GDP	-1.819165***	-1.492189***	-1.395199***	-1.393895***
TO	0.166765***	0.042100**	.0716333	0.06013**

Note: Asterisks *** & ** show a 1%, & 5% level of significance, respectively.

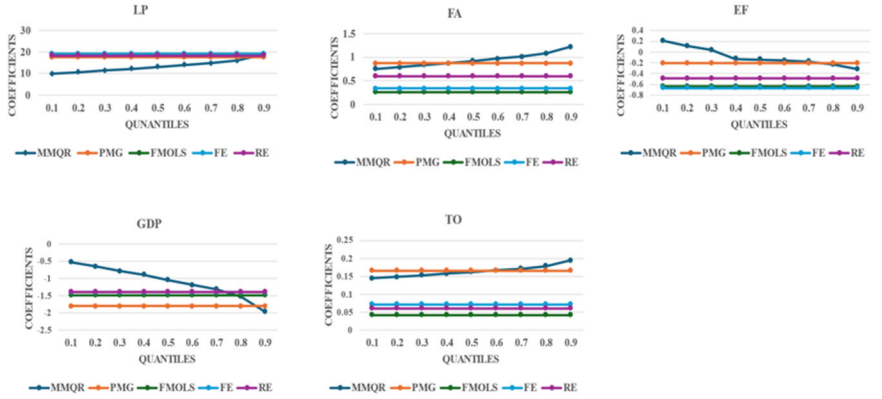

Fig. 8 Graphical illustration of projected estimates from adopted methods

The outcomes of a causal connection between explanatory variables and DEB are verified by (Dumitrescu & Hurlin 2012) estimation of panel causality. The analysis reveals a significant bidirectional causality between the variables, suggesting that there is a mutual influence between them. It highlights the interconnectedness of these factors in shaping DEB (See Table 10). Here, the w-bar statistic measures the strength of the causal

relationship between variables. A higher w-bar value indicates a stronger causal effect. Moreover, the z-bar statistic measures the significance of the causal relationship. A larger absolute value of the z-bar suggests a more significant relationship between the variables. The p-values associated with the z-bar statistic tell us about the hypothesis being tested. If the p-value is below (usually 0.05) significance level, it suggests that the results are statistically significant, and we reject H_0 in favour of the alternative hypothesis and vice versa. Bidirectional causal relationships are significant in highlighting the interconnectivity and interdependency of variables. A feedback loop could exist due to the ripple effect of changes in one variable to connected variables. (See Fig 9 to see flowchart).

Table 10 Dumitrescu-Hurlin panel causality results

Causality	W-bar Stat.	Z-bar Stat.	p-value	Result
EF→DEB	1.8816	3.6881	0.0002	Bidirectional
DEB→EF	4.7823	15.8225	0.0000	Causality
LP→DEB	2.8920	7.9147	0.0000	Bidirectional
DEB→LP	3.0607	8.6206	0.0000	Causality
FA→DEB	3.6543	11.1039	0.0000	Bidirectional
DEB→FA	4.6726	15.3636	0.0000	Causality
GDP→DEB	2.5153	6.3389	0.0000	Bidirectional
DEB→GDP	3.0405	8.5359	0.0000	Causality
TO→DEB	1.9970	4.1709	0.0000	Bidirectional
DEB→TO	3.1629	9.0481	0.0000	Causality
LP→EF	2.4107	5.9015	0.0000	Bidirectional
EF→LP	2.2351	5.1667	0.0000	Causality
FA→EF	2.5485	6.4779	0.0000	Bidirectional
EF→FA	1.5576	2.3326	0.0197	Causality
GDP→EF	2.1228	4.6970	0.0000	Bidirectional
EF→GDP	2.8778	7.8552	0.0000	Causality
TO→EF	2.6579	6.9355	0.0000	Bidirectional
EF→TO	2.7839	7.4624	0.0000	Causality
FA→LP	2.2579	5.2622	0.0000	Bidirectional
LP→FA	2.9516	8.1642	0.0000	Causality
GDP→LP	1.6931	2.8994	0.0037	Bidirectional
LP→GDP	2.9676	8.2310	0.0000	Causality
TO→LP	1.6711	2.8074	0.0050	Bidirectional
LP→TO	2.7701	7.4048	0.0000	Causality
GDP→FA	2.9844	8.3015	0.0000	Bidirectional
FA→GDP	1.7523	3.1470	0.0016	Causality
TO→FA	2.7702	7.4052	0.0000	Bidirectional
FA→TO	2.8540	7.7556	0.0000	Causality

TO→GDP	2.3004	5.4398	0.0000	Bidirectional
GDP→TO	1.7865	3.2901	0.0010	Causality

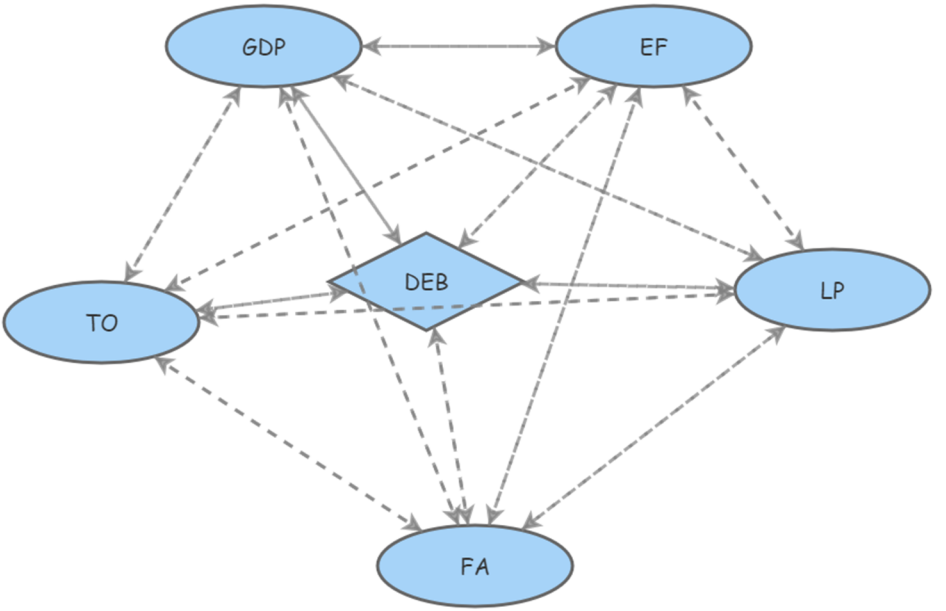

Fig. 9 Bidirectional Causal Links Chart

Source: Authors own

4.2 Further Discussion

The following study enriches the discussion in subsequent fields. *Firstly*, DEB is positively influenced by FA and TO (McGillivray & Ouattara, 2005; Ahmed et al., 2016). *Secondly*, an antagonistic association between EF and GDP growth with DEB has been established by the findings of current and prior studies (Sempala et al., 2020; Jovan Vojnovic, 2023; Donath et al., 2023). Ongoing study suggests that as the economy experiences higher GDP growth and greater EF, the weight of debt diminishes. *Thirdly*, when LP improves, trade becomes more open, and FA increases, which tends to result in higher DEB. The theoretical implications

of the research findings are significant as they align with the literature in terms of expected relationships.

These findings also give weight to the theoretical framework of DSA, which is proven to be a key tool in regulating DEB through monitoring and assessment of debt levels (Ahmed et al., 2023; Grosu et al., 2022; Bouabdallah et al., 2017). The empirical evidence of this study also supports the underlying principles of agency theory. A positive relationship between LP, TO and FA with DEB explains the lack of effective monitoring coupled with control mechanisms. It suggests that agents might prioritize short-term gains from TO and FA irrespective of the long-term ramifications on the sustainability of debt. Similarly, a negative relationship between EF and GDP growth with DEB can be contextualized by the fact that when agents have concentrated powers without institutional checks then it can lead to prioritization of skewed interests against general well-being. This can, hitherto, negatively impact GDP and increase DEB (Uyar et al., 2021; Partyka et al., 2021; Carbonara et al., 2018). The results further show alignment with the expectations of institutional theory, whose underpinnings explain the influence of factors under discussion on the outcomes and behaviours of countries (Zhang et al., 2016; Hussain et al., 2016). A negative correlation of EF & GDP with DEB indicates institutional constraints affecting financial decisions. Conversely, the positive relationship of independent variables with DEB shows how institutional structures shape resource flow and financial management, thus affecting the debt level. These results further show consistency with the principles of RDT & suggest that those countries often rely on external resources to address their needs. The idea that countries with greater access to resources, such as efficient logistics, TO policies, and FA, may also accumulate greater debt is also consistent with the outcomes of this analysis. A negative relationship between EF and DEB is a reflection of dependence on external sources for funding, and thus, institutional constraints can impact economic growth and debt management. These carefully crafted connections between results and theoretical underpinnings provide a sound ground for research findings (Jiang et al., 2022; Van et al., 2020).

5. Conclusion and Policy Implications

The present paper explored the effect of EF, LP, FA, GDP and TO on DEB for thirty-five debt-prone economies ranging between 2007–2018. Starting by conducting 2nd-generation diagnostic tests of stationarity, CSD, SHT and cointegration tests, this study has taken necessary steps to identify any potential outliers in data and ensured the accuracy and integrity of research. The findings based on the MMQR show that EF has a positive relationship with DEB at lower quantiles (0.10-0.40). As we headed to higher quantiles (0.50-0.90), which captured the majority of data, we saw a negative association between EF and DEB. When considering the overall distribution of the data, it is often more informative to focus on higher quantiles. Since they contain a majority of data, they provide a better understanding of larger or more extreme values in the dataset. Thereby, we may conclude that expanded EF dampens DEB.
Moreover, LP and FA have a statistically positive and significant effect on DEB across all quantiles, suggesting worsening DEB with augmented LP and ameliorated FA. Besides, TO relate positively with DEB, while GDP has a negative relationship with DEB. The results of this study perfectly align with our research objectives and provide strong support for the hypothesis we initially set out to investigate. Over and above, the empirical findings provide support for the theories incorporated in this study, thus demonstrating that this research is grounded in established frameworks and concepts. Besides, a supplementary layer of checks for robustness ensures the validity of results. Furthermore, supporting evidence from the Dumitrescu-Hurlin test strongly signifies bidirectional causality between variables. The indispensable nature of these results has important implications for policymakers as it highlights that any changes in EF, LP, and FA can have an impact on the DEB and vice versa.

Based on empirical findings, this research offers the following recommendations. *(i)* EF and DEB are negatively correlated (Vojnovic, 2023); therefore, the promotion of EF could favourably alleviate DEB. Strategic planning and implementing of a policy framework featuring alleviation of excessive regulations, promotion of free trade, safeguarding of property rights and fostering of a competitive environment can enhance EF. By adhering to the distinctive features of optimization of bureaucratic

procedures, the establishment of straightforward and equitable regulatory structures, and advocation for market-driven changes, countries can garner investment and mitigate DEB. *(ii)* As LP can improve DEB (Karanina et al., 2020; Yildiz et al., 2017), the efficiency of logistics ought to be prioritized, and this can be achieved by optimization of transportation routes, adaption of technology for real-time tracking and data analysis, improvement of supply chain communication nexus, and investment in infrastructure and automation. *(iii)* Owing to a positive correlation between FA and DEB (McGillivray and Ouattara, 2005; Tombofa et al., 2013), administration and spending of desired aid by rigorous implementation of policies that ensure openness, accountability, and proper governance of allocated funds with effective handling should be the centre of attention. Strengthening of institutions, improvement of monitoring and assessment procedures, and encouragement of sustainable development practices are sub-strategies to enhance aid effectiveness. *(iv)* Empirical findings further suggest a focus on the implementation of efficient debt management practices. By creating a strong DSA (Grosu et al., 2022; Bouabdallah et al., 2017), debt can be strategically managed. The significance of frequent audits and negotiation measures for debt rescheduling can also not be denied. *(v)* Advocation of a negative relationship between GDP and DEB (Ssempala et al., 2020), suggests that the focal point for the policies should be the promotion of sustainable GDP growth. An action plan to achieve this encompasses infrastructure investments by attracting FDI, initiation of public-private partnerships & capacity building of individuals and institutions through skill and resource enhancement methods. *(vi)* Lastly, a positive linkage between DEB and TO (Ahmed et al., 2016) implies that though TO can contribute towards economic progress, it can also potentially augment DEB. Therefore, maintaining a trade balance is indispensable to fix debt responsibility by eschewing overdependence on imports. By the stringent implementation of policies, e.g., diversification of exports by exploring new markets, improved trade competitiveness through brand building of products, selling of finished goods rather than raw or intermediate items and support for domestic sectors through control mechanisms, this balance can be achieved.

5.1 Limitations of Study

Contextualizing the results of this study by acknowledging limitations is pertinent. To begin with, a panel consisting of 35 countries spanning 12 years is limited in representing the true population & capturing the diversity

of countries worldwide. Furthermore, missing values of LPI are approximated by taking the weighted average, which resulted in a simplification assumption. Owing to the limited availability of data from 2007 to 2018 for LPI, time frame challenges are evident and possibly not capture all relevant policy shifts and economic dynamics influencing the results. Future studies can expand on an investigation with a larger and more diverse sample with alternative methods for handling missing data, such as exercising a longitudinal study covering a wider time frame.

Declaration of Competing Interest

The author declares that no financial/personal interest or belief could affect the objectivity of this manuscript.

Data Availability

Data will be made available on request.

Funding: We did not receive any funding to complete this study.

ANNEX-I

Table A. List of Countries

1.Tajikistan	17. Ghana
33. Tanzania	
2. Uzbekistan	18. Nigeria
34. Algeria	
3. Kyrgyz Republic	19. Cote d'Ivoire
35. Morocco	
4. Iran	20. Angola
5. Armenia	21. Cameroon
6. Malaysia	22. Burkina Faso
7. Indonesia	23. Mali
8. India	24. Chad

9. Philippines	25. Mozambique
10. Vietnam	26. Benin
11. Cambodia	27. South Africa
12. Pakistan	28. Zambia
13. Bangladesh	29. Mozambique
14. Nepal	30. Kenya
15. Kazakhstan	31. Uganda
16. Mongolia 32.Rwanda	

References

Adebayo, T. S., Akadiri, S. S., Akanni, E. O., & Sadiq-Bamgbopa, Y. (2022). Does political risk drive environmental degradation in BRICS countries? Evidence from method of moments quantile regression. *Environmental Science and Pollution Research*, *29*(21), 32287-32297. https://doi.org/10.1007/s11356-022-20002-w

Ahmed, S. S., Raza, S. H., & Mehmood, B. (2016). Debt, Trade Openness and Economic Growth: What Does Pakistani Data Show. *International Journal of Economics and Empirical Research (IJEER)*, *4*(6), 333-341.

Ahmed, S., Mushtaq, M., Fahlevi, M., Aljuaid, M., & Saniuk, S. (2023). Decomposed and composed effects of economic freedom on economic growth in south Asia. *Heliyon*, *9*(2). https://doi.org/10.1016/j.heliyon.2023.e13478

Aluko, F., Dare Arowolo, & Arowolo, D. (2010). Foreign aid, the Third Worlds debt crisis and the implication for economic development: The Nigerian experience. *African Journal of Political Science and International Relations*, *4*(4), 120–127. https://doi.org/10.5897/ajpsir.9000050

Annual Report 2020 | *UNDP*. (n.d.). UNDP. https://annualreport.undp.org/2020/

Arvis, J. F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., & Raj, A. (2014). *Connecting to compete 2014 : trade logistics in the global economy - the logistics performance index and its indicators*. *2007*, 1–68. https://doi.org/10.1596/20399

Bakhtiari, S., Izadkhasti, H., & Tayebi, S. K. (2013). Crowding out effect of foreign aid in selected developing countries: panel data evidence. *Iranian Economic Review*, *17*(2), 35-50. https://doi.org/10.22059/ier.2013.53522

Berggren, N., & Bjørnskov, C. (2019). Regulation and government debt. *Public Choice*, *178*(1), 153–178. https://doi.org/10.1007/s11127-018-0621-6

Bird, G., & Rowlands, D. (2017). The Effect of IMF Programmes on Economic Growth in Low Income Countries: An Empirical Analysis. *Journal of Development Studies*, *53*(12), 2179–2196. https://doi.org/10.1080/00220388.2017.1279734

Bjerg, C., Bjørnskov, C., & Holm, A. (2011). Growth, debt burdens and alleviating effects of foreign aid in least developed countries. *European Journal of Political Economy*, *27*(1), 143-153. https://doi.org/10.1016/j.ejpoleco.2010.08.003

Bjørnskov, C., & Schröder, P. J. (2013). Are debt repayment incentives undermined by foreign aid? *Journal of Comparative Economics*, *41*(4), 1073-1091. https://doi.org/10.1016/j.jce.2013.04.004

Bouabdallah, O., Checherita-Westphal, C. D., Warmedinger, T., De Stefani, R., Drudi, F., Setzer, R., & Westphal, A. (2017). Debt sustainability analysis for euro area sovereigns: a methodological framework. *ECB Occasional Paper*, (185). https://doi.org/10.2139/ssrn.2950979

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The review of economic studies*, *47*(1), 239-253. https://doi.org/10.2307/2297111

Canay, I. A. (2011). A simple approach to quantile regression for panel data. *Econometrics Journal*, *14*(3), 368–386. https://doi.org/10.1111/j.1368-423x.2011.00349.x

Carbonara, E., Santarelli, E., Obschonka, M., Tran, H. T., Potter, J., & Gosling, S. D (2018). Agency culture, constitutional provisions and entrepreneurship: a cross-country analysis. *Industrial and Corporate Change*, *27*(3), 507–524. https://doi.org/10.1093/icc/dtx047

Chen, L., Galvao, A. F., & Song, S. (2021). Quantile regression with generated regressors. *Econometrics*, *9*(2), 16.

Cheng, L. (2023). Logistics Level and Debt Pressure: Empirical Analysis Based on Regional Panel Data. *Advances in Economics, Management and Political Sciences*, *65*, 118-127.

Di Bella, C. & Di Bella, G. (2008). A Stochastic Framework for Public Debt Sustainability Analysis. *IMF Working Papers*, *8*(58), 1. https://doi.org/10.5089/9781451869200.001

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, *48*(2), 147-160. https://doi.org/10.1515/9780691229270-005

Drees, J. M., & Heugens, P. P. (2012). Synthesizing and extending resource dependence theory: A meta-analysis. *Journal of management*, *39*(6), 1666-1698. https://doi.org/10.1177/0149206312471391

Dumitrescu, E. I., & Hurlin, C. (2012). Testing for Granger Non-causality in Heterogeneous Panels. *Economic Modelling*, *29*(4), 1450–1460. https://doi.org/10.1016/j.econmod.2012.02.014.

Fink, F., & Scholl, A. (2016). A quantitative model of sovereign debt, bailouts and conditionality. *Journal of International Economics*, *98*, 176–190. https://doi.org/10.1016/j.jinteco.2015.09.007

Gani, A. (2017). The Logistics Performance Effect in International Trade. *The Asian Journal of Shipping and Logistics*, *33*(4), 279–288. https://doi.org/10.1016/j.ajsl.2017.12.012

Ginn, W., & Saadaoui, J. (2024). Impact of supply chain disruptions on financial leverage. *Available at SSRN 4892285*. https://dx.doi.org/10.2139/ssrn.4892285

Glenn Richey Jr, R., Tokman, M., Wright, R. E., & Harvey, M. G. (2005). Monitoring Reverse Logistics Programs: A Roadmap to Sustainable Development in Emerging Markets. *The Multinational Business Review*, *13*(3), 41–65. https://doi.org/10.1108/1525383x200500014

GROSU, A. C., PINTILESCU, C., & VIORICĂ, E. D. (2022). Public Debt Sustainability in the EU Developed Countries. *Journal of Public Administration, Finance and Law*, *24*, 133–149. https://doi.org/10.47743/jopafl-2022-24-13

Gündüz, F. F., & Özlem, A. K. A. Y. (2022). The Effect Of International Aid On Per Capita Income: A Panel Data Analysis. *Pakistan Journal of Statistics and Operation Research*, 383–394. https://doi.org/10.18187/pjsor.v18i2.4042

Guzman, M., & Heymann, D. (2015). The IMF debt sustainability analysis: issues and problems. *Journal of Globalization and Development*, *6*(2), 387-404.

Gwartney, J. Lawson, R. ,Hall,J., Murphy, R., Djankov, S. & McMahon, F. (2023). Economic Freedom of the World: 2022 Annual Report. *Social Science Research Network*. https://doi.org/10.2139/ssrn.4327127

Hagan, S. (2020). Sovereign debt restructuring: The centrality of the IMF's role. *Peterson Institute for International Economics Working Paper*, (20-13). https://doi.org/10.2139/ssrn.3667881

Hailu, D., & Shiferaw, A. (2016). Determinants of 'Exit' from High Aid-Dependence. *Journal of African Economies*, *25*(5), 670–698. https://doi.org/10.1093/jae/ejw012

Hayaloğlu, P. (2023) Foreign Aid, Institutions, and Economic Performance in Developing Countries. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *18*(3), 748-765. https://doi.org/10.17153/oguiibf.1277348

Herrera-Echeverri, H., Haar, J., & Estévez-Bretón, J. B. (2014). Foreign direct investment, institutional quality, economic freedom and entrepreneurship in emerging markets. *Journal of Business Research*, *67*(9), 1921–1932. https://doi.org/10.1016/j.jbusres.2013.11.020

Ike, G. N., Usman, O., & Sarkodie, S. A. (2020). Testing the role of oil production in the environmental Kuznets curve of oil producing countries: New insights from Method of Moments Quantile Regression. *Science of The Total Environment*, *711*, 135208. https://doi.org/10.1016/j.scitotenv.2019.135208

İMRE, S. (2022). The Impact of Economic Freedom on the Human Development in the Fragile Five Countries: Panel Cointegration. *Stratejik ve Sosyal Araştırmalar Dergisi*. https://doi.org/10.30692/sisad.1097950

Islam, W., Ahmed, J., & Faraz, N. (2023). *To borrow or not to borrow: Empirical evidence from the public debt sustainability of Pakistan* (No. 1354). ADBI Working Paper. https://doi.org/10.56506/mowj8135

Javed, A., Rapposelli, A., Khan, F., Javed, A., & Abid, N. (2024b). Do green technology innovation, environmental policy, and the transition to renewable energy matter in times of ecological crises? A step towards ecological sustainability. Technological Forecasting and Social Change, 207, 123638.

Jiang, H., Luo, Y., Xia, J., Hitt, M., & Shen, J. (2022). Resource dependence theory in international business: Progress and prospects. *Global strategy journal*, *13*(1), 3-57. https://doi.org/10.1002/gsj.1467

Jorra, M. (2012). The effect of IMF lending on the probability of sovereign debt crises. *Journal of International Money and Finance*, *31*(4), 709-725. https://doi.org/10.1016/j.jimonfin.2012.01.010

Karanina, E., Selezneva, E., & Chuchkalova, S. (2020). Improving the national logistics model on an international scale in the context of the economic crisis. *IOP Conference Series: Materials Science and Engineering*, *918*(1), 012041. https://doi.org/10.1088/1757-899x/918/1/012041

Khan, M. A., Islam, M. A., Akbar, U., & Akbar, U. (2021). Do economic freedom matters for finance in developing economies: a panel threshold analysis. *Applied Economics Letters*, *28*(10), 840–843. https://doi.org/10.1080/13504851.2020.1782335

KIZILGÖL, Ö. A., & Evren, İ. (2014). An empirical evaluation of the relationship between trade openness and external debt: Turkish case. *International Econometric Review*, *6*(1), 42-58. https://doi.org/10.33818/ier.278030

Koenker, R. (2004). Quantile regression for longitudinal data. *Journal of multivariate analysis*, *91*(1), 74-89.

Krahnke, T. (2020). Doing More with Less: The Catalytic Function of IMF Lending and the Role of Program Size. *Social Science Research Network*. https://doi.org/10.2139/ssrn.3581213

Lamarche, C. (2019). Quantile regression methods. In *Handbook of labor, human resources and population economics* (pp. 1-15). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-57365-6_42-1

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24. https://doi.org/10.1016/s0304-4076(01)00098-7

Machado, J. A., & Silva, J. S. (2019). Quantiles via Moments. *Journal of Econometrics*, *213*(1), 145–173. https://doi.org/10.1016/j.jeconom.2019.04.009

Marti, L., Medina, R. P., Puertas, R., & García, L. (2014). Relevance of trade facilitation in emerging countries' exports. *Journal of International Trade & Economic Development*, *23*(2), 202–222. https://doi.org/10.1080/09638199.2012.698639

Marti, L., Medina, R. P., Puertas, R., & García, L. (2014). The importance of the Logistics Performance Index in international trade. *Applied Economics*, *46*(24), 2982–2992. https://doi.org/10.1080/00036846.2014.916394

Mazher, M. A., & Dahalan, J. (2022). External Debt, NODA, and GDP Growth Nexus for South Asian and Southeast Asian Selected Economies. *Journal of Corporate Finance Management and Banking System*, 1–12. https://doi.org/10.55529/jpome.23.14.25

McGillivray, M., & Ouattara, B. (2005). Aid, debt burden and government fiscal behaviour in Cote d'Ivoire. *Journal of African Economies*, *14*(2), 247-269. https://doi.org/10.1093/jae/eji003

Meckling, W. H., & Jensen, M. C. (1976). Theory of the Firm. *Managerial Behavior, Agency Costs and Ownership Structure*. https://doi.org/10.1016/0304-405X(76)90026-X

Meraj, M., Malik, A., Khan, S., Khan, A. A., & Noman, M. (2024). Towards A Debt-Overhanged Economy: Causes and Consequences for the Economy of Pakistan. *Bulletin of Business and Economics (BBE)*, *13*(2), 368-376. https://doi.org/10.61506/01.00340

MirajulHaq, M., Shamim, N., & Luqman, M. (2020). Foreign Aid, Political Institutions and Economic Freedom: Empirical Evidence from Selected Developing Countries. *Lahore Journal of Economics*, *25*(1), 153–178. https://doi.org/10.35536/lje.2020.v25.i1.a6

Mura, P. O., & Donath, L. E. (2023). Government Debt and Economic Freedom in the CEE countries. Less is More. *Prague Economic Papers*, *32*(4), 350-366. https://doi.org/10.18267/j.pep.834

OECD International Development Statistics. (2022). https://doi.org/10.1787/dev-data-en

Otáhal, T. (2012). The Agency Problem in New Institutional Economics. *SSRN 2053674*. https://doi.org/10.2139/ssrn.2053674

Ouattara, B. (2006). Foreign aid and government fiscal behaviour in developing countries: Panel data evidence. *Economic Modelling*, *23*(3), 506-514. https://doi.org/10.1016/j.econmod.2006.02.001

Partyka, R. (2021). Supply chain management: an integrative review from the agency theory perspective. *Revista de Gestao*, *29*(2), 175-198. https://doi.org/10.1108/rege-04-2021-0058

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, *61*(S1), 653-670.

Pedroni, P. (2001). Fully modified OLS for heterogeneous cointegrated panels. In *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 93-130). Emerald Group Publishing Limited.

Persyn, D., & Westerlund, J. (2008). Error–correction–based cointegration tests for panel data. *Stata Journal*, *8*(2), 232–241. https://doi.org/10.1177/1536867x0800800205

Perveen, F., & Khan, A. (2021). Impact of official development assistance on sustainable development of Pakistan. *American Economic & Social Review*, 11–21. https://doi.org/10.46281/aesr.v8i1.1454

Pesaran, M. H. (2007). A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. *Journal of Applied Econometrics,* , *22*(2), 265-312. https://doi.org/10.2139/ssrn.457280

Pesaran, M. H., & Yamagata, T. (2008). Testing Slope Homogeneity in Large Panels. *Journal of Econometrics* , *142*(1), 50-93. https://doi.org/10.1016/j.jeconom.2007.05.010

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American statistical Association*, *94*(446), 621-634.

Pfeffer, J., & Salancik, G. (2015). External control of organizations—Resource dependence perspective. In *Organizational behavior 2* (pp. 355-370). Routledge.

Powell, R., & Bird, G. (2010). Aid and debt relief in Africa: have they been substitutes or complements?. *World Development*, *38*(3), 219-227. https://doi.org/10.1016/j.worlddev.2009.06.005

Roychoudhury, S., & Lawson, R. A. (2010). Economic freedom and sovereign credit ratings and default risk. *Journal of Financial Economic Policy*, *2*(2), 149-162. https://doi.org/10.1108/17576381011070201

Saibu, O. M., Ikechukwu, O. M., & Nwosa, P. I. (2022). Dynamic Effects of Foreign Aid, Trade Openness and Fdi on Economic Growth for West African Countries. *Journal of Developing Areas*, *56*(2), 49–63. https://doi.org/10.1353/jda.2022.0034

San, C. K., & Chin, L. (2023). Impact of Public Debt on Economic Growth: A Quantile Regression Approach. *South Asian Journal of Macroeconomics and Public Finance*, *12*(2), 250-278. https://doi.org/10.1177/22779787231207218

Sethi, N., Bhujabal, P., Das, A., & Sucharita, S. (2019). Foreign aid and growth nexus: Empirical evidence from India and Sri Lanka. *Economic Analysis and Policy*, *64*, 1-12. https://doi.org/10.1016/j.eap.2019.07.002

Sharma, A., Sharma, V., & Tokas, S. (2023). Does economic freedom promote financial development? Evidence from EU countries. *Statistics in Transition New Series*, *24*(3), 187-200. https://doi.org/10.59170/stattrans-2023-043

Smets, L., & Knack, S. (2014). World Bank lending and the quality of economic policy. *The Journal of Development Studies*, *52*(1), 72-91. https://doi.org/10.1080/00220388.2015.1068290

Solomon, S. J., Bendickson, J. S., Marvel, M. R., McDowell, W. C., & Mahto, R. (2021). Agency theory and entrepreneurship: A cross-country analysis. *Journal of Business Research*, *122*, 466-476.

Ssempala, R., Ssebulime, K., Enock Nyorekwa, & Twinoburyo, E. (2020). *Uganda's experience with debt and economic growth: an empirical analysis of the effect of public debt on economic growth—1980–2016*. *9*(1), 1–18. https://doi.org/10.2139/ssrn.3497383

Stupachev, S. (2022). Analysis of financial assistance from international financial institutions to Moldova. *Economy and Sociology*, (1), 28-35. https://doi.org/10.36004/nier.es.2022.1-03

Swamy, V. (2015). Government debt and economic growth–decomposing the cause and effect relationship. *SSRN 2601874*. https://doi.org/10.2139/ssrn.2601874

Swamy, V. (2020). Debt and growth: Decomposing the cause and effect relationship. *International Journal of Finance & Economics*, *25*(2), 141–156. https://doi.org/10.1002/ijfe.1729

Swiss, L. (2020). The Globalisation of Foreign Aid: Global Influences and the Diffusion of Aid Priorities. *The Palgrave Handbook of Development Cooperation for Achieving the 2030 Agenda*, 113–125. https://doi.org/10.1007/978-3-030-57938-8_6

Teachman, J., Duncan, G. J., Yeung, W. J., & Levy, D. (2001). Covariance structure models for fixed and random effects. *Sociological Methods & Research*, *30*(2), 271-288.

Tiruneh, E. A., & Wamboye, E. (2017). *Have Debt Relief Initiatives Yielded Varying Effects in Resource and Non-resource Endowed Countries in Africa?* 423–447. https://doi.org/10.1057/978-1-137-53496-5_19

Tombofa, S. S., Edoumiekumo, S. G., & Obudah, B. C. (2013). Foreign aid, debt and growth nexus in Nigeria. *Research Journal of Economics, Business and ICT*, *8*(2).

Turan, N. (2013). The Government Debt to GDP Ratio as a headline indicator and the information value of Net Debt concept as an alternative. *Turkish Experience*.

Uyar, A., Fernandes, V., & Kuzey, C. (2021). The mediating role of corporate governance between public governance and logistics performance: International evidence. *Transport Policy*, *109*, 37-47. https://doi.org/10.1016/j.tranpol.2021.05.023

Van, N. T. T., Phong, H. T., & Thanh, B. T. (2020). Applying resource dependence theory and network theory to analysis of relationship quality between logistics users and providers. *HO CHI MINH CITY OPEN UNIVERSITY JOURNAL OF SCIENCE-*

ECONOMICS AND BUSINESS ADMINISTRATION, *7*(1), 24-33. https://doi.org/10.46223/hcmcoujs.econ.en.7.1.194.2017

Vojnovic, J. (2023). Economic Freedom and Debt: An Empirical Investigation on The Institutional Determinants of Public Debt. *Journal of Economic Research & Reviews*, *3*(2), 37-51. https://doi.org/10.33140/jerr.03.02.01

Winters, M. S. (2010). Accountability, Participation and Foreign Aid Effectiveness. *International Studies Review*, *12*(2). https://doi.org/10.1111/j.1468-2486.2010.00929.x

Ye, Y., Wang, H., Tian, K., & Li, M. (2024). Supply chain risks and the cost of debt: Evidence from the COVID-19 pandemic. *Research in International Business and Finance*, *70*, 102399. https://doi.org/10.1016/j.ribaf.2024.102399

Yeo, A. D., & Deng, A. (2020). Logistics performance as a mediator of the relationship between trade facilitation and international trade: A mediation analysis. *South African Journal of Economic and Management Sciences*, *23*(1). https://doi.org/10.4102/sajems.v23i1.3453

Yeo, A. D., Deng, A., & Nadiedjoa, T. Y. (2020). The Effect of Infrastructure and Logistics Performance on Economic Performance: The Mediation Role of International Trade: *Foreign Trade Review*, *55*(4), 450–465. https://doi.org/10.1177/0015732520947676

Yildiz, T. (2017). An empirical analysis on logistics performance and the global competitiveness. *Verslas: teorija ir praktika*, *18*(1), 1-13. https://doi.org/10.3846/btp.2017.001

Zhang, S. (2016). Institutional arrangements and debt financing. *Research in International Business and Finance*, *36*, 362-372. https://doi.org/10.1016/j.ribaf.2015.10.006