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# The Causal Triadic Nexus between Debt, Economic Growth, and Export: A Time Series Analysis of the United States of America (1970 - 2021)

**Mohammad Rashed Yadgari**
Faculty of Economics and Business, Universitas Islamic International Indonesia (UIII)

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**KEYWORDS:** GDP implosion, debt-to-GDP ratio, Toda Yamamoto causality, Autoregressive distributed Lag cointegration test.

**Corresponding Author**:
**Mohammad Rashed Yadgari**

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**ABSTRACT**

This paper examines the relationship between GDP, Exports, and Debt of America from 1970 to 2021. It is worth investigating whether the marginal decline or increase in GDP and exports impacts the debt. The methodology consists of ARDL bounds cointegration of short-run relationship and found a negative relationship between debt and exports and a positive relationship between GDP and Debt, while Toda-Yamamoto Causality found unidirectional causality that runs from exports to Debt, exports to GDP, and debt to GDP. This study provides practical contributions to assist decision-makers in formulating fiscal policies to bring the debt to a sustainable level.

## 1. INTRODUCTION

To date, there has been numerous research about how debt affects the economic output of countries, but conversely, it is worth researching whether the marginal or rapid decline in GDP and export because export constructs a major component of the balance of payments and an important factor of GDP increase for trade-driven economies, does impact on the level of debts countries obtain. It is clear that when the output of a country is growing, debts they acquire to fund their expenditures for investments they make in human and physical resources within the country or abroad will be covered and repaid with outputs they will obtain over time, but what matters is that most of the time changes in the production make it difficult to cope with the amount and level of debt countries have accumulated, here is what it is termed to be as the GDP implosion against the concept of debt explosion which long has been the subject of debate and researches.

Although for the study in hand, implosion is not entirely evident in the GDP of America despite the Financial crises over the years between 1990 to 2021 with the outbreak of Covid-19 as the latest one, therefore it is purposed to seek the marginal changes and its effect on debt ratio for the country while regarding the consistent adversity of GDP implosion and Debt explosion, as these two phenomena present severe implications for the economic stability of countries. (Kumar,2014)

GDP stands for the market value of the produced goods and services, showing the size and health of an economy. At the same time, debt is the money a country owes to its creditors, like other countries, international organizations, or private lenders. The entire amount of direct government contractual commitments that are still in effect as of a certain date is referred to as the debt-to-GDP ratio by the World Development Indicators (WDI) of the World Bank. This comprises local and international obligations such as cash and savings accounts, non-equity securities, and loans. It is determined by subtracting the total of the government's equity and financial derivatives from its total liabilities. (IMF,2022)

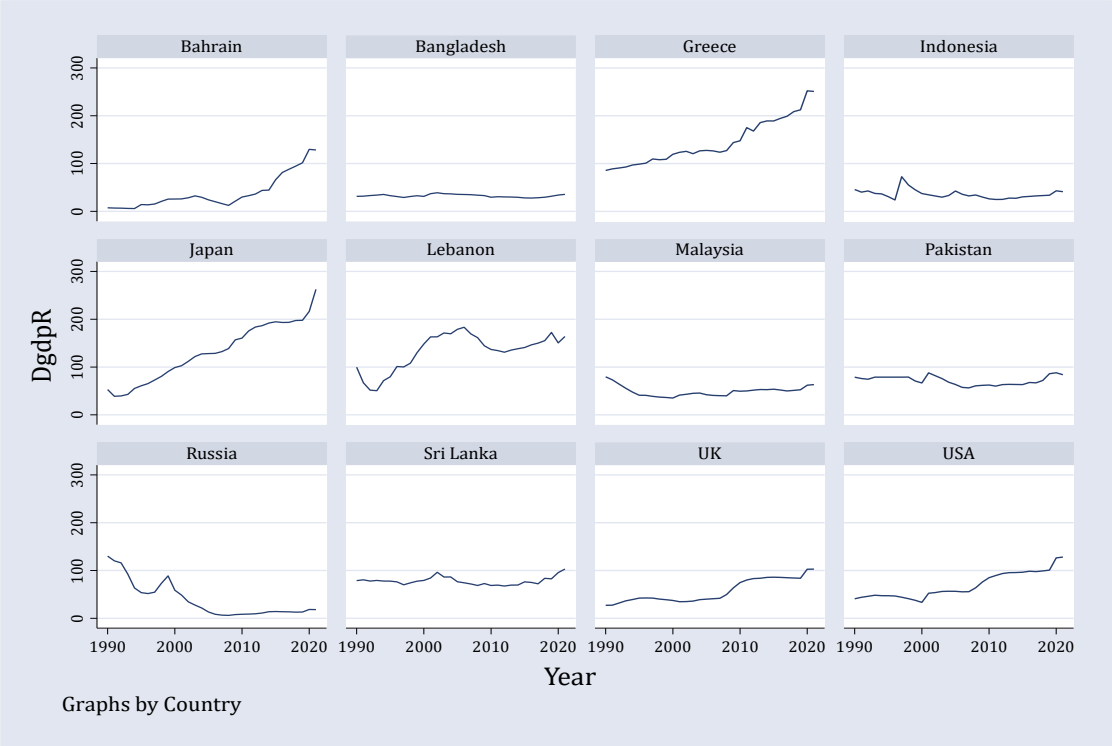
A higher debt-to-GDP ratio means that a country has a large debt relative to its economic output. This can impose negative impacts on the country's GDP growth, stability, and credit rating, it can also make it harder for a country to borrow more money, as creditors may demand higher interest rates or refuse to lend at all. It can also limit the country's fiscal space, which is the ability to use spending and revenues to stimulate the economy or respond to shocks. The high ratio can also increase the risk of default, which is when a country fails to repay its debt obligations. This can trigger financial panic and contagion in domestic and international markets.

A lower debt-to-GDP ratio means that a country has a small debt relative to its economic output. This can have positive consequences for the country's economic growth, stability, and credit rating. It can also make it easier for a country to borrow more money, as creditors may offer lower interest rates or more favorable terms. The low ratio can also reduce the risk of default, which is when a country fails to repay its debt obligations. This can enhance financial confidence and stability in domestic and international markets. (Syukri,2020)

Changes in GDP can affect the debt-to-GDP ratio in different ways, depending on whether GDP increases or decreases, and whether debt increases or decreases. If GDP increases faster than debt, the debt-to-GDP ratio will decrease. This means that the country's economic output is growing faster than its debt burden, which can improve its ability to pay back its debt and its attractiveness to creditors. If GDP decreases faster than debt, the ratio will increase. This means that the country's economic output is shrinking faster than its debt burden, which can worsen its ability to pay back its debt and its attractiveness to creditors. (Easterly,2010)

The World Bank and IMF have provided general guidelines on the debt levels for countries. The World Bank discovered that countries with debt-to-GDP ratios exceeding 77% for extended periods experience significant economic growth slowdowns. The IMF recommends that advanced economies keep their debt-to-GDP ratio below 60% while emerging economies keep them below 40%. However, these thresholds are not absolute and may vary depending on other factors such as interest rates, exchange rates, Inflation, growth prospects, and political stability. (IMF,2022)

Meanwhile, with the given thresholds of debt criteria by the IMF and the World Bank, it is evident that the debt-to-GDP ratio of the United States of America has been consistently high compared to the debt-to-GDP of the countries(countries with three levels of debt-to-GDP ratio, (high, medium and low)) as shown in Figure 1.




The export sector of a nation's GDP reveals the level of demand for its goods across the world. They influence the trade balance or the gap between imports and exports. A surplus is shown by a positive trade balance, whereas an excess of imports over exports is indicated by a negative one. Export is a crucial part of the global balance of payments since it displays the trade balance, net income (the sum of income received and investments made), and net transfer, which combines transfers made and payments made on investments.

While exports are an important component of GDP, including both in the study might impulse the multicollinearity issue which would affect the results, but it should be indicated that the countries that have trade-driven economies, meaning that their GDP is highly sensitive to the changes in the exports and imports they do, then it is the matter of collinearity and it should be avoided, while in the study in hand, the United States of America is one of those countries that its GDP is not majorly compiled of the trade factor as shown in Figure 2 as it roughly reaches 14% over the course of study period, therefore the exports is used as the second explanatory variable to see how much of its marginal changes affect debt of the country.

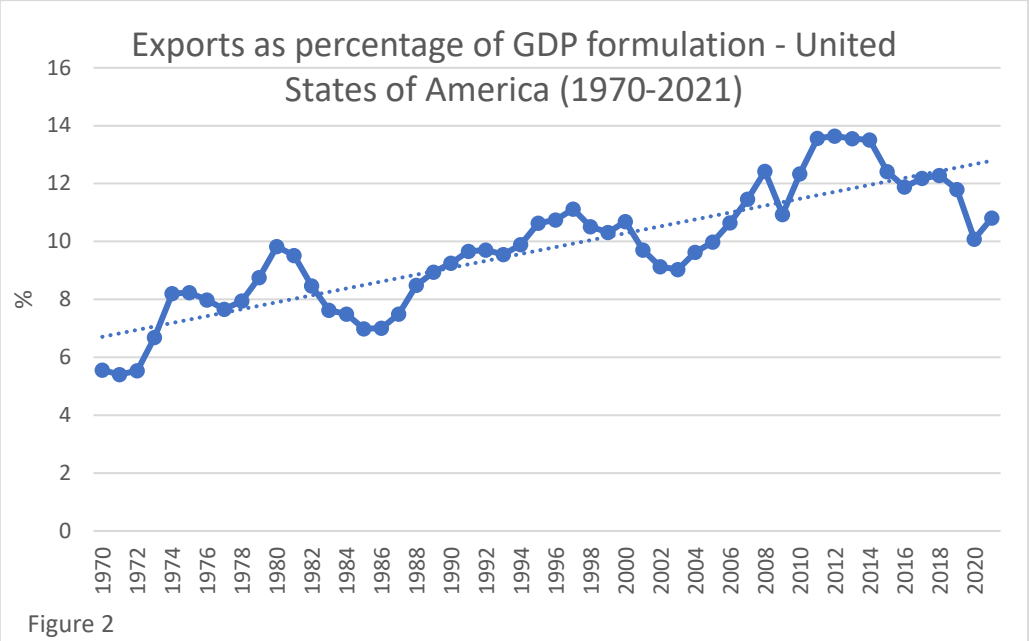


Figure 2

Exports generate foreign exchange earnings that can be used to pay for imports, to service external debt, or to accumulate foreign reserves which in turn are used for debt servicing. Changes in exports might bring changes to debt in two important ways. Firstly, if exports increase, the country will earn more foreign exchange, which reduces the debt burden and avoids more borrowing. Secondly, if exports decrease the country will face shortages in foreign exchange and reserves which makes it difficult to pay the debt. Therefore, if exports become more volatile the country might face uncertainty and hardship in planning its debt repayment schedules and eventually defaults.

## 2. LITERATURE REVIEW

### 2.1 Theoretical Framework

Initially, governments intend to boost their economy when they borrow money from the World Bank, IMF, or other international agencies with the assumption that government spending will stimulate the economy and demand will increase which also would boost the economy. However, this is not the case entirely, as suggested by David Ricardo the famous British political economist who lived from 1772 to 1823, that debt-financed government spending does not increase demand but rather remains the same. (Ricardo, 1951)

The Ricardian Equivalence Hypothesis (REH), a theory of economics, asserts that internal income and borrowings provide equivalent sources of funding for public expenditures. In other words, the effects on the overall economy will be the same whether government spending is financed by current taxes or future taxes (and current deficit). (Barro, 1990) the theory relies on the assumption that people are forward-looking and rational, they know that government spending will bring with itself high taxes to be paid in the future and when it is debt-financed, it implies that the government needs to repay with future taxes that people shall pay, therefore, they save rather than to consume and demand which causes slow growth and stagnant GDP causing more indebted situation for the countries, this idea based on this theory is suggested by some economists as the matter of GDP implosion and debt explosion where the government no longer able to repay their debt. (Afzal, 2012)

While this theory has been acknowledged by most classical economists, it has a flaw suggested by some economists of neoclassic that people are not always rational and future so they spend even if they know it is based on accumulated debt and it would boost the GDP and economy and generate revenues pay back debt. Specifically for trade-driven economies, it works well to accumulate exchange reserves to repay debt. (Kourtellos, 2013)

Against the REH, this study significantly contributes to acknowledging the Modern Monetary Macroeconomic theory which depicts that debt is only money that is put by the government into the economy and is not taxed back. A government's budget shall not be compared with the average household, governments shall not be expected to default on debt when they issue debt on their currency, it furthermore asserts that central banks can consistently organize interest rates close to zero to finance deficit when the economy is at low growth and still would have the ability to repay their debt. (Wray, 2015)

According to the MMT, governments can substitute printing money for taxes or borrowing for their spending, and in the short run, the deficit would be low enough to control inflation and boost economic growth. (Driessen and Gravelle, 2019) Meanwhile, mixed policies specifically designed to develop trade would increase the foreign exchange reserves that play a crucial role in financing debts.

### 2.2 Empirical Review

Empirical studies addressing the matter more often focused on the causality between Exports, GDP, and debt in its different forms, particularly with the given dimension that there is the matter of marginal changes complexity which is

hard to unfold with long-term effect revealing equations and statistical model analysis, that is why more often researches used VAR and VECM models to check on the short-term changes the variables bring to each other.

Syukri (2020) using the data from 1978 to 2018 examined the relationship between foreign debt, imports, foreign exchange reserves, exports, and GDP in Indonesia, this paper used the Vector Autoregression (VAR) method performing ADF tests of stationarity as a different order of integration existed in variables, Johanssen Cointegration test of determining long and short run equilibrium and the relationship between variables, VECM with Error Correction Term for showing adjustment towards the long-run relationship, Granger Causality Test, Impulse Response Function for showing the effect of unit shocks imposed to the equation and Cholesky Variance Decomposition, although the difference in the order of integration showcase the inappropriateness of using Granger Causality, IRF and VD tests as variance, covariance and mean for the variables over the time are not consent in one order.

The study discovered that among the five variables examined, there were no two-way causal relationships. However, six one-way relationships were identified. The study found that GDP is positively influenced by foreign debt and exports. Exports are positively influenced by GDP and imports. Imports are positively influenced by exports, GDP, and foreign exchange reserves. Foreign debt is positively influenced by GDP and imports. Foreign exchange reserves are positively influenced by exports and foreign debt. The paper recommends that the government should allocate funds from foreign debt to the export sectors to increase GDP.

Hidayat (2020) with data from the World Bank from 1980 to 2018 analyzed the effect of Economic Growth, Exports, and Savings on External Debt in Indonesia, in his paper a multiple linear regression model was used and it found that economic growth has a significantly positive impact on debt, meaning that an increase in GDP leads to increase in debt, but exports have insignificant and positive impact on debt, meaning that changes in exports does not impact or impact mildly on debt of the country. Furthermore, it concluded that the government should use debt-financed funds for the productive sector which could increase GDP and exports.

Timmer (2021) used quantitative empirical analysis of panel data regression and made stability, normality, and autocorrelation tests of robustness for the validity of the results. The study used panel data for 178 countries from 1995 to 2020 and examined the public debt forecast errors to identify exogenous changes in public debt and assess the impact of a change in debt on real GDP. According to the study, unexpected debt increases hurt real GDP in countries that were already indebted, but the effects on low-income countries or those that had already completed the HIPC debt relief initiative were minimal and insignificant.

Dritsaki (2013) using the time series data from 1960-2011 investigated the relationship among economic government debt, GDP growth, and exports in Greece, in his paper he used ADF tests, the Johansen cointegration, VECM, and the Granger causality test. The study found evidence of cointegration between variables indicating a long-run equilibrium relationship, it also found that exports granger-cause economic growth and economic growth granger-cause government debt in both the short and long-run. However, didn't find any causal nexus between exports and government debt.

Bivens (2010) criticized the work of Reinhart and Rogoff (2010) on the negative nexus between debt and GDP growth when debt exceeds 90%. The paper argued that their sample size was insufficient to draw such a conclusion. Additionally, they did not consider the possibility that low growth could cause high debt and ignored important variables in their study. The paper also stated that there is no theoretical or empirical basis for the claims made by the authors for the USA. The results for the USA are very sensitive to a few years in the 1940s dominated by World War II. The paper concluded that there is weak evidence of a causal relationship between government debt and economic growth.

Reinhart and Rogoff (2010) Using data from 44 countries between 1800 and 2009, the association between public debt and economic growth was examined. The study found a nonlinear relationship between debt and growth. Debt has a negative and significant impact on growth, according to the study, which used descriptive statistics and linear regression to reach this conclusion.

Saad (2012) Performed research on the connection between exports, economic development, and external debt in Lebanon between 1970 and 2010. Following ADF testing, Johansen cointegration, and Granger causality, the study applied the VECM model. According to the study, there is a two-way causal link between GDP and repaying external debt, thus an increase in GDP causes an increase in debt payments and vice versa. Additionally, there is a one-way causal link between debt and exports, indicating that greater debt levels stimulate more exports to produce foreign currency for repayment. According to the report, exports and debt are what drive Lebanon's economy, hence it is best to seek out additional loans to fund exports and amass more foreign currency.

Ahmad, Sabihuddin, and Shaista (2000) investigated the causal relationship between GDP, exports, and external debt in Asian countries from 1972 to 1996 and used VAR along with Cointegration analysis and the Granger causality to examine the data. The results showed a long-term relationship among the variables and unidirectional causality from debt to GDP for all countries except Indonesia and Malaysia, implying a negatively significant relationship between GDP and Debt.

Perasso (1992) analyzed how external debt affects the investment behavior of some highly indebted developing

countries, in this study a simple model was developed that compared the effects of debt servicing obligations and domestic policies on the marginal efficiency of capital and the propensity to invest. Furthermore, panel data from 15 countries from 1970 to 1988 was used to perform OLS and two-stage least square (2SLS) and found that debt servicing reduces the marginal efficiency of capital and propensity to invest by increasing the cost of capital and crowding out private investments, therefore countries don't involve with investments and their GDP implodes.

Karagol (2002) This paper examined the relationship between debt service and Gross National Product (GNP) in Turkey from 1970 to 1998. A theoretical model was developed to show how external debt service can affect GNP through two channels: the debt overhang and the liquidity effect. Time series data was used and a Vector Error Correction Model (VECM) with Granger Causality tests was applied. The study found that external debt service has a short-term negative effect on GNP through the debt overhang channel and a long-term positive effect under the liquidity effect. Higher debt payments were shown to decrease GDP and economic growth.

## 3. DATA AND METHODOLOGY

This study's data was sourced from the World Bank, IMF, and the US Federal Reserve. It consists of time-series data from 1970 to 2021, with 52 observations. The methodological framework consists of:

- Unit root tests of stationarity of variables.
- identification of maximum order of integration
- Establishing a basic Vector Auto Regression model
- Determining the optimum lag for the model
- Determining ARDL Bounds test.
- VAR model with Toda-Yamamoto approach – Causality analysis.
- Implementation of Granger non-Causality test by employing a modified standard Wald test

**Table 3.1 Variable Description**

| Variables | Description | Source |
|---|---|---|
| Debt-to-GDP ratio | Entire stock of direct-government fixed-term contractual obligations.<br>Domestic liabilities<br>Foreign liabilities<br>Net debt | International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates. |
| Exports % of GDP | Value of all goods and market services provided to the rest of the world | World Bank national accounts data, and OECD National Accounts data files. |
| GDP growth | Percentage change of the sum of all value added by all resident producers. | World Bank national accounts data, and OECD National Accounts data files. |

### 3.1 Pre-estimation Analysis

This section provides a descriptive analysis of the data to give an overview and help with model selection. A numerical and graphical summary of the data is shown in Table 3.2, and Table 3.3. This includes the mean, median, standard deviation, variability of the data, correlation matrix among variables, and normality of distribution through Jarque-Berra, Skewness, and Kurtosis tests.

#### 3.1.1 Summary Statistics

As shown in Table 3.2, data points for exports and GDP are consistent and close to each other, while std.dev for the debt-to-GDP ratio is higher and shows widely dispersed data points and variability, but extreme values or outliers don't exist. Meanwhile, Jarque-Berra values for variables seem to show different assumptions to make on their distribution normality, although the JB value for exports and GDP indicates normal distribution, the overall normality check is done post-estimation through diagnostic tests.

**Table 3.2: Summary Stats**

| | Debt-to-GDP | Exports | Log GDP |
|---|---|---|---|
| Mean | 56.65385 | 9.759615 | 29.54327 |
| Median | 47.30000 | 9.705000 | 29.69000 |
| Maximum | 128.1000 | 13.64000 | 30.78000 |
| Minimum | 30.90000 | 5.410000 | 27.70000 |
| Std. Dev. | 26.69781 | 2.121446 | 0.890445 |
| Skewness | 1.115677 | -0.049440 | -0.512168 |
| Kurtosis | 3.108002 | 2.441765 | 2.117266 |

| | | | |
|---|---|---|---|
| Jarque-Bera | 10.81297 | 0.696375 | 3.961718 |
| Probability | 0.004487 | 0.705967 | 0.137951 |
| Sum | 2946.000 | 507.5000 | 1536.250 |
| Sum Sq. Dev. | 36351.43 | 229.5272 | 40.43754 |
| Observations | 52 | 52 | 52 |

### 3.1.2 Correlation Matrix and Graph

To see how variables are related to each other, Table 3.3 shows the correlation matrix which shows a moderate positive relation among variables, meaning that it is possible to use the variables to establish a relationship and contingently with some cautions predict the future for them.

**Table 3.3: Correlation Matrix**

| Obs 52 | Debt-to-GDP | Exports | Log GDP |
|---|---|---|---|
| CGD | 1.000000 | 0.707430 | 0.795683 |
| EXPO | 0.707430 | 1.000000 | 0.856393 |
| LGDP | 0.795683 | 0.856393 | 1.000000 |

### 3.1.3 Stationarity of Variables

The stationarity test is essential to determine the order of Integration of data which would make it possible to determine the optimal analysis model with the given time series dimension for the data. For this purpose, the ADF test and Philips-Perron are performed to see if the variance, covariance, and mean for the variables are constant so that it would enable establishing a relation between them which is based on this regression equation,

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_p \Delta y_{t-p} + \varepsilon_t \quad (1)$$

$$\Delta y_t = \beta 0 + \beta 1 t + \sum \beta 2 y_{t-1} + \sum \alpha 1 \, \Delta y_{t-i} + \varepsilon_t \quad (2)$$

Where Y is the series with t as time, Δ is the difference operator, $\beta_0$, $\beta_1$, $\beta_2$, and $\alpha_1$ are the coefficients that are estimated, $\varepsilon_t$ is the error term. For the tests that are meant to be tests of nonstationary, the $H_0$ is that series are not stationary which gets to be rejected once the value of the t-stat is lower than critical values at 1%, 5%, and 10% with p-values lower than 0.05 significance level.

### 3.2 ARDL Bounds Cointegration Analysis

With the order of integration identified to be as stationary at the level for GDP and stationery at the first difference I(1) for debt and exports variables, the ARDL Bounds cointegration is the appropriate analysis based on the following reasons:

- This test allows the co-integration analysis of data with different order of stationarity, a mixture of I(0) and I(1) if they are not stationary at the second difference I(2).
- The ARDL bounds test allows this option to provide an optimum lag level for the series separately, so different series can have different optimum lag levels.
- ARDL will form a single equation for variables in the study.

The ARDL Bounds cointegration is critical to understanding the possibility of having a long-run equilibrium among variables and requires estimation of unrestricted error correction general equation as:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \sum_{j=0}^{q} \lambda_j \Delta x_{t-1} + \varphi_1 y_{t-1} + \varphi_2 x_{t-1} + e_t \quad (3)$$

The ARDL approach consists of the procedure as follows:

- To determine the optimal lag level based on the AIC, BIC, HQIC, and SBC criteria.
- As developed and stated by Pesaran et al (2001), page 308, residuals should not be correlated (autocorrelation check).
- Checking the dynamic stability of the ARDL model based on the unit circle (inverse roots of Autoregressive characteristic Polynomial).
- Bounds cointegration check based on equation (3) with criteria that H0 is that there is no cointegration; if F-stat is greater than the critical value for upper bound I (1), cointegration and long-run relationship exist; however, if F-stat is less than the critical value for lower bounds I(0), there is no cointegration and a short-run model of ARDL will be estimated.
- If cointegration is found, equation (4) will be applied for long-run relationship and unrestricted error correction equation (5). If cointegration is not found, then equation (6) will be applied to the short-run relationship.

$$\text{Long-run equation - } CGD_t = \alpha_0 + \alpha_1 LogGDP_t + \alpha_2 Exports_t + \varepsilon_t \quad (4)$$

$$\text{ECM - } \Delta CGD_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta CGD_{t-i} + \sum_{j=0}^{q} \lambda_j \Delta Ex_{t-j} + \sum_{j=0}^{r} \lambda_j \Delta LGDP_{t-j} + \delta z_{t-1} + \varepsilon_t \quad (5)$$

$$\text{Short-run equation } \Delta CGD_t = \beta_0 + \theta_0 CGD_{t-1} + \sum_{j=1}^{p} \beta_j \Delta CGD_{t-j} + \theta_1 Ex_{t-1} + \sum_{j=0}^{q} \lambda_j \Delta Ex_{t-j} + \theta_2 LGDP_{t-j} + \sum_{j=0}^{r} \lambda_j \Delta LGDP_{t-j} + \varepsilon_t \quad (6)$$

### 3.3 Causality Analysis

The causality analysis of VAR models is the study of how one variable affects another variable, and whether the observed relationship is causal or spurious. For the study, the approach of Toda-Yamamoto causality (TYDL) is preferred over Johansen and Juselius (1990) and Engle and Granger (1987) because the TYDL establishes causal relationships while if done with Johansen or Engle cointegration the result will be spurious on functions with integrated variables and time lags.

#### 3.3.1 Toda-Yamamoto

In this section, it is intended to find the causal relationship among debt, GDP, and exports while GDP is stationary at the level and if they have a common stochastic trend then the causality will be detected. Toda-Yamamoto (1995), to investigate the causality developed an augmented VAR model with VAR $_{(dmax+k)}$, where dmax shows the maximum order of integration among series, and k shows the optimum lag length to include for the study. The procedure includes these steps:

- Finding the order of integration and Dmax
- VAR model on level order of series
- The optimum lag length is determined through AIC, HQIC, SBC, and FPE which stands the for final prediction criteria.
- Autocorrelation check and the VAR stability condition check
- Estimating the suggested VAR (dmax+k), we pursue with Granger non-Causality test using the Modified Wald Test (MWald) which is followed by chi-squared distribution.

Augmented VAR model of TYDL:

$$Vb_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} Vb_{t-i} + \sum_{j=k+1}^{dmax} \alpha_{2i} Vb_{t-j} + \sum_{i=1}^{k} \beta_{1i} Va_{t-i} + \sum_{j=k+1}^{dmax} \beta_{2i} Va_{t-j} + \sum_{i=1}^{k} \gamma_{1i} Vc_{t-i} + \sum_{j=k+1}^{dmax} \gamma_{2i} Vc_{t-j} + \sum_{i=1}^{k} \delta_{1i} Vd_{t-i} + \sum_{j=k+1}^{dmax} \delta_{2i} Vd_{t-i} + \sum_{i=1}^{k} \rho_{1i} Ve_{t-i} + \sum_{j=k+1}^{dmax} \rho_{2i} Ve_{t-j} + \sum_{i=1}^{k} \sigma_{1i} Vf_{t-i} + \sum_{j=k+1}^{dmax} \sigma_{2i} Vf_{t-j} + \sum_{i=1}^{k} \mu_{1i} Vg_{t-i} + \sum_{j=k+1}^{dmax} \mu_{2i} Vg_{t-j} u_{1t} \quad (7)$$

### 3.4 The T-Y Granger non-causality

The First step for the T-Y procedure was to determine the maximum order of integration with the optimum lag length to be used, with unit root tests it was found that the maximum order of integration for the data dmax is one and the optimum lag length K is one as well but a basic VAR on levels model with the selected optimum lag needs to be attested for the stability condition and autocorrelation as well prior to proceed with further steps.

The autocorrelation check and stability check are must things in the T-Y analysis therefore the result shown in Tables 3.4 and 3.5 respectively shows that there is no serial autocorrelation, and the suggested VAR model satisfies the condition.

The inverse roots of the AR characteristic polynomial in Table 3.5 display the stationarity condition of the AR process, it is used in the stability condition check. The AR process is stationary and only intended to verify the stability and invertibility if the inverse root lies inside the unit circle.

**Table 3.4: VAR Residual Correlation LM-test**

The null hypothesis is no serial correlation n at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 9.757853 | 9 | 0.3704 | 1.107000 | (9, 61.0) | 0.3716 |
| 2 | 2.112409 | 9 | 0.9896 | 0.225650 | (9, 61.0) | 0.9896 |
| 3 | 15.35876 | 9 | 0.0815 | 1.822297 | (9, 61.0) | 0.0823 |
| 4 | 6.589258 | 9 | 0.6798 | 0.729015 | (9, 61.0) | 0.6806 |
| 5 | 5.977695 | 9 | 0.7421 | 0.658174 | (9, 61.0) | 0.7429 |
| 6 | 4.749380 | 9 | 0.8556 | 0.517906 | (9, 61.0) | 0.8560 |
| 7 | 10.32523 | 9 | 0.3248 | 1.176666 | (9, 61.0) | 0.3260 |
| 8 | 12.14388 | 9 | 0.2053 | 1.404145 | (9, 61.0) | 0.2064 |
| 9 | 15.83766 | 9 | 0.0703 | 1.886390 | (9, 61.0) | 0.0710 |
| 10 | 13.34407 | 9 | 0.1476 | 1.557817 | (9, 61.0) | 0.1486 |
| 11 | 12.66499 | 9 | 0.1784 | 1.470516 | (9, 61.0) | 0.1794 |
| 12 | 13.64329 | 9 | 0.1356 | 1.596577 | (9, 61.0) | 0.1365 |

**Table 3.5: roots of the characteristic polynomial**

| Root | Modulus |
|---|---|
| 0.987691 | 0.987691 |
| 0.650705 - 0.218043i | 0.686265 |
| 0.650705 + 0.218043i | 0.686265 |
| -0.044452 - 0.306839i | 0.310042 |
| -0.044452 + 0.306839i | 0.310042 |

| | |
|---|---|
| 0.306578 | 0.306578 |
| No root lies outside the unit circle. | |
| VAR satisfies the stability condition. | |

The Granger non-Causality test was applied to the stable VAR model utilized in this work using a modified WALD test. Table 3.6's findings reveal that there is a one-way causal relationship between exports and debt-to-GDP ratio, exports and gross domestic product (GDP), and debt-to-GDP ratio and GDP. This implies that exports affect debt and that GDP is influenced by both debt and exports.

**Table 3.6: VAR Granger Causality/Block Exogeneity Wald Test**

| Dependent variable: Debt-to-GDP | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| EXPO | 5.852983 | 2 | 0.0536 |
| LGDP | 0.127152 | 2 | 0.9384 |
| All | 6.165999 | 4 | 0.1871 |
| Dependent variable: Exports | | | |
| Excluded | Chi-sq | df | Prob. |
| CGD | 2.179949 | 2 | 0.3362 |
| LGDP | 3.239884 | 2 | 0.1979 |
| All | 5.946633 | 4 | 0.2032 |
| Dependent variable: Log GDP | | | |
| Excluded | Chi-sq | df | Prob. |
| CGD | 10.25228 | 2 | 0.0059 |
| EXPO | 21.76531 | 2 | 0.0000 |
| All | 26.82553 | 4 | 0.0000 |

While understanding the causality between variables, the variance decomposition is checked for the reasons provided below:

- To understand the dynamic effects of shocks without imposing any restrictions on the long-run relationships among them.
- to identify the direction and magnitude of causality between variables.

To compare how much of the variability in the debt-to-GDP is explained by its shocks to shocks in other variables in the system, the variance decomposition shows the fraction of the error made in forecasting the variables across time owing to the shocks. Table 3.7 shows for the first 2 periods the debt-to-GDP is explained by its own shock. However, debt-to-GDP is explained by exports and GDP gradually over the 20 periods reaching up to 26 percent by exports and 6.7 percent by GDP. Therefore, exports do affect the debt-to-GDP ratios by 26 percent in just 20 periods, and over the long run, it will have more explaining power. However, it should be considered that the debt-to-GDP strongly shows endogeneity and dependency on its own shocks.

**Table 3.7: Variance Decomposition of CGD**

| Period | S.E. | Debt-to-GDP | Exports | Log GDP |
|---|---|---|---|---|
| 1 | 5.197006 | 100.0000 | 0.000000 | 0.000000 |
| 2 | 6.960324 | 99.21571 | 0.761021 | 0.023271 |
| 3 | 7.992974 | 93.76922 | 6.200656 | 0.030120 |
| 4 | 8.831673 | 86.15175 | 13.78502 | 0.063234 |
| 5 | 9.526415 | 80.13531 | 19.80867 | 0.056023 |
| 6 | 10.10609 | 76.32533 | 23.56678 | 0.107890 |
| 7 | 10.61429 | 74.21531 | 25.42918 | 0.355509 |
| 8 | 11.08741 | 73.20976 | 25.95860 | 0.831637 |
| 9 | 11.54668 | 72.84753 | 25.67299 | 1.479478 |
| 10 | 11.99895 | 72.83009 | 24.96345 | 2.206456 |
| 11 | 12.44258 | 72.98236 | 24.08657 | 2.931063 |
| 12 | 12.87328 | 73.20659 | 23.19106 | 3.602352 |
| 13 | 13.28730 | 73.45006 | 22.35192 | 4.198026 |
| 14 | 13.68253 | 73.68575 | 21.59938 | 4.714867 |

| | | | | |
|---|---|---|---|---|
| 15 | 14.05840 | 73.90135 | 20.93905 | 5.159599 |
| 16 | 14.41539 | 74.09280 | 20.36452 | 5.542681 |
| 17 | 14.75461 | 74.26046 | 19.86466 | 5.874874 |
| 18 | 15.07736 | 74.40683 | 19.42747 | 6.165702 |
| 19 | 15.38501 | 74.53504 | 19.04199 | 6.422970 |
| 20 | 15.67879 | 74.64820 | 18.69898 | 6.652814 |

## 4. EMPIRICAL RESULTS

### 4.1 Order of Integration

Two widely used stationarity tests—ADF and PP—were used to ascertain the sequence of integration in the research. The null hypothesis for the ADF test, which examines for non-stationarity, is non-stationarity. The null hypothesis can be disproved, and stationarity proven if the p-value is less than 0.05. Debt-to-GDP ratio and exports are not stationary at level I(0), as shown by the results in Tables 4.1 and 4.2, but they do become stationary at the first difference I(1) following differencing. At level I(0), the GDP is stagnant. Therefore, dmax = 1, and the series' maximum order of integration is 1.

**Table 4.1: UNIT ROOT TEST TABLE (PP)**

| | **At Level** | | | |
|---|---|---|---|---|
| | | Debt-to-GDP | Exports | Log GDP |
| With Constant | t-Statistic | 1.9981 | -2.0420 | -7.4990 |
| | ***Prob.*** | ***0.9998*** | ***0.2686*** | ***0.0000*** |
| | | n0 | n0 | *** |
| With Constant & Trend | t-Statistic | -0.6557 | -2.4300 | -2.3016 |
| | ***Prob.*** | ***0.9709*** | ***0.3604*** | ***0.4254*** |
| | | n0 | n0 | n0 |
| Without Constant & Trend | t-Statistic | 2.9634 | 0.5052 | 7.0522 |
| | ***Prob.*** | ***0.9990*** | ***0.8213*** | ***1.0000*** |
| | | n0 | n0 | n0 |
| | **At First Difference** | | | |
| | | d(Debt-to-GDP) | d(Exports) | d(Log GDP) |
| With Constant | t-Statistic | -6.0337 | -5.4380 | -3.6341 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0084*** |
| | | *** | *** | *** |
| With Constant & Trend | t-Statistic | -6.5716 | -5.5021 | -5.8896 |
| | ***Prob.*** | ***0.0000*** | ***0.0002*** | ***0.0001*** |
| | | *** | *** | *** |
| Without Constant & Trend | t-Statistic | -5.5002 | -5.4197 | -0.8965 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.3229*** |
| | | *** | *** | n0 |

**Notes: (*)Significant at 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant *MacKinnon (1996) one-sided p-values.**

**Table 4.2: UNIT ROOT TEST (ADF)**

| | | At Level | | |
|---|---|---|---|---|
| | | Debt-to-GDP | Exports | Log GDP |
| With Constant | t-Statistic | 1.7973 | -2.0100 | -7.1548 |
| | ***Prob.*** | ***0.9997*** | ***0.2818*** | ***0.0000*** |
| | | n0 | n0 | *** |
| With Constant & Trend | t-Statistic | -0.6035 | -3.2994 | -2.2401 |
| | ***Prob.*** | ***0.9745*** | ***0.0781*** | ***0.4579*** |
| | | n0 | * | n0 |
| Without Constant & Trend | t-Statistic | 3.0270 | 0.6110 | 3.1718 |
| | ***Prob.*** | ***0.9992*** | ***0.8452*** | ***0.9995*** |
| | | n0 | n0 | n0 |
| | | **At First Difference** | | |
| | | d(Debt-to-GDP) | d(Exports) | d(Log GDP) |
| With Constant | t-Statistic | -6.0234 | -5.5655 | -3.7247 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0065*** |
| | | *** | *** | *** |
| With Constant & Trend | t-Statistic | -6.5906 | -5.6356 | -5.8860 |
| | ***Prob.*** | ***0.0000*** | ***0.0001*** | ***0.0001*** |
| | | *** | *** | *** |
| Without Constant & Trend | t-Statistic | -5.5152 | -5.5068 | -1.2949 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.1777*** |
| | | *** | *** | n0 |

**Notes: (*)Significant at 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant**

***MacKinnon (1996) one-sided p-values.**

### 4.2 ARDL Bounds Testing Approach

To find out whether two variables have a long-term connection, the ARDL Bounds cointegration test is applied. A long-run relationship will exist if the variables exhibit cointegration, and the relationship may be established using an ECM equation. In the absence of cointegration, the link may be established using a short-run autoregressive distributed lag equation. This approach's null hypothesis is that cointegration or a level connection doesn't exist. It is acceptable to employ ECM for the long-run model if the estimated F-statistic is bigger than the crucial value for the upper bounds I(1), which is the criterion for defining cointegration. There is no cointegration and an ARDL may be built for the short-run model if the F-statistic is smaller than the crucial value for the lower bounds I(0). Lag 1 is accepted to utilize based on all criteria as stated in Table 4.3 with the cointegration test in Table 4.4. (Pesaran et al.2001)

After selecting the best lag order for each variable, the bounds test was used to determine if an Error Correction Model equation should be used to estimate the long-term relationship among variables or if the short-run ARDL model should be used. The results showed that the F-statistic was lower than the critical value for all upper bounds I(0), indicating that there is no cointegration and the null hypothesis cannot be rejected. The ARDL regression results in Table 4.5 show that a 1% increase in the first lag of the debt-to-GDP ratio is associated with a 1.04% increase in itself on average at a 1% significance level. A 1% increase in exports is associated with a 1.2% decrease in debt on average at a 5% significance level. Finally, a one-point change in the first lag of Gross Domestic Product (GDP) is associated with a 122.4% increase in the country's debt on average at a 1% significance level.

**Table 4.3: Optimum Lag-order Selection Criteria**

Sample: 1974 thru 2021 Number of obs = 48

| Lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| 0 | -326.446 | | | | 183.698 | 13.7269 | 13.7711 | 13.8439 |
| 1 | -64.7894 | 523.31* | 9 | 0.000 | 0.004928* | 3.19956* | 3.376634* | 3.66736* |
| 2 | -57.3408 | 14.897 | 9 | 0.094 | 0.005284 | 3.264 | 3.57357 | 4.08285 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | -54.6855 | 5.3105 | 9 | 0.806 | 0.006968 | 3.52856 | 3.97052 | 4.69806 |
| 4 | -51.5138 | 6.3434 | 9 | 0.705 | 0.009089 | 3.77141 | 4.34595 | 5.29176 |

* optimal lag

Endogenous: cgd lgdp exports

Exogenous: _cons

***Table 4.4: Pesaran/Shin/Smith (2001) ARDL Bounds Cointegration Test***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| H0: no levels relationship | | | F = 0.877 | | | | | |
| | | | t = 1.055 | | | | | |
| Critical Values (0.1 - 0.01), **F-statistic**, Case 3 | | | | | | | | |
| | [I_0] L_1 | [I_1] L_1 | [I_0] L_05 | [I_1] L_05 | [I_0] L_025 | [I_1] L_025 | [I_0] L_01 | [I_1] L_01 |
| K_2 | 3.17 | 4.14 | 3.79 | 4.85 | 4.41 | 5.52 | 5.15 | 6.36 |
| accept if F < critical value for I(0) regressors | | | | | | | | |
| reject if F > critical value for I(1) regressors | | | | | | | | |
| Critical Values (0.1 - 0.01), **t-statistic**, Case 3 | | | | | | | | |
| | [I_0] L_1 | [I_1] L_1 | [I_0] L_05 | [I_1] L_05 | [I_0] L_025 | [I_1] L_025 | [I_0] L_01 | [I_1] L_01 |
| K_2 | -2.57 | -3.21 | -2.86 | -3.53 | -3.13 | -3.80 | -3.43 | -4.10 |
| accept if t > critical value for I(0) regressors | | | | | | | | |
| reject if t < critical value for I(1) regressors | | | | | | | | |
| k: # of non-deterministic regressors in long-run relationship | | | | | | | | |
| critical values from Pesaran/Shin/Smith (2001) | | | | | | | | |

**Table 4.5: Short-run ARDL regression**

| | | |
|---|---|---|
| Dependent Variable | Debt-to-GDP | R-squared – 0.9740 |
| Sample | 1974 2021 | Adjusted R-squared – 0.9715 |
| Obs (adjusted) | 48 | |
| Debt-to-GDP (L1) | 0.0489534*** | |
| Coefficient | 1.075283 | |
| Exports | 0.6120964** | |
| | -1.246697 | |
| Log GDP | 31.47772*** | |
| | -123.4368 | |
| Log GDP (L1) | 30.36153*** | |
| | 122.4735 | |

*Denotes significance at 10%, **significance at 5%, and *** significance at 1%.

## 5. CONCLUSION AND POLICY IMPLICATIONS

This paper examined the causal nexus among Debt, Gross Domestic Products, and Exports with the initial assumption that when GDP increases, revenues are generated that in turn give the ability to repay the debt the country has, and the same with the exports, as they increase, foreign exchanges generate the ability to repay. This study also aimed to address the theory proposed by some economists about GDP implosions and debt explosions which implies that with the rapid decrease in GDP, debt increases, which seems critical to examine, however, the study found that GDP has no or mild impact on debt. A Toda-Yamamoto Causality analysis was performed on World Bank data from 1970 to 2021 due to the different orders of integration for the data. The procedure included a cointegration analysis, which found that the variables were not cointegrated and only had short-run relationships. The ARDL showed a significant negative relationship between debt and exports and a significant positive relationship between debt-to-GDP ratio and GDP at lag levels.

Furthermore, finding the causality required the use of T-Y Granger non-causality using a modified Wald test and found that there is a unidirectional cause from exports to CGD meaning that exports do Granger cause debt, Exports to

GDP, and CGD to GDP, meaning that exports granger cause debt and exports and debt granger cause GDP. Furthermore, the variance decomposition and impulse response functions provided the explanatory power for exports and GDP over the long run as it showed that over the years changes to GDP and exports will affect debt for the country implying that with the strong endogeneity nature of CGD, it will be affected mainly by itself as more debt will cause debt repayments difficult and it will cause high recession for the country but the long-run effects of GDP and Exports, specifically exports have the explanatory power to address the debt and gradually decrease it, but the GDP have mild effect on debt.

This study agrees with Saad's (2012) findings that exports are important for reducing government debt in the long run. However, it disagrees with Dritsaki's (2013) study which found no causality between the variables. Dritsaki used a Vector Error Correction Model (VECM) which may not have been appropriate since the variables did not meet the prerequisites for VECM estimation.

With the results, these are some implications for the federal government that will help to overcome the existing issue of high debt accumulation. With fiscal policies such as:

- lowering taxes or increasing government spending can increase the demand for imported goods and have a positive impact on trading partners.
- Providing subsidies, tax incentives, or public investment to support export-oriented sectors, such as manufacturing, agriculture, or services.
- Implementing trade agreements or reducing trade barriers to facilitate market access and reduce trade costs for exporters,

  Implementing these policies would facilitate exporting goods and services which will effectively decrease debt levels by generating foreign exchange and reserves and will help GDP increase as well.

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