Public Debt and Economic Growth of Nepal

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Abstract

The economy of Nepal has been characterized by a high level of public debt coinciding with a higher level of resource gap and deficit balance of payment for a long period of time which is indicative of debt overhang. This paper investigates the effect of public debt on the economic growth of Nepal using annual time-series data from the period 1978 to 2020. The study is based on an unrestricted Vector Auto regression model, which captures Multivariate Granger Causality between the variables. The result from the analysis reveals that there is no significant causal relationship between public debts and to the economic growth of Nepal.

Keywords

Public Debt, Economic Growth, Vector Auto Regression, Multivariate Grange Causality

1. Introduction

Public debt is a modern invention and was not heard of prior to the 17th century. Public debt is the creation of the last three centuries. It originated in Great Britain in the mid-17th century. However, in modern globalised times, the growth of public debt is the result of evolving economic and political situations in an attempt to create harmony between the two (Ventura & Voth, 2015).

As the government raises loans internally or externally from individuals, banks and financial institutions, global monetary institutions, and even foreign governments, it incurs a debt (liability) known as public debt. Public debt is an important source of revenue for a modern government. In other words, public debt refers to a loan raised by a government within the country or outside the country. In recent years, government expenditure is increasing faster than its ability to raise revenue because of economic complexities. Therefore, when expenditure

exceeds revenue, a deficit arises in the budget of the government. In a much broader sense, public debt may be defined as a kind of deferred tax through which the public enjoys the advantage of the public expenditure much before it is met out of the current revenue and it refers to those obligations of the state as the borrower and private investors of capital as lenders where state promises to pay the lender the amount borrowed with interest after a given period of time.

The Nepalese government has a very brief history of budgeting started in 1951. Since that, the Nepal government has had frequent experiences of deficit budgeting. Public debt has been an important tool of the Nepalese fiscal policy. However, public debt in Nepal was taken after 11 years of initiation of budgetary practice. Thus, our history of public debt is not so long. The government started to take domestic loans in 1962 whereas it started to take foreign loans in 1963. The first foreign creditors of Nepal were the former USSR and UK. Now it is widely accepted as a means of financing measures to reduce BOP deficit, trade deficit or imbalance, and resource gap. The role of public debt is increased significantly by the planned economic development. The main objective of public debt is to promote economic growth in poor countries and thereby lift people out of poverty (Acharya, 1998). Government expenditure in Nepal has been increasing day by day because of development activities (Thapa, 2010).

2. Review

Reinhart and Rogoff (2010) for the first time introduced the Debt to GDP ratio threshold for both advanced countries and emerging market economies. However, Bhatta and Mishra (2020) reveal from their empirical research that the optimum level of Debt to GDP ratio threshold for Nepal is 33%. It implies that public debt accumulation beyond the Debt to GDP threshold ratio of 33% would impact negatively the economic growth of Nepal. However, Shrestha (2021) stated that with the productive use of debt, we can boost our economy and economic expansion is a must to enhance the country's ability to pay the debt back. However, just in case, if Bhatta & Mishra happen to be correct with their empirical findings from their study, then Nepal would have to face a decline in economic growth or even worst, default on public debt, which would lead to debt crisis and extremely painful economic reforms. Nepal is currently operating at 41% Debt to GDP ratio. In this regard, the paper wanted to examine the cause and effect relationship between public debt and the economic growth of Nepal.

Governments should not run budget deficits, because the accumulation of debt is considered "pernicious" for the nation even if all of it is owed to domestic investors consequently (Smith, 1937). Smith proposed balanced budgets, where all government expenditures are financed by taxation However, some classical economists like Thomas Malthus and his successor John Stuart Mill come up with a different approach claiming that public debt doesn't necessarily act detrimental to the accumulation of productive capital, if they are directed either to balance overproduction of goods or in more advantageous uses (Tsoulfidis,

2007).

In contrast, fundamental change of perspective comes from J.M. Keynes (2018) "General Theory of Employment, Interest and Money." Thus, author advocates that as long as there is a sustainable growth of the economy deficit financing need not be considered (Gaspar, Harris, & Tieman, 2018). Ludvigson (1996) also explored how deficit financing could stimulate investment rather than crowding it out. However, the recent debt crisis of Sri-Lanka, debt crisis of Greece in 2017, Asian debt crisis of 1997, and the Latin American debt crisis of 1982 bring argument in favour of the classical economists.

Reinhart and Rogoff (2010) discovered that, across both advanced countries and emerging markets, high debt/GDP levels (90% and above) are associated with notably lower growth outcomes. Much lower levels of external debt/GDP (60%) are associated with adverse economic growth for emerging markets. Matiti (2013) discovered that public debt had a positive relationship with economic growth in Kenya. Tarick (2015) finds that domestic public and external debt negatively affect economic growth in excess of 100 per cent and 55 per cent of GDP respectively. Mencinger, Aristovnik, & Verbič (2014) and their empirical results across all models indicate a statistically significant non-linear impact of public debt ratios on the annual GDP per capita growth rate for the "old" and "new" EU member states included in the sample. Shah and Pervin (2012) disclosed that there is significant impact of the total external debt service and external debt stock on GDP growth in the long run. Total debt service payment has negative effect while total debt stock has positive effect at 5% level of significance. Amos (2015) concludes that external debt and trade openness impacts negatively on economic growth in Zimbabwe while capital investment and labour force growth has positive effects. Ntshakala (2015) reveals that domestic debt is an important determinant of economic growth. Increase in domestic debt will spur economic growth of the nation. This means that domestic debt has a positive impact on Swaziland economic growth. Choong, Lau, Liew, & Puah (2010) have found existence of a short-run causality linkage between all debt measures and economic growth in the short-run. When government expenditures are raised by 1 percent, GDP will increase by 0.29 percent, while increasing GDP by 1 percent, revenue increase by 3.12 percent. Increasing external financing including external debt by 1 percent increases GDP by 0.24 percent and when external investments are effectively implemented, its impact grows to 0.56 percent (Akhmedov, 2016). Akram (2011) stated there is a negative relationship between public debt and economic growth in the short and long term. Empirical results show that the population growth has a strong negative and significant relationship with economic growth, while public debt and inflation rate have positive and significant relationship with economic growth in Jordan (Ali & Zeaud, 2014).

Applying exogeneity of external debt and exchange rate, these variables significantly affect the GDP of Iraq negatively and positively respectively in the long run and that a one percent increases in external debt decreases the Iraqi GDP by 0.33% and a one percent increase in exchange rate increases the GDP of

Iraq by 0.22% in the long run. The short-run estimations of economic growth are different from its long-run estimations that is, a one percent increases in external debt decreases the GDP by 0.55 % and a 1% increase in exchange rate increases the GDP by 0.36% in the short run (Saeed, Ahmed, & Saed, 2015). Kumar and Woo (2010) infer an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10-percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 0.2 percentage points per year, with the impact being smaller (around 0.15) in advanced economies.

Bhattarai (2013) has ddiscovered that in spite of increased budget and increased public debt, the growth rate of economy is relatively low. On average it is 4.28%. But, the rate of inflation is, on average, 8.31%. Thus, Nepalese economy is facing the problem of low rate of economic growth and high rate of inflation. Bhatta and Mishra (2020) found that the optimum public debt to GDP ratio in context of Nepal is 33 percent. Debt sustainability, Nepal would have to raise real GDP growth rate substantially over coming years, raising the rate of investment well above the recent trend of 22% of GDP at market prices to be financed by a combination of increased savings and borrowing, domestic and external (Alamgir & Ra, 2005).

As shown in **Figure 1**, private fixed investment and export will act as control variables, which the researcher intends to hold constant when conducting the research. These control variables bear the ability to influence the outcome by enhancing the internal validity of the study. They are helpful in establishing a causal relationship between variables under investigation.

The study will generate the following research hypothesis:

H0: There is no significant causality between public debt and GDP.

H1: There is a significant causality between public debt and GDP.

3. Methods

Descriptive as well as causal comparative research design in pursuit of the potential effect of public debt on economic growth has been adopted and the study is based on time series data spanning from the period 1978 to 2020. Total number of observations = 43. The data used for the study is retrieved from free online
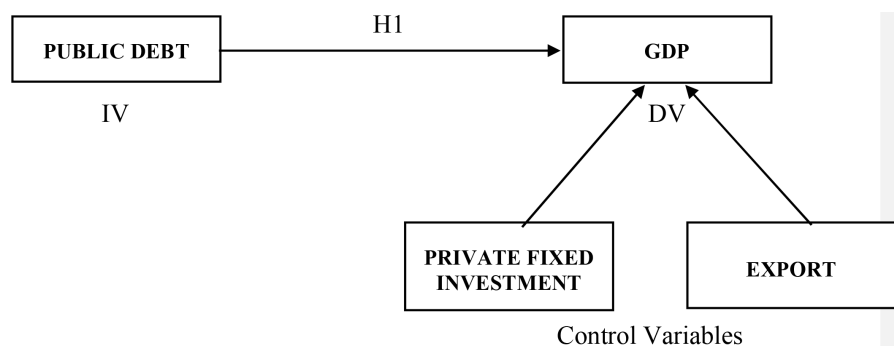

Figure 1. Theoretical framework.

internet forums and public worldwide open source data reserves such as World Bank (WB), Nepal Rastra Bank (NRB), International Monetary Fund (IMF), National Planning Commission-Government of Nepal.

Data analysis procedure for this study will follow some of the most rigorous, widely known, and widely accepted econometric models. Data analysis procedure will be divided into four coherent parts for the sake of reader's best convenience, namely; model specification, ex-ante diagnostic check, Technique for data analysis, and ex-post diagnostic check.

4. Model Specification

In order to analyse the effect of public debt on the economic growth of Nepal, the model can be expressed as:

$$\text{GDP} = F\left(\text{PD}, \text{PFI}, \text{EXP}\right) \tag{1.1}$$

where,

GDP = Gross Domestic Product;

PD = Public Debt;

PFI = Private Fixed Investment;

EXP = Export.

By fitting the given functional form into econometric VAR model, we get:

$$Y_t = \alpha + \beta_0 Y_{t-1} + \beta_1 \text{PD}_{t-1} + \beta_2 \text{PFI}_{t-1} + \beta_3 \text{EXP}_{t-1} + \varepsilon_t \tag{1.2}$$

where,

β_0 = Intercept term;

β_j = Slope coefficients for each of the independent variables;

ε_t = Error term;

$t - 1$ = First order lag.

To obtain elasticity coefficients and remove the effect of outliers, the variables must be transformed to logarithm. In log linear form, the function becomes as:

$$\log Y_t = \alpha + \beta_0 \log Y_{t-1} + \beta_1 \log \text{PD}_{t-1} + \beta_2 \log \text{PFI}_{t-1} + \beta_3 \log \text{EXP}_{t-1} + \varepsilon_t \tag{1.3}$$

where,

$\log Y_t$ = Natural logarithm of GDP;

$\log \text{PD}$ = Natural logarithm of Public Debt;

$\log \text{PFI}$ = Natural logarithm of Private Fixed Investment;

$\log \text{EXP}$ = Natural logarithm of Export;

β_0 = Intercept term;

β_j = Slope coefficients for each of the independent variables;

ε_t = Error term;

$t - 1$ = First order lag.

This paper incorporated a dummy variable. Dummy variables indicate the presence or absence of the 'quality' or an attribute, such as male or female, yes or no, etc. They are essentially nominal scale variables. In this study, value of 1 will be assigned for the presence of economic liberalization in Nepal after year 1990, and the value of 0 will be assigned for the absence of economic liberalization

prior to year 1990. The dummy variable will be given a name called 'shift' as there had been a shift in the economic system of Nepal being economically liberal after year 1990 followed by privatization in 1994.

4.1. Ex-Ante Diagnostic Check

Descriptive Statistics, Unit Root Test-Augmented Dickey Fuller Test (ADF) of estimating the following regression function:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \alpha_3 Y_{t-1} + \sum_{t=1}^{n} \beta \Delta Y_{t-1} + e_t \tag{1.4}$$

Phillip-Perron Test (PP)—The Phillip Perron Test functional model given is used:

$$Y_t = c + \delta t + a y_{t-1} + e(t) \tag{1.5}$$

Johansen Cointegration Test, in statistics, the Johansen cointegration test, named after Søren Johansen is a procedure for testing cointegration of several, say k, I(1) time series.

4.2. Technique for Data Analysis

Multivariate Granger Causality Test, Impulse Response Function (IRF), Variance Decomposition of forecast errors has been done.

4.3. Post Diagnostic Check

i. VAR Residuals Normality Test

$$JB = n - k + 1/6 \left(s^2 + 1/4 (C-3)^2 \right) \tag{1.6}$$

where, n = sample size, s = skewness coefficient and k = kurtosis coefficient. For a normally distributed variable, $s = 0$ and $k = 3$.

4.4. Independent Variable-Public Debt

Public debt is the form of promises by the treasury to pay to the holders of these promises a principle sum and in most instances interest on that principle (Jordá, Taylor, & Schularick, 2013). A nation can't any more than an individual keep adding continually to its liabilities without at least coming to the end of its resources (Emad & Abdullatif, 2006).

4.5. Dependent Variable

Gross Domestic Product (GDP): Generally speaking, GDP can be defined as the aggregate production of goods and services within a country's territory within a given period of time. GDP and economic growth are used synonymously.

4.6. Control Variables

4.6.1. Private Fixed Investment
Private fixed investment (PFI) measures spending by private businesses, non-profit

institutions, and households on fixed assets. Fixed assets consist of structures, equipment, and intellectual property products that are used in the production of goods and services. PFI encompasses the creation of new productive assets, the improvement of existing assets, and the replacement of worn out or obsolete assets (Evans, Cooper, Landefeld, & Marcuss, 2003).

The PFI estimates serve as an indicator of the willingness of private businesses and non-profit institutions to expand their production capacity and as an indicator of the growth in demand. Thus, movements in PFI serve as a barometer of confidence in, and support for, future economic growth (Evans, Cooper, Landefeld, & Marcuss, 2003).

PFI also provides comprehensive information on the composition of business fixed investment. Thus, for example, it can be used to assess the penetration of new technology. In addition, the investment estimates are the building blocks for estimates of capital stock, which are used in measuring rates of return on capital and in analysing multifactor productivity (Evans, Cooper, Landefeld, & Marcuss, 2003).

4.6.2. Export

Exports are goods and services that are produced in one country and sold to buyers in another. Exports, along with imports, make up international trade. Exports are incredibly important to modern economies because they offer people and firms many more markets for their goods. One of the core functions of diplomacy and foreign policy between governments is to foster economic trade, encouraging exports and imports for the benefit of all trading parties (Segal, 2021).

5. Analysis

Figure 2 presented below shows the GDP time series of Nepal.

As one can see from the graph, Nepal's GDP from year 1978 to 2020 has been rising steadily. That is most likely the result of economic liberalisation. Moreover, Nepal privatization act of 1994 has had a propelling effect on the growth of
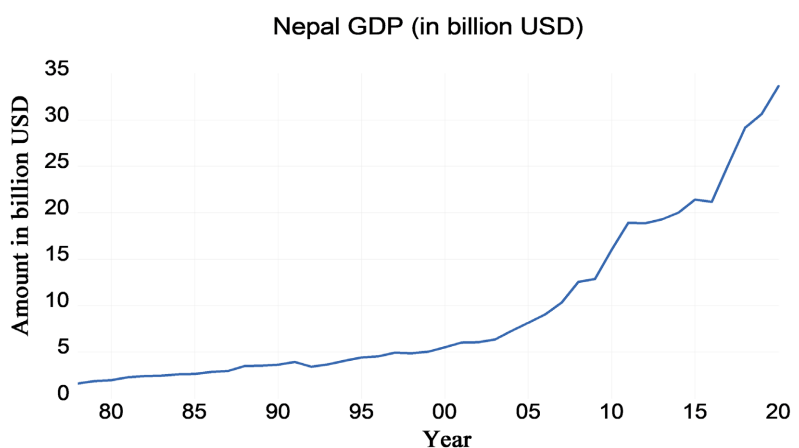
Figure 2. Nepal GDP time series plot from year 1978 to 2020.

GDP in Nepal. The growth of GDP had remained below USD 3 billion until 1993. After year 1994, Nepal's GDP is on a constant rise with minor downticks along the line. It is also believed that part of the reason why the growth of GDP in Nepal is substantial over the period of 1994 till 2020 is due to the currency pegging of NPR to INR at 1 INR per 1.60 NPR since the year 1994. Gross Domestic Product is an outcome of government spending on infrastructures and sound policies combined with a liberal innovative economy where private entities can freely enter and exit the market.

Similarly, **Figure 3** presented below shows the public debt time series of Nepal.

Throughout the study period, the public debt of Nepal exhibits a steady rise except from year 2014, 2015, and 2016, which is indicative of the government of Nepal lacking revenue streams to sufficiently cover the expenditure. One of the main reasons behind such increase in public debt is increase in size of budget significantly over the period of time.

Similarly, **Figure 4** presented below shows the PFI time series of Nepal.

Figure 3. Nepal public debt time series plot from year 1978 to 2020.

Figure 4. Nepal private fixed investment time series plot from year 1978 to 2020.

Private fixed investment (PFI) measures spending by private businesses, non-profit institutions, and households on fixed assets. Fixed assets consist of structures, equipment, and intellectual property products that are used in the production of goods and services. PFI encomp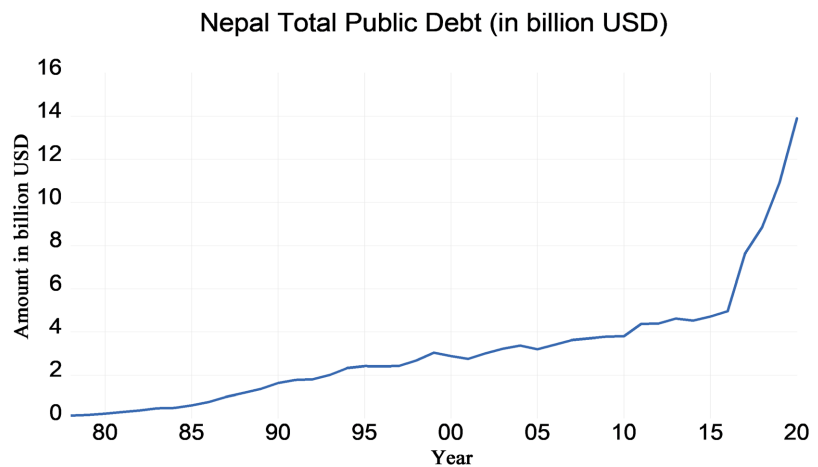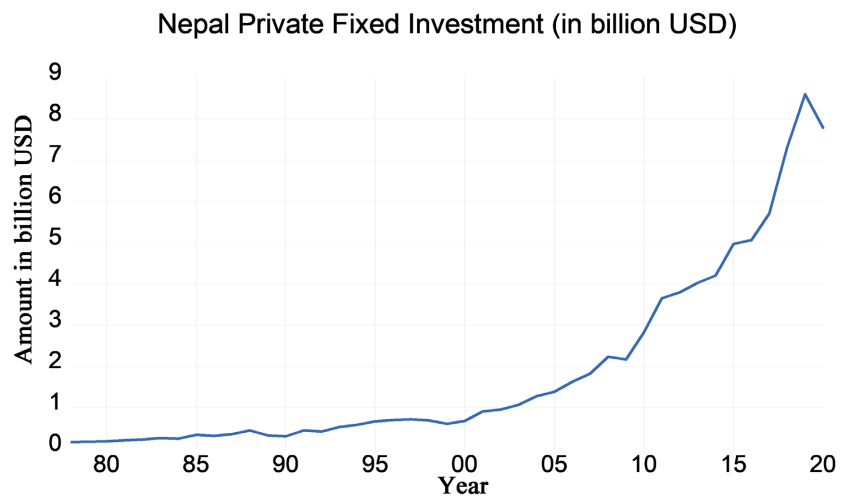asses the creation of new productive assets, the improvement of existing assets, and the replacement of worn out or obsolete assets.

The PFI estimates serve as an indicator of the willingness of private businesses and non-profit institutions to expand their production capacity and as an indicator of the growth in demand. Thus, movements in PFI serve as a barometer of confidence in, and support for, future economic growth. The PFI during the observation period is continuously in increasing trend.

Similarly, **Figure 5** presented below shows the Export time series of Nepal.

Increase in the volume of export is indicative of openness of the economy, membership in multiple trade organisations, and growth in economy which has been observed during the study period.

6. Model Specification

In order to analyse the effect of public debt on the economic growth of Nepal, the econometric VAR model can be specified as:

$$Y_t = \alpha + \beta_0 Y_{t-1} + \beta_1 \text{PD}_{t-1} + \beta_2 \text{PFI}_{t-1} + \beta_3 \text{EXP}_{t-1} + \varepsilon_t \tag{1.7}$$

To obtain elasticity coefficients and remove the effect of outliers, the variables must be transformed to logarithm. In log linear form, the function becomes as:

$$\log Y_t = \alpha + \beta_0 \log Y_{t-1} + \beta_1 \log \text{PD}_{t-1} + \beta_2 \log \text{PFI}_{t-1} + \beta_3 \log \text{EXP}_{t-1} + \varepsilon_t \tag{1.8}$$

7. Descriptive Statistics

The measures used to describe the data set for this study are measures of central tendency and measures of variability/dispersion.

Table 1 presents the summary of descriptive statistics that one can refer to get a proper insight of the characteristics of the data. It serves as a preliminary
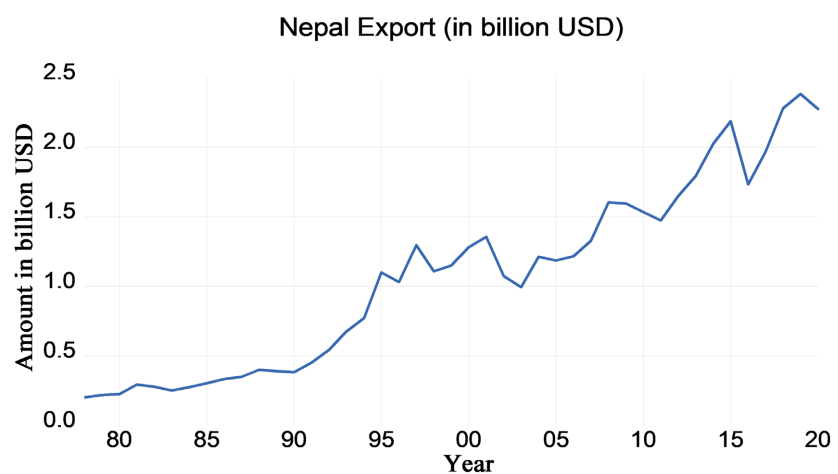

Figure 5. Nepal export time series plot from year 1978 to 2020.

Table 1. Summary of descriptive statistics.

	GDP	PD	PFI	EXPORT
Mean	1.868610	0.686243	−0.040241	−0.183552
Median	1.615420	1.008213	−0.359106	0.101473
Maximum	3.516013	2.631169	2.151471	0.868654
Minimum	0.472501	−2.184802	−1.801810	−1.603456
Std. Dev.	0.882710	1.124409	1.184045	0.784305
Skewness	0.371881	−0.882055	0.326802	−0.446022
Kurtosis	1.887304	3.237757	1.883647	1.739365
Jarque-Bera	3.209368	5.677101	2.998248	4.273022
Probability	0.200953	0.058510	0.223326	0.118066
Sum	80.35022	29.50844	−1.730350	−7.892748
Sum Sq. Dev.	32.72540	53.10044	58.88241	25.83566
Observations	43	43	43	43

assessment for further analysis. One can see that the variables are normally distributed. The basic rule of thumb for a normally distributed data is that the p-value for Jarque-Bera must be above 5% significance level or 0.05. Jarque-Bera test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. As the p-value for Jarque-Bera test for all the variables is greater than the significance level of 5% or 0.05, we accept the null hypothesis.

8. Unit Root Test

The following table presents Augmented Dickey-Fuller (ADF) test that follows intercept as test equation based on SIC lag length criteria.

Table 2 presents the Augmented Dicky-Fuller test results. The obtained ADF t-statistic (absolute value) was compared with the t-critical absolute values. The general rule of thumb for unit root test is that, if the p-value is less than 0.05 or 5%, then in that case we can reject the null hypothesis (H0) that the series has a unit root and claim that the series is stationary. In the above table, one can see that all the variables are significantly stationary at first difference I (1). Thus, we reject the null hypothesis.

Similarly, the following table presents Phillip-Perron (PP) test that follows intercept as test equation based on SIC lag length criteria.

Table 3 presents Phillip-Perron (PP) test results. The obtained PP t-statistic (absolute value) was compared with the t-critical absolute values. The general rule of thumb for interpreting PP test is same that of ADF test. So, in the above table, one can see that all the variables are significantly stationary at first difference I (1). Thus, we reject the null hypothesis.

Table 2. Augmented dickey-fuller test.

Order of integration	Variables	Intercept
Level	GDP (t-stat)	0.791305
	P-value	(0.9927)
First difference I (1)	GDP (t-stat)	−6.353740***
	P-value	(0.0000)
Level	PD (t-stat)	−1.772119
	P-value	(0.3887)
First difference I (1)	PD (t-stat)	−3.540631**
	P-value	(0.0117)
Level	PFI (t-stat)	0.284648
	P-value	(0.9747)
First difference I (1)	PFI (t-stat)	−7.747734***
	P-Value	(0.0000)
Level	EXP (t-stat)	−1.356242
	P-value	(0.5943)
First difference I (1)	EXP (t-stat)	−6.642274***
	P-value	(0.0000)
1%		−3.600987
5%	Critical values	−2.935001
10%		−2.605836

Values marked with a "***" represent stationary variables at 1% significance level. Values marked with "**" represent stationary variables at 5% significance level.

Table 3. Phillip-perron test.

Order of integration	Variables	Intercept
Level	GDP (t-stat)	0.827825
	P-value	(0.9934)
First difference I (1)	GDP (t-stat)	−6.358265***
	P-value	(0.0000)
Level	PD (t-stat)	−2.822602
	P-value	(0.0637)
First difference I (1)	PD (t-stat)	−3.398307**
	P-value	(0.0167)
Level	PFI (t-stat)	0.284648
	P-value	(0.9747)
First difference I (1)	PFI (t-stat)	−7.747734***
	P-Value	(0.0000)
Level	EXP (t-stat)	−1.412458
	P-value	(0.5672)
First difference I (1)	EXP (t-stat)	−6.671804***
	P-value	(0.0000)

Continued

1%	Critical values	−3.596616
5%		−2.933158
10%		−2.604867

Values marked with a "***" represent stationary variables at 1% significance level. Values marked with "*" represent stationary variables at 5% significance level.

9. Johansen Cointegration Test

For this study, identification of a long-run equilibrium relationship between the model variables will be achieved through the Johansen cointegration test using the Trace and Max-Eigen value tests. Accordingly, the non-stationary variables (at level) shown in Table 2 and Table 3 will allow accurate determination of the econometric model. A number of two lags by default were chosen which will make it possible to apply the cointegration test. Table 4 presents criteria for selecting the most appropriate number of lags required to apply Johansen cointegration test.

As shown in Table 4, the most appropriate number of lags to apply Johansen cointegration test is 1 lag highlighted by an asterisk sign '*'. Since lag one has achieved the maximum number of asterisk sign, Johansen cointegration test will be performed based on that. Similarly, Johansen cointegration test results are presented in Table 5 given below.

The Trace and Max-Eigen value tests defining for the Johansen cointegration test are presented with intercept (no trend) in the CE and test VAR. They confirm the inexistence of a cointegrating relationship, since the p-value is greater than the 0.05 significance level, the null hypothesis of no cointegration is accepted. In this regard, the existence of a short-run relationship between the model variables can be considered. In order to move to the next stage in the econometric analysis, it must be taken into account that both the integration order I (1) of the time series and the absence of cointegration relationships make it possible to fulfill the conditions for running the unrestricted VAR model. Coefficients of the unrestricted vector autoregressive model will provide evidence of a short-run relationship between GDP, PD, PFI, and EXP variables.

Similarly, the VAR lag exclusion Wald test is a safety test for the number of lags chosen from the selection criteria. The P-value common to the model variables indicates the possibility of using the chosen lag if its value is at a significance level of less than 0.05. Wald statistic for the joint significance of all endogenous variables at that lag is reported for each equation separately and jointly. Table 6 presented below shows the result of VAR lag exclusion Wald test.

As shown in Table 6, the variables used indicate a common p-value of 0.0000, significantly less than 0.05. Thus, it is confirmed that the vector autoregression model will be estimated by using a number of 1 lag.

Moreover, as an extension to determining the optimal number of lags, the stability

Table 4. Criteria for selecting the most appropriate number of lags to apply Johansen cointegration test.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	11.40213	NA	9.73e−06	−0.189007	0.162886	−0.066187
1	158.5104	245.1805*	6.76e−09*	−7.472801	−6.417122*	−7.104341
2	167.9753	13.67145	1.02e−08	−7.109737	−5.350272	−6.495637
3	178.3841	12.72190	1.56e−08	−6.799117	−4.335865	−5.939376
4	189.1778	10.79367	2.60e−08	−6.509876	−3.342838	−5.404495
5	214.7992	19.92780	2.27e−08	−7.044401	−3.173577	−5.693380
6	255.8383	22.79948	1.17e−08	−8.435460	−3.860850	−6.838798
7	285.4316	9.864424	2.23e−08	−9.190642*	−3.912245	−7.348340*

Table 5. Johansen cointegration test.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE (s)	Eigen value	Trace Statistic	0.05 Critical Value	*P*-value
None	0.431310	47.05152	47.85613	0.0594
At most 1	0.314053	23.91027	29.79707	0.2043
At most 2	0.170082	8.455121	15.49471	0.4181
At most 3	0.019599	0.811533	3.841465	0.3677

Trace test indicates no cointegration at the 0.05 level.

Unrestricted Cointegration Rank Test (Maximum Eigen value)				
Hypothesized No. of CE (s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	*P*-value
None	0.431310	23.14125	27.58434	0.1675
At most 1	0.314053	15.45515	21.13162	0.2583
At most 2	0.170082	7.643588	14.26460	0.4161
At most 3	0.019599	0.811533	3.841465	0.3677

Max-Eigen value test indicates no cointegration at the 0.05 level.

Table 6. VAR lag exclusion wald test

Chi-squared test statistics for lag exclusion: Numbers in [] are *p*-values					
	GDP	PD	PFI	EXP	Joint
Lag 1	43.76407 [0.0000]	46.38364 [0.0000]	23.18964 [0.0001]	14.80346 [0.0051]	122.2539 [0.0000]
Lag 2	7.513688 [0.1111]	4.964028 [0.2910]	0.345319 [0.9867]	0.780436 [0.9411]	17.92995 [0.3280]
d.f	4	4	4	4	16

of the VAR model was also considered because if the VAR is not stable, certain results such as impulse response functions are not valid. There will be roots where the number of endogenous variables is the largest lag. If you estimated a VEC with cointegrating relations, then roots should be equal to unity. Table 7 shows the inverse roots of the autoregressive characteristic polynomial. The condition that must be satisfied in order for the VAR model to be dynamically stable is that the roots of the autoregressive model equation must lie within the circle. The characteristic equation has three real roots and two complex pairs of conjugated roots, the inverse roots are distributed only within the unit circle.

The estimated VAR is stable (stationary) if all roots have modulus less than one and lie inside the unit circle. As shown in Table 7, the AR process is stationary, since all the roots have modulus of less than I. Therefore, it is established that the VAR model is stable. According to the steps followed, it can be stated that the stability of the VAR model was demonstrated. The Johansen cointegration test, as well as the integration order I (1) of the variables indeed required the autoregressive vector to run. Also, by analyzing the inverse roots of the autoregressive characteristic polynomial, it was found that they were distributed in the center of the unit circle, demonstrating the validity of the VAR model.

10. Empirical Results

Multivariate Granger Causality Test

As shown in Table 8, the causality between four variables was investigated based on the Granger Causality/Block Exogeneity Wald Test. The existence of a causal relationship between the variables of a model under analysis is verified only if the p-value is at a significant level of less than 0.05. Proceeding to interpret results from Table 8, when GDP is held as the dependent variable, PD, PFI, and EXP all acting as independent variables are statistically insignificant individually, confirming that there is no significant effect of public debt on GDP. Thus, we

Table 7. Inverse roots of AR characteristic polynomial.

Root	Modulus
0.963774−0.032861i	0.964334
0.963774+0.032861i	0.964334
0.383941−0.299424i	0.486894
0.383941+0.299424i	0.486894
0.434615	0.434615
0.156466−0.132272i	0.204884
0.156466+0.132272i	0.204884
−0.117916	0.117916

<div align="center">
No root lies outside the unit circle.
VAR satisfies the stability condition.
</div>

Table 8. VAR granger causality/block exogeneity wald tests.

Dependent Variable: GDP			
Excluded	Chi-sq	df	Probability (*P*-Value)
PD	1.266227	2	0.5309
PFI	4.176203	2	0.1239
EXP	3.412525	2	0.1815
All/Joint	12.68213	6	0.0484
Dependent Variable: PD			
Excluded	Chi-sq	df	Probability (*P*-Value)
GDP	2.372665	2	0.3053
PFI	4.257066	2	0.1190
EXP	1.914779	2	0.3839
All/Joint	12.15476	6	0.0586
Dependent Variable: PFI			
Excluded	Chi-sq	df	Probability (*P*-Value)
GDP	5.581534	2	0.0614
PD	0.557775	2	0.7566
EXP	2.470627	2	0.2907
All/Joint	11.52163	6	0.0735
Dependent Variable: EXP			
Excluded	Chi-sq	df	Probability (*P*-Value)
GDP	0.801098	2	0.6700
PD	2.993223	2	0.2239
PFI	1.353769	2	0.5082
All/Joint	9.236741	6	0.1607

accept the Null hypothesis, which states that there is no significant causal relationship between public debt and GDP. However, PD, PFI, and EXP are jointly statistically significant at 4.84% or 0.0484 which is less than 0.05. Meaning that, PD, PFI, and EXP jointly can Granger cause GDP and that PD, PFI, and EXP are complimentary to each other and not the substitutes. Similarly, when PD is held as the dependent variable, GDP, PFI, and EXP all act as independent variables that are statistically insignificant individually. Moreover, GDP, PFI, and EXP cannot Granger cause PD jointly as 0.0586 is greater than the 0.05 significance level. Similarly, when PFI is held as the dependent variable, GDP, PD, and EXP all act as independent variables that are statistically insignificant. Moreover, GDP, PD, and EXP cannot Granger cause PFI jointly as 0.0735 is greater than the 0.05 significance level. Finally, when EXP is held as the dependent variable, GDP, PD, and PFI all act as independent variables that are insignificant individually. Moreover, GDP, PD, and PFI cannot Granger cause EXP as 0.1607 is

greater than the 0.05 significance level.

It is imperative to know the causes underpinning the evolution of a national economy. Essentially, the political and business environment plays a defining role in supporting growth and subsequent development of a sustainable economy of a country, as they are the indispensable tool for all sorts of economic activities. Applying the Granger causality test was an absolute necessity since it provides an overview of the causality produced between the variables under investigation for this study.

11. Impulse Response Function

Table 9 presents the response of GDP as a result of one standard deviation shock to GDP PD, PFI, and EXC. It shows that GDP will respond positively to its own shock throughout the period. From the second year, shocks start to appear in the independent variables. GDP will respond positively to shock in PD up to next 4 years, and then it will respond negatively to PD from year 5 to 10. A standard deviation shock in PFI in period 2 will lead to a negative response of GDP. However, from period 3 to 10, GDP will respond positively to shock in PFI. On the contrary, a standard deviation shock in EXP in period 2 will lead to a negative response of GDP throughout the period up to next 10 year.

Table 10 presents the response of PD as a result of one standard deviation shock to PD, GDP, PFI, and EXP. It shows that PD will respond positively to its own shock throughout the period. Similarly, PD will respond positively to the shock in PFI from year 2 to 10. On the other hand, PD will respond negatively to the shock in GDP for the year 2 and 3, while responding positively thereafter. A shock in Export however, will force PD to respond negatively throughout the period from year 2 to 10.

Table 11 presents the response of PFI to one standard deviation shock to GDP, PD, PFI, and, EXP. It shows that PFI will respond positively to its own

Table 9. Response of GDP.

Period	GDP	PD	PFI	EXP
1	0.062981	0.000000	0.000000	0.000000
2	0.061039	0.014769	−0.000882	−0.021137
3	0.060920	0.013151	0.017520	−0.025168
4	0.063236	0.005155	0.027657	−0.023686
5	0.066256	−0.000948	0.028770	−0.024816
6	0.069138	−0.004952	0.025855	−0.027708
7	0.071664	−0.008253	0.022549	−0.030165
8	0.073808	−0.011638	0.020116	−0.031291
9	0.075599	−0.015215	0.018539	−0.031251
10	0.077069	−0.018821	0.017457	−0.030526

Table 10. Response of PD.

Period	GDP	PD	PFI	EXP
1	0.002730	0.089310	0.000000	0.000000
2	−0.008516	0.104679	0.009437	−0.021975
3	−0.004179	0.095241	0.035038	−0.024417
4	0.003670	0.081919	0.043797	−0.024920
5	0.011904	0.072572	0.041772	−0.029662
6	0.019636	0.065450	0.036692	−0.035308
7	0.026729	0.058583	0.032432	−0.039187
8	0.033204	0.051313	0.029727	−0.040860
9	0.039114	0.043779	0.028104	−0.040990
10	0.044502	0.036302	0.026981	−0.040340

Table 11. Response of PFI.

Period	GDP	PD	PFI	EXP
1	0.068789	0.009153	0.100903	0.000000
2	0.074987	0.001186	0.055047	−0.016350
3	0.080398	0.007591	0.035107	−0.038263
4	0.084518	0.006430	0.026994	−0.046827
5	0.088201	0.001164	0.025301	−0.047488
6	0.091426	−0.005424	0.025197	−0.045394
7	0.094227	−0.011822	0.024913	−0.043067
8	0.096625	−0.017591	0.024143	−0.041166
9	0.098633	−0.022739	0.023067	−0.039625
10	0.100269	−0.027379	0.021887	−0.038250

shock throughout the period. Similarly, a shock in GDP will force PFI to respond positively throughout the period. On the other hand, PFI will respond positively to PD up to period 5, and then will respond negatively thereafter. A shock in export today however, will force PFI to respond negatively throughout the period in the future.

Table 12 presents the response of EXP to one standard deviation shock to GDP, PD, PFI, and EXP. It shows that EXP will respond positively to its own shock up to period 5, and will respond negatively thereafter. However, EXP will respond positively throughout the period as a result of shocks in GDP and PFI at present. Similarly, a shock in PD will force EXP to react negatively in the first period, and then react positively thereafter.

12. Variance Decomposition

Variance Decomposition is a statistical method to observe the percentage of er-

ror made while forecasting a variance over time due to a specific shock. Table 13 presents the variance decomposition of GDP.

Table 13 presents the variance decomposition of GDP. Due to Cholesky decomposition order, there is no contemporaneous effect on PD, PFI, and EXC in the first year. However, one can observe that in the second year, 92.03% of variance in GDP is explained by itself, when 2.60% is explained by PD, 0.0093% is explained by PFI, and remaining 5.34% is explained by EXP. The sum of these variances totals as 100%. And as time passes, the variance in GDP explained by GDP itself and PD tend to decline, but the variance in GDP explained by PFI and EXP tend to increase over the period of time. Similarly, Table 14 presents the variance decomposition of PD.

Table 14 presents the variance decomposition of PD over the period of time. One can observe from the table that, in the first period, 99.90% of variance in PD

Table 12. Response of EXP.

Period	GDP	PD	PFI	EXP
1	0.027442	−0.029095	0.014727	0.107641
2	0.013246	0.000951	0.022870	0.068433
3	0.010456	0.010911	0.034440	0.037681
4	0.012718	0.013141	0.033941	0.017303
5	0.015996	0.014822	0.026968	0.001694
6	0.019114	0.015773	0.019986	−0.009155
7	0.021883	0.015237	0.015453	−0.015287
8	0.024331	0.013347	0.013152	−0.017928
9	0.026512	0.010675	0.012121	−0.018583
10	0.028463	0.007738	0.011599	−0.018361

Table 13. Variance decomposition of GDP.

Period	S.E.	GDP	PD	PFI	EXP
1	0.062981	100.0000	0.000000	0.000000	0.000000
2	0.091422	92.03548	2.609701	0.009315	5.345500
3	0.114816	86.50504	2.966541	2.334332	8.194084
4	0.136140	83.10398	2.253400	5.787472	8.855149
5	0.156103	81.22176	1.717574	7.798458	9.262203
6	0.174955	80.27813	1.447492	8.392365	9.882014
7	0.192954	79.79338	1.372955	8.265314	10.56835
8	0.210234	79.54121	1.462957	7.877994	11.11783
9	0.226859	79.41479	1.706216	7.433410	11.44558
10	0.242890	79.34594	2.088832	7.001115	11.56411

is explained by itself, while 0.093% of variance is explained by GDP. There is no contemporaneous effect of PFI and EXP in the first period. As time passes, the variance in PD explained by itself tends to decline, while the variance in PD explained by GDP, PFI, and EXP all tend to increase throughout the period. Similarly, Table 15 presents the variance decomposition of PFI.

Table 15 presents the variance decomposition of PFI over the period of time. One can observe from the table that, in the first period, 67.88% of variance in PFI is explained by itself, while 31.55% and 0.55% of variance in PFI is explained by GDP and PD respectively. There is no contemporaneous effect of EXP in the first period. As time passes, the variance in PFI explained by itself tends to decline. But on the contrary, the variance in PFI explained by GDP, PD, and EXP tend to increase throughout the period. Similarly, Table 16 presents the variance decomposition of EXP.

Table 14. Variance decomposition of PD.

Period	S.E.	GDP	PD	PFI	EXP
1	0.089352	0.093367	99.90663	0.000000	0.000000
2	0.139950	0.408348	96.67142	0.454733	2.465496
3	0.174637	0.319516	91.82482	4.317471	3.538189
4	0.199403	0.278957	87.30956	8.135765	4.275716
5	0.218620	0.528574	83.65432	10.41915	5.397959
6	0.234642	1.159173	80.40055	11.49008	6.950202
7	0.248577	2.189059	77.19285	11.94015	8.677940
8	0.260920	3.606317	73.92983	12.13523	10.32862
9	0.272022	5.385467	70.60874	12.23236	11.77344
10	0.282222	7.489590	67.25152	12.27807	12.98082

Table 15. Variance decomposition of PFI.

Period	S.E.	GDP	PD	PFI	EXP
1	0.122463	31.55258	0.558661	67.88876	0.000000
2	0.154653	43.28880	0.356179	55.23733	1.117691
3	0.182032	50.75338	0.430973	43.59055	5.225094
4	0.207946	55.41110	0.425863	35.08810	9.074937
5	0.232202	58.86773	0.344053	29.32772	11.46049
6	0.254953	61.68919	0.330646	25.30370	12.67646
7	0.276578	64.02690	0.463660	22.31299	13.19645
8	0.297353	65.95209	0.751097	19.96331	13.33351
9	0.317437	67.52494	1.172189	18.04507	13.25781
10	0.336915	68.80003	1.700948	16.44091	13.05811

Table 16. Variance decomposition of EXP.

Period	S.E.	GDP	PD	PFI	EXP
1	0.115772	5.618418	6.315709	1.618072	86.44780
2	0.137060	4.942594	4.510950	3.938616	86.60784
3	0.147037	4.800336	4.470229	8.908591	81.82084
4	0.152989	5.125142	4.866943	13.15081	76.85710
5	0.156880	5.913753	5.521141	15.46152	73.10359
6	0.160340	7.082469	6.253235	16.35520	70.30909
7	0.163989	8.551450	6.841359	16.52342	68.08377
8	0.167800	10.26993	7.166831	16.39565	66.16759
9	0.171657	12.19905	7.235190	16.16589	64.39988
10	0.175521	14.29746	7.114435	15.89856	62.68955

Table 16 presents the variance decomposition of EXP over the period of time. One can observe from the table that, in the first period, 86.44% of variance in EXP is explained by itself, while 5.61%, 6.31%, and 1.61% of variance in EXP is explained by GDP, PD, and PFI respectively. As time passes, the variance in EXP explained by itself tends to decline. Whereas, the variance in EXP explained by GDP and PD tend to decline for period 2, 3, and 4. After period 4, the variance in EXP explained by GDP and PD tend to increase. On the other hand, the variance in EXP explained by PFI tends to increase steadily until it shows sign of decline from 8th period.

13. Ex-Post Diagnostic Check

Ex-post diagnostic checks help to determine the validity and reliability of the VAR model. They include the following tests.

13.1. VAR Residuals Normality Test

Table 17 presents the result of normality test. One can observe from the results that the residuals are normally distributed, confirming that is the joint probability value of Jarque-Bera 0.5686, which is exceptionally more than 0.05. In other words, we accept the null hypothesis that states residuals are multivariate normal.

13.2. VAR Residuals Heteroskedasticity Test

The study used Breusch Pagan LM test of 1979. Table 18 presents the result of test of homoskedasticity.

One can observe from the results that there is no presence of heteroskedasticity and that the data set is indeed homoscedastic. In other words, the variation of "X" values around the regression line is more or less the same. The probability value of 0.4233 is exceptionally above 0.05, confirming that there is absence of heteroskedasticity in the residuals. In other words, we accept the null hypothesis.

13.3. VAR Residuals Serial Correlation LM Test

The term serial correlation (or autocorrelation) may be defined as a correlation between members of the series of observation ordered in time (as in time series data) or space (as in cross section data).

Table 19 presents the result of VAR Residuals Serial Correlation LM test. One can observe from the table that there is no presence of serial correlation. The probability values of LRE statistics and Rao F-statistics both are exceptionally above 0.05 significance level at lag 1, 2 and 3, confirming that the residuals are free from serial correlation. In other words, we accept the null hypothesis.

13.4. Ramsey's RESET Test

Ramsey's RESET Test is a statistical method to check whether the parameters of the model are stable across various subsamples of the data.

Table 20 presents the result of Ramsey's RESET test. One can observe from the table that the chosen model for the study is free from speciation errors. In

Table 17. VAR residuals normality test.

Component	Jarque-Bera	df	*P*-value
1	3.465656	2	0.1768
2	2.034956	2	0.3615
3	0.387924	2	0.8237
4	0.818424	2	0.6642
Joint	6.706961	8	0.5686

Table 18. VAR residual heteroskedasticity test.

Chi-sq	Df	Prob.	Joint Test
172.9172	170	0.4233	

Table 19. VAR residuals serial correlation LM test.

Null hypothesis: No Serial Correlation at lag h						
Lag	LRE*stat	Df	Prob.	Rao F-stat	df	Prob.
1	18.16938	16	0.3141	1.163029	(16, 74.0)	0.3174
2	10.39754	16	0.8451	0.633466	(16, 74.0)	0.8465
3	13.24035	16	0.6551	0.821301	(16, 74.0)	0.6578

Table 20. Ramsey's RESET test.

	Value	d.f.	Probability
t-statistics	1.053926	37	0.2988
F-statistics	1.110761	(1,37)	0.2988
Likelihood ratio	1.271887	1	0.2594

other words, the model is not mis-specified. The probability value of t-statistics, F-statistics, and likelihood ratio all are exceptionally above 0.05, confirming that there is no specification error. In other words, we accept the null hypothesis.

14. Discussion

Empirical analysis conducted in this study yields the following results for the causal relationship between public debt and economic growth: first, public debt does not cause economic growth of Nepal; second, structural factors such as Private Fixed Investment (PFI), and Export (EXP) is complementary to public debt and not substitutes. Empirical findings from this study are in line and consistent with the empirical findings obtained by Mencinger, Aristovnik, & Verbič (2014), Tarick (2015), Amos (2015), Akram (2011), Saeed, Ahmed, & Saed (2015), Amos (2015). Whereas, the empirical findings from this study are not in line and inconsistent with the empirical findings obtained by Matiti (2013), Shah and Pervin (2012), Ntshakala (2015), Choong, Lau, Liew, & Puah (2010), Ali and Zeaud (2014).

15. Conclusion

Since Nepal is dependent on internal private and external private and public borrowing for covering high government spending aside from tax revenue that has seemingly reached a saturation point, the main objective of the study was to explore the causal relationship between public debt, GDP, Private Fixed Investment (PFI), and Export (EXP) of Nepal from the period 1978 to 2020 using an unrestricted VAR approach. Originally, the paper investigated if public debt causes the economic growth of Nepal. The empirical results revealed that public debt does not cause the economic growth of Nepal. In other words, there is no significant unidirectional causal relationship running from public debt to the economic growth of Nepal. Moreover, shocks in public debt appeared to have both positive and negative effects on GDP in the future point of time. The negative response of GDP to a shock in public debt is indicative of mismanagement of public debt and a hint of the crowding-out effect.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendices

Appendix 1. Time Series Data Employed for the Study

Observation date	GDP (in Billion USD)	PD (in Billion USD)	PFI (in Billion USD)	EXP (in Billion USD)
1978	1.604	0.1125	0.165	0.2012
1979	1.851	0.1463	0.177	0.2181
1980	1.946	0.2044	0.1845	0.2245
1981	2.276	0.2784	0.2063	0.2936
1982	2.395	0.3527	0.2301	0.2776
1983	2.447	0.4524	0.2634	0.2503
1984	2.581	0.4702	0.24689	0.2749
1985	2.62	0.5897	0.3419	0.302
1986	2.851	0.7437	0.3179	0.3324
1987	2.957	0.9858	0.358	0.3493
1988	3.487	1.1652	0.446	0.3991
1989	3.525	1.3557	0.3267	0.3901
1990	3.63	1.6266	0.3054	0.3821
1991	3.92	1.7651	0.4463	0.4504
1992	3.4	1.798	0.4216	0.5426
1993	3.66	2.003	0.5314	0.6746
1994	4.06	2.3202	0.5837	0.7711
1995	4.4	2.4097	0.6685	1.0988
1996	4.52	2.3978	0.6983	1.0313
1997	4.92	2.4133	0.7172	1.2953
1998	4.85	2.6684	0.69	1.1068
1999	5.03	3.0277	0.6081	1.1492
2000	5.5	2.8744	0.6795	1.2806
2001	6.007	2.7407	0.9072	1.3552
2002	6.05	2.9975	0.954	1.073
2003	6.33	3.2132	1.071	0.9938
2004	7.27	3.3663	1.2762	1.2128
2005	8.13	3.189	1.3837	1.1856
2006	9.04	3.4027	1.6311	1.2156
2007	10.32	3.6131	1.8245	1.3267
2008	12.54	3.6966	2.2361	1.6021
2009	12.85	3.777	2.1683	1.5958

Continued

2010	16	3.7874	2.832	1.5332
2011	18.91	4.371	3.6534	1.4728
2012	18.85	4.3816	3.7954	1.6493
2013	19.27	4.6103	4.0249	1.7911
2014	20	4.515	4.2061	2.0248
2015	21.41	4.7046	4.9671	2.187
2016	21.18	4.9644	5.0642	1.7325
2017	25.18	7.62	5.7057	1.967
2018	29.17	8.86	7.3216	2.2799
2019	30.64	10.9	8.5975	2.3837
2020	33.65	13.89	7.7866	2.2747

Appendix 2. Dummy Variable (SHIFT)

Observation date	Value
1978	0
1979	0
1980	0
1981	0
1982	0
1983	0
1984	0
1985	0
1986	0
1987	0
1988	0
1989	0
1990	0
1991	1
1992	0
1993	1
1994	1
1995	1
1996	1
1997	1
1998	1

Continued

	1999	1
	2000	1
	2001	1
	2002	1
	2003	1
	2004	1
	2005	1
	2006	1
	2007	1
	2008	1
	2009	1
	2010	1
	2011	1
	2012	1
	2013	1
	2014	1
	2015	1
	2016	1
	2017	1
	2018	1
	2019	1
	2020	1

Appendix 3. Descriptive Statistic

Group: UNTITLED   Workfile: GDP ::Untitled\

View | Proc | Object | Print | Name | Freeze | Sample | Sheet | Stats | Spec

	LNGDP	LNPD	LNPFI	LNEXP
Mean	1.868610	0.686243	-0.040241	-0.183552
Median	1.615420	1.008213	-0.359106	0.101473
Maximum	3.516013	2.631169	2.151471	0.868654
Minimum	0.472501	-2.184802	-1.801810	-1.603456
Std. Dev.	0.882710	1.124409	1.184045	0.784305
Skewness	0.371881	-0.882055	0.326802	-0.446022
Kurtosis	1.887304	3.237757	1.883647	1.739365
Jarque-Bera	3.209368	5.677101	2.998248	4.273022
Probability	0.200953	0.058510	0.223326	0.118066
Sum	80.35022	29.50844	-1.730350	-7.892748
Sum Sq. Dev.	32.72540	53.10044	58.88241	25.83566
Observations	43	43	43	43

Appendix 4. Ramsey's RESET Test

	GDP	PD	PFI	EXPORT
Mean	1.868610	0.686243	−0.040241	−0.183552
Median	1.615420	1.008213	−0.359106	0.101473
Maximum	3.516013	2.631169	2.151471	0.868654
Minimum	0.472501	−2.184802	−1.801810	−1.603456
Std. Dev.	0.882710	1.124409	1.184045	0.784305
Skewness	0.371881	−0.882055	0.326802	−0.446022
Kurtosis	1.887304	3.237757	1.883647	1.739365
Jarque-Bera	3.209368	5.677101	2.998248	4.273022
Probability	0.200953	0.058510	0.223326	0.118066
Sum	80.35022	29.50844	−1.730350	−7.892748
Sum Sq. Dev.	32.72540	53.10044	58.88241	25.83566
Observations	43	43	43	43

Appendix 5. Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	11.40213	NA	9.73e−06	−0.189007	0.162886	−0.066187
1	158.5104	245.1805*	6.76e−09*	−7.472801	−6.417122*	−7.104341
2	167.9753	13.67145	1.02e−08	−7.109737	−5.350272	−6.495637
3	178.3841	12.72190	1.56e−08	−6.799117	−4.335865	−5.939376
4	189.1778	10.79367	2.60e−08	−6.509876	−3.342838	−5.404495
5	214.7992	19.92780	2.27e−08	−7.044401	−3.173577	−5.693380
6	255.8383	22.79948	1.17e−08	−8.435460	−3.860850	−6.838798
7	285.4316	9.864424	2.23e−08	−9.190642*	−3.912245	−7.348340*

Appendix 6. VAR Lag Exclusion Wald Tests

Chi-squared test statistics for lag exclusion:
Numbers in [] are p-values

	GDP	PD	PFI	EXP	Joint
Lag 1	43.76407 [0.0000]	46.38364 [0.0000]	23.18964 [0.0001]	14.80346 [0.0051]	122.2539 [0.0000]
Lag 2	7.513688 [0.1111]	4.964028 [0.2910]	0.345319 [0.9867]	0.780436 [0.9411]	17.92995 [0.3280]
d.f	4	4	4	4	16

Appendix 7. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE (s)	Eigen value	Trace Statistic	0.05 Critical Value	*P*-value
None	0.431310	47.05152	47.85613	0.0594
At most 1	0.314053	23.91027	29.79707	0.2043
At most 2	0.170082	8.455121	15.49471	0.4181
At most 3	0.019599	0.811533	3.841465	0.3677

Trace test indicates no cointegration at the 0.05 level.

Unrestricted Cointegration Rank Test (Maximum Eigen value)				
Hypothesized No. of CE (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	*P*-value
None	0.431310	23.14125	27.58434	0.1675
At most 1	0.314053	15.45515	21.13162	0.2583
At most 2	0.170082	7.643588	14.26460	0.4161
At most 3	0.019599	0.811533	3.841465	0.3677

Max-Eigen value test indicates no cointegration at the 0.05 level.

Appendix 8. VAR Residuals Serial Correlation LM Test

Null hypothesis: No Serial Correlation at lag h					
Lag	LRE*stat	df	Prob.	Rao F-stat	df	Prob.
---	---	---	---	---	---	---
1	18.16938	16	0.3141	1.163029	(16, 74.0)	0.3174
2	10.39754	16	0.8451	0.633466	(16, 74.0)	0.8465
3	13.24035	16	0.6551	0.821301	(16, 74.0)	0.6578

Appendix 9. VAR Residual Heteroskedasticity Tests

Chi-sq	df	Prob.	
172.9172	170	0.4233	Joint Test

Appendix 10. Roots of Characteristic Polynomial
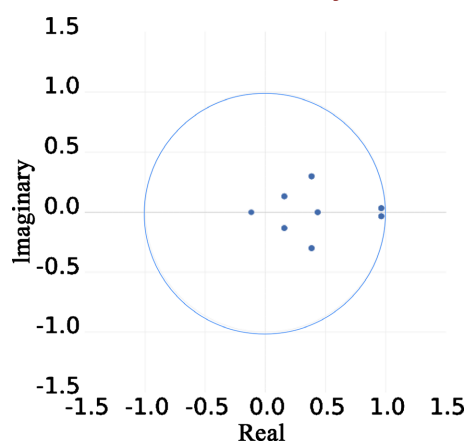
Appendix 11. VAR Residual Normality Tests

Component	Jarque-Bera	df	P-value
1	3.465656	2	0.1768
2	2.034956	2	0.3615
3	0.387924	2	0.8237
4	0.818424	2	0.6642
Joint	6.706961	8	0.5686

Appendix 12. VAR Granger Causality/Block Exogeneity Wald Tests

Dependent Variable: GDP			
Excluded	Chi-sq	df	Probability (P-Value)
PD	1.266227	2	0.5309
PFI	4.176203	2	0.1239
EXP	3.412525	2	0.1815
All/Joint	12.68213	6	0.0484

Dependent Variable: PD			
Excluded	Chi-sq	df	Probability (P-Value)
GDP	2.372665	2	0.3053
PFI	4.257066	2	0.1190
EXP	1.914779	2	0.3839
All/Joint	12.15476	6	0.0586

Dependent Variable: PFI			
Excluded	Chi-sq	df	Probability (P-Value)
GDP	5.581534	2	0.0614
PD	0.557775	2	0.7566
EXP	2.470627	2	0.2907
All/Joint	11.52163	6	0.0735

Dependent Variable: EXP			
Excluded	Chi-sq	df	Probability (P-Value)
GDP	0.801098	2	0.6700
PD	2.993223	2	0.2239
PFI	1.353769	2	0.5082
All/Joint	9.236741	6	0.1607

Appendix 13. Impulse Response Function Multiple Graph

Response to Cholesky One S.D. (d.f. adjusted) Innovations – 2 S.E.
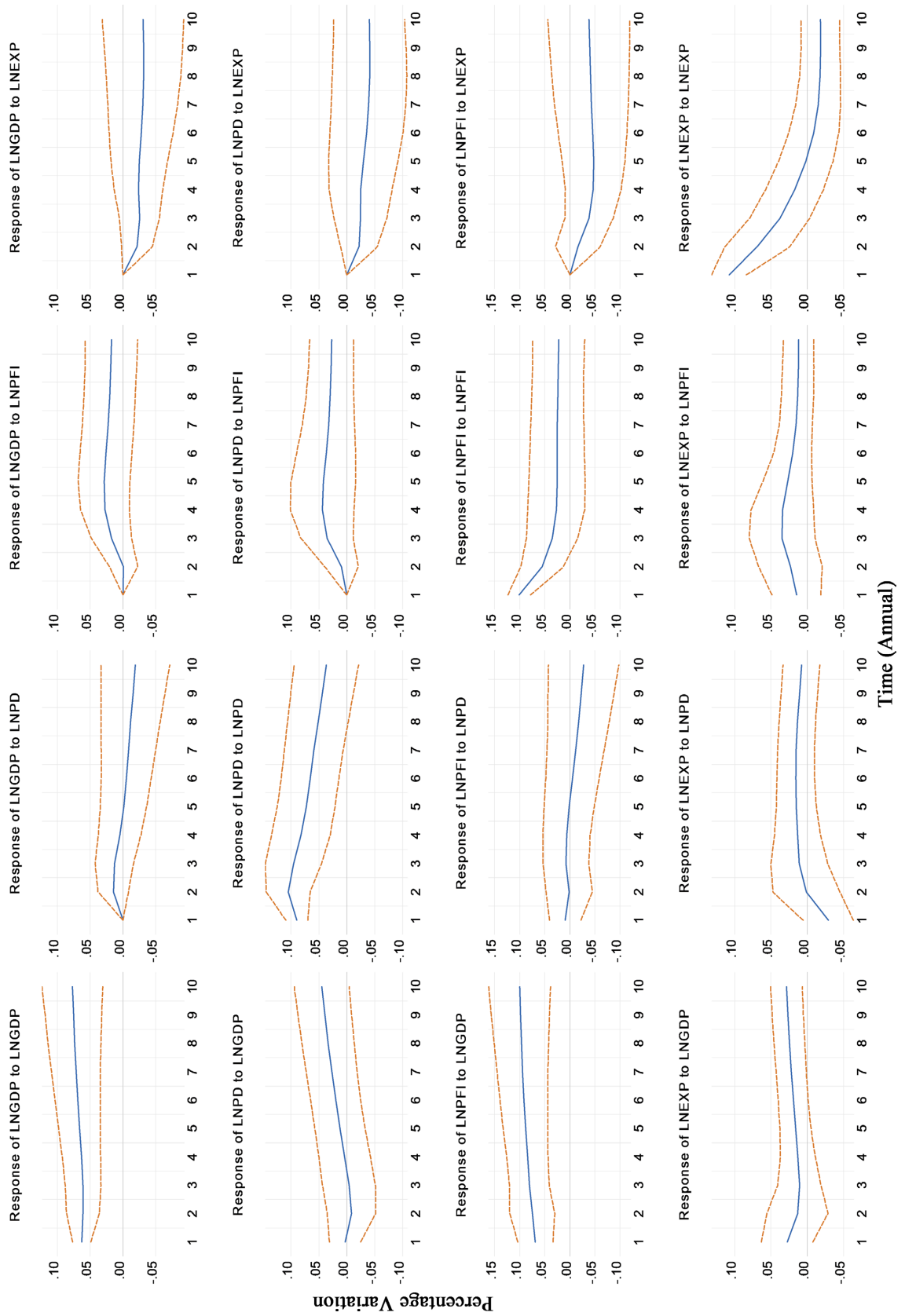
Appendix 14. Variance Decomposition Multiple Graph

Variance Decomposition using Cholesky (d.f. adjusted) Factors