Economic Growth and Public Debt

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Abstract

There is a controversy in the literature about the economic contribution of public deficit. Keynesian economists generally argue that by spending more on goods and services and infrastructure possible budget deficit is helpful to create more jobs, reduce unemployment rate and raise the rate of economic growth of an economy. Neoclassical economists are worried about the adverse consequences of public deficit on capital accumulation and economic growth rate. Under classical Ricardian equivalence proposition private savings offsets public dis-saving thus budget deficit does not matter in the long run. Development economist often warn against the adverse consequences of budget deficit on inflation, current account balances and redistribution of income. Empirical evidence is found for a positive or a negative or no effect of debt on growth. Debt promote growth if it is used for investment and harms growth if it is used for consumption. Whether debt is more for investment or consumption depends on economic and political circumstances of a country.

Key words: Growth, inflation, budget deficit
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1 Introduction

The major objectives of fiscal policy in any country include 1) macroeconomic stabilisation for higher growth rate of output, full employment, stable prices, interest and exchange rates and low inflation 2) attaining horizontal and vertical equity through taxes and transfers and achieving efficiency in resource allocation and provision of public goods; 3) maximizing positive externality by investing in public services such as health and education and minimising the negative externality through appropriate taxes and subsidies. Direct taxes on income, profit and wealth and indirect taxes including VAT, tariff, excise, business and subsidies on goods and services and for use of inputs and spending on pure public goods (defence, law-order, national parks and semi-public goods) including education, health and R&D are major instruments to achieve these objectives. When the revenue from taxes, the compulsory payments from citizens to the government, in return of public services are not enough to meet public spending government borrows from the private sector. It crowds out private investment raising interest rate, inflation as well as the current account deficit while it borrows from the central banks.

There is a controversy in the literature about the economic contribution of public deficit. Keynesian economists generally argue that by spending more on goods and services and infrastructure, budget deficit is helpful in creating more jobs, reducing the unemployment rate and raising the economic growth rate of the economy. Neoclassical economists are more concerned about the adverse consequences of public deficit on capital accumulation and economic growth. Classical economists under Ricardian equivalence proposition argue that private saving and public deficit (dis-saving) offset each other. Despite this all recognise the adverse consequences of excessive budget deficit on inflation, current account balances and redistribution of income. How much budget deficit influences real choices of people through its impact on economic growth is essentially an empirical issue. Enough debates have taken place regarding the optimal size of the government (Pigou (1947), Samuelson (1954), Buchanan (1965), Atksinson and Stern (1974), Feldstein (1974), Whalley (1975), Boadway (1979), Summer (1980), Blomquest (1985), Bovenberg (1989), Benabou (2002) and Taveres (2004)).

Whether deficit is good, bad or insignificant partly depends on which of these paradigms one tends to believe. Barro (1974, 1989) argues for the Ricardian equivalence theory - households with perfect foresight maintain balance between the present value of their income and expenditure and internalise the public deficit through intertemporal optimisation raising savings to make up for anticipated higher tax rates in the future. This result may not apply when households face lending and borrowing constraints. Aiyagari et al. (2002) use a stochastic Ramsey model to prove that intertemporal balance is essential for maximising welfare but budget need not to be balanced on a continual basis. They favour tax and expenditure smoothing policies when both of these are subject to random shocks. Burnheim (1989) denounces Ricardian view in favour of New-Keynesian

propositions. He draws parallels between these two and suggests decomposing deficit into permanent and temporary parts. In the neoclassical model where farsighted individuals plan consumption over lifetime, budget deficit raises lifetime consumption by shifting taxes to the next generation; this raises consumption and lowers savings and raises interest rate. Public sector deficit then crowds out private investment. As Diamond (1965) and Auerbach and Kotlikoff (1986) demonstrated high debt to GDP ratio depresses capital labour ratio. Ni and Wang (1995) have proven how high saving fiscal policy regime with lower public sector deficit enhances long run growth rate of the economy. In contrast Keynesian models show positive multiplier effect of budget deficit on income and consumption- which is just inverse of the marginal propensity to save. Beetsma and Giuliodori (2011) using VAR impulse response analysis have found positive impacts of government purchases among EU countries. Based on major theoretical paradigms this paper aims to provide empirical evidence to support in favour or against these theories and reexamine the claim that there is a weak link between deficit and income.

2 Theories on public debt

2.1 Ricardian Equivalence and Neoclassical Arguments on Debt

Ricardian equivalence means that individual households save more in response to a rise in the budget deficit now so that they will be able to pay higher rates of taxes when the government imposes on them when repaying those debts in the future. The household budget constraint shows how the accumulation of public debt (B_{t+1}) and private asset (A_{t+1}) in $t+1$ period relate to the current income from wages ($W_t N_t$), profits (Π_t), interest income on bonds $(1+R_t)\,B_t$ and income on assets $(1+R_{At})\,A_t$ and expenses on consumption (C_t) and taxes (T_t).

$$B_{t+1} + A_{t+1} = W_t N_t + \Pi_t - T_t - C_t + (1+R_t)\,B_t + (1+R_{At})\,A_t \tag{1}$$

Changes in government borrowing occurs due to difference in government spending and taxes and the interest rate payment on outstanding debt. Thus the government's budget constraint becomes:

$$B_{t+1} - B_t = G_t - T_t + R_t B_t \Longrightarrow (1+R_t)\,B_t = B_{t+1} - G_t + T_t \tag{2}$$

Putting government budget into the household budget constraint

$$B_{t+1} + A_{t+1} = W_t N_t + \Pi_t - T_t - C_t + B_{t+1} - G_t + T_t + (1+R_{At})\,A_t \tag{3}$$

Which yields to Ricardian Equivalence (Only G_t affects household budget not T_t):

$$A_{t+1} = W_t N_t + \Pi_t - C_t - G_t + (1 + R_{At})\, A_t \tag{4}$$

Thus in the classical spirit the larger public sector (G_t) implies smaller private sector assets (A_{t+1}). Then the dynamic equilibrium with this constraint implies market clearing in each period.

$$Y_t = W_t N_t + \Pi_t = C_t + G_t \tag{5}$$

2.2 Role of Debt in a Keynesian Model

Marginal propensity to consume with lump-sum or proportional taxes are key components in a Keynesian model of government spending.

$$Y = C + I + G \tag{6}$$

$$C = a + b(Y - T); \quad a > 0\ ,\ 0 < b < 1 \tag{7}$$

Assume that tax (T) is collected lump sum and deficit ($G - T$) is financed by borrowing (B) when tax (T) is not enough to meet expenses (G).

$$G = T + B \tag{8}$$

Rearrange for a matrix:

$$Y - C = I + T + B \tag{9}$$

$$-bY + C = a - bT \tag{10}$$

$$\begin{pmatrix} Y \\ C \end{pmatrix} = \begin{bmatrix} 1 & -1 \\ -b & 1 \end{bmatrix}^{-1} \begin{pmatrix} I + T + B \\ a - bT \end{pmatrix} \tag{11}$$

Using Cramer's rule

$$Y = \frac{(I + T + B) + (a - bT)}{1 - b} \tag{12}$$

$$C = \frac{(a - bT) + (I + T + B)}{1 - b} \tag{13}$$

$$Y = \frac{a + I + (1-b)\,T}{1-b} + \frac{B}{1-b} \tag{14}$$

Thus the budget deficit will have direct impact on output and consumption by the Keynesian multiplier, $\frac{\partial Y}{\partial B} = \frac{1}{1-b} > 0$ or $\frac{\partial C}{\partial B} = \frac{1}{1-b} > 0$. In this set up $\frac{\partial Y}{\partial T} = 1$ and $\frac{\partial C}{\partial T} = 1$ a balanced budget multiplier effect is achieved when budget is exactly balanced, $B = 0$. By log differentiation it can be shown that growth rate of GDP depends on the percentage change in the public borrowing:

$$g_{_Y} = \beta_1 + \beta_2 g_{_B} \tag{15}$$

Here β_1 can be negative or positive or zero ($\beta_1 \lesseqgtr 0$) depending how the positive effect of investment compares to the negative impact of taxes. Normally it should be $\beta_1 > 0$. The Keynesian model implies $\beta_2 > 0$.

This model can be extended to an open economy model by adding exports and imports in the aggregate demand functions. It can include inflation making the interest rate subject to the real interest rate and using the Fisher equation. With these modifications the model becomes:

$$Y = C + I\,(r) + G + X - IM \tag{16}$$

$$r = \pi - i \tag{17}$$

$$IM = mY \tag{18}$$

$$Y = C + I\,(\pi - i) + T + B + CA \tag{19}$$

$$X - IM = Y - C - I\,(r) - G = Y - C - I\,(r) - T - B \tag{20}$$

If the investment and savings in the private sector are balanced this simply becomes:

$$X - IM = -\,(T + B) \tag{21}$$

Whilst a central bank determines the nominal interest rate the inflation is determined from the money market where the demand for money required for transactions or precautionary purposes equals the supply of money, which itself is infinitely elastic given the central bank's commitment to a certain interest rate.

$$\frac{M}{P} = kL(\pi - i) + fY \tag{22}$$

Taking log differentiation of this function inflation is the difference between the growth rate of money supply and the sum of growth rate of output and liquidity as:

$$\pi = g_m - g_y - g_L \tag{23}$$

From this equation one could link inflation, current account deficit and deficit to the growth rate of the economy.

$$g_Y = \beta_1 + \beta_2 g_B + \beta_2 \pi + \beta_2 g_{CA} + e \tag{24}$$

From this equation one could argue that higher government deficit will lead to higher growth but this effect could be offset by inflation and the current account deficit. For a sustainable debt inflationtax component of bet should be $\pi = \frac{\Delta M}{PY} = \frac{G-T}{Y} + (i - \pi - g)\frac{B}{Y}$.[1]

2.3 New-Keynesian business cycle model

Neo-Keynesian business cycle model with leisure and consumption in the utility functions and a stochastic technology of production is expressed in the following form:

$$\max \quad E\left[\sum_{t=0}^{\infty} \beta^t U\left(C_{t+i}, L_{t+i}\right) | \Omega_t\right] \tag{28}$$

subject to:

$$N_{t+i} + L_{t+i} = 1 \tag{29}$$

$$C_{t+i} + S_{t+i} = Z_{t+i} F\left(K_{t+i}, N_{t+i}\right) - G_{t+i} \tag{30}$$

$$K_{t+i-1} = (1 - \delta) K_{t+i} + S_{t+i} \tag{31}$$

First order conditions imply that the disutility from labour should equal the marginal utility

[1]

$$\frac{\Delta(PB)}{PY} + \frac{\Delta M}{PY} = \frac{PG - PT}{PY} + i\frac{PB}{PY} \tag{25}$$

$$\frac{\Delta PB}{PY} + \frac{\Delta B}{Y} = \frac{G - T}{Y} + i\frac{B}{Y} - \frac{\Delta M}{PY} \tag{26}$$

$$\Delta\left(\frac{B}{Y}\right) = \frac{G - T}{Y} + (i - \pi - g)\frac{B}{Y} - \frac{\Delta M}{PY} \tag{27}$$

from work as:

$$V'(L_{t+i}) = \frac{W_t}{C_t} \tag{32}$$

The first order condition for optimisation:

$$E\left[\left\{\beta\left(1+r_{t+1}\right)\frac{C_{it}}{C_{it+1}}\right\}|\Omega_t\right] = 1 = E\left[\left\{\beta R_{t+1}\frac{C_t}{C_{t+1}}\right\}|\Omega_t\right] \tag{33}$$

The New Keynesian model thus suggests that the higher government spending leads to lower private consumption but the decrease is less than one to one. It raises output and employment. Taxes go up if increase in G_t is permanent and investment is lower. Higher the transitory component of G_t lower will be its influence in output. Substitution and income effects work; taxes are highly discretionary and distortionary. Optimal size of public sector, thus, is a political issue. Higher the transitory component of output, smaller the decrease in consumption and greater the impact on output. Ricardian equivalence fails.

2.4 Impacts of public deficit in the Neoclassical growth model

Impacts of public deficit in a neoclassical growth model could be based on studies of Feldstein (1974), Whalley (1975), Boadway (1979), Summer (1980), Blomquest (1985), Bovenberg (1989), Rankin (1992), Ni and Wang (1995), Benabou (2002). Larger public sector deficit is found to be harmful for long term growth in neoclassical growth models where households choose the optimal path of consumption and accumulation of capital $\{c_t, k_t\}_{t=1}^{\infty}$ in response to public policy that includes plan of taxes and public expenditure $\{\tau, g\}_{t=1}^{\infty}$. Particularly the household's optimisation problem is:

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{34}$$

subject to

$$c_t + k_{t+1} = (1-\tau_t) f(k_t) \qquad \tau_t \geq 0 \tag{35}$$

Euler equation implied by this equals:

$$U_c\left((1-\tau_t) f(k_t) - k_{t+1}\right) = \beta E_t (1-\tau_{t+1}) U_c\left((1-\tau_{t+1}) f(k_{t+1}) - k_{t+2}\right) f'(k_{t+1}) \tag{36}$$

When government is forced to operate a balanced budget every period the link between tax revenue and public spending is given by:

$$\tau_t f(k_t) = G \tag{37}$$

When government is allowed to operate a structural balance it is permitted to intertemporally balance the budget

$$\tau f(k_t) + \frac{b_{t+1}}{1+r_t} = b + G \tag{38}$$

Balancing the budget in the entire model horizon would imply

$$\tau f(k_0) - G + \sum_{t=1}^{\infty} \left\{ \frac{\tau_t f(k_t) - G}{\prod_{t=0}^{t-1}(1+r_t)} \right\} = 0 \tag{39}$$

$$U_c\left((1-\tau_t) f(k_t) - k_{t+1} - G\right) = \beta E_t (1-\tau_{t+1}) U_c\left((1-\tau_{t+1}) f(k_{t+1}) \ - k_{t+2} \ - G\right) f'(k_{t+1}) \tag{40}$$

In steady sate

$$\beta(1-\tau) f'(k) = 1 \tag{41}$$

$$\beta\left(1 - \frac{G}{f'(k)}\right) f'(k) = 1 \tag{42}$$

$$G(k) = \left(1 - \frac{G}{f'(k)}\right) f'(k) = \frac{1}{\beta} \tag{43}$$

Positive effect of public sector finances is possible only when ratio of public spending to the marginal productivity of capital (tax rate) is less than one, $\left(1 - \frac{G}{f'(k)}\right) > 0$.

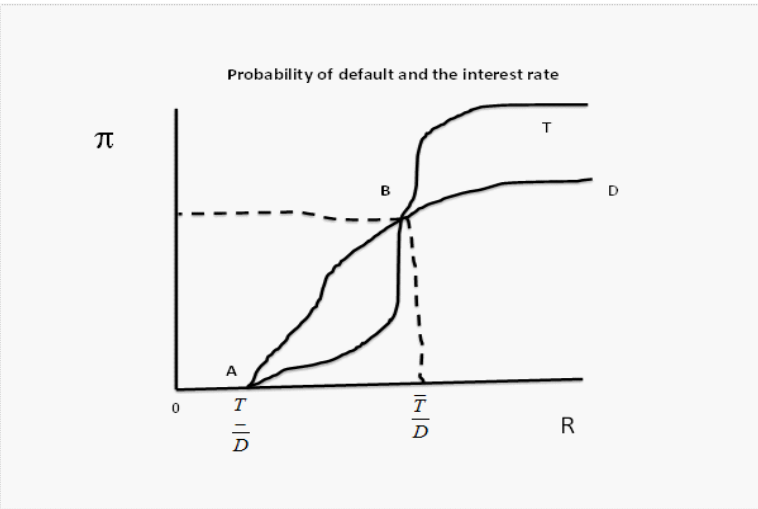
2.5 Cause of a debt crisis

Let $\overline{R}$ be the risk free payoff for investors and R be the return on government bonds. Let π be the probability of default. Then an arbitrage condition implies

$$(1-\pi) R = \overline{R} \tag{44}$$

Some arrangement yields:

$$\pi = \frac{R - \overline{R}}{R} \tag{45}$$



As the probability of default rises the government need to pay higher interest rate, as shown by line D in the graph.

Then the government retire debt if $T \geqq RD$. This implies $\frac{T}{D} = R$. When the interest rate is low, as at point A, the collected tax revenue is likely to be enough to serve the debt and therefore probability of default (π) on public debt is zero. Then $0 < \pi < 1$ between A and B points and probability of default line is shown by line T. After point T the probability of default is 1 therefore the government cannot borrow even paying very high interest rate and $R \Longrightarrow \infty$.

When more than one period is involved, then beliefs of other people about the possibility of default in the next period affects the decision whether to purchase a bond at the current period. Beliefs about beliefs about beliefs and thus leads to a self fulfilling crisis.

One could apply above model in the context of current debt crises faced by Greece, Spain or Portugal in recent years. This is one of the reason why the UK government would like to limit debt GDP ratio at the reasonable rate of around 76 percent (See Romer (2006), Calvo (1988), Cole and Keheo (2000)).

3 Credibility:Dynamic Programming Squared (DPS)

Ljungqvist and Sargent (2012) characterise the values of a government that are consistent to sustainable reputation using dynamic programming squared (dps) concept following Abreu Pease and Stachetti (1986, 1990) to deal with a set of value functions associated to the history of a set of strategy profiles of households and governments. On one side they show equivalence of the debt profiles in the rational expectation to that in the competitive equilibrium and they compare these to the debt profiles in the Nash equilibrium. Reputation is subject to ability to commit. This

requires forming a strategy space that is history dependent. Reputation could be based on the rational expectation. Credibility is based on beliefs and it leads to the theory of government. They will do as this is in their interest and feasible. Motives of the government is included along with that of the households in a dps model.

Household h chooses consumption $\xi \in X$ and the private sector average $x \in X$. The public sector chooses y, e.g. inflation. Utility is $u(\xi, x, y)$; when $x = Q \quad y = \tau_{t+j}$. This generates choice problem:

$$\max_{\xi \in X} \; u(\xi, x, y)$$

where choice of household depends on average choice (x) and public policy $(y) : \xi = f(x, y)$. The rational expectation equilibrium is equivalent to competitive equilibrium: $REE \sim CE; \;\; x = f(x, y)$

Set of competitive equilibrium

$$C \Longrightarrow \{(x, y) ; \; X = h(g)\}$$

For instance in a Ramsey problem, the government chooses y knowing $x = \ln(y)$

$$\max_{y \in Y} \; u(h(y), h(y), y) = \max_{(x,y) \in C} \; u(x, x, y) \Longrightarrow V^R, y^R$$

While the solutions of the Nash equilibrium $\left(X^N, y^N\right)$ satisfies the competitive equilibrium $\left(X^N, y^N\right) \in C$, but the Nash solutions are inferior to the rational expectation solutions, G, X^N, $u\left(X^N, X^v, y^G\right) = \max_{\eta \in Y} \; u(x', x', \eta) \Longrightarrow V^N, y^N$ and $V^N < V^R$.

Reputational choice is history dependent. An example of Ljungqvist and Sargent (2012) chapter 22:

$$u(l, c, g) = l + \lg(\alpha + c) + \lg(\alpha + g) ; \quad \alpha \in \left(0, \frac{1}{2}\right)$$

$$\bar{l} + \bar{g} = \left(1 + \bar{l}\right) ; \quad (\tau, g) \sim y$$

$$l(\tau) = \begin{cases} \frac{\alpha}{1-\alpha} & \text{if } \tau \in (0, 1-\alpha) \\ 1 & \text{if } \tau > 1-\alpha \end{cases}$$

History $\xi_t \in X \;\; \forall_t$; $x_t \in X \;\; \forall_t$; $y_t \in X \;\; \forall_t$ for $t \geqslant 1$

$$V_g\left(\vec{x}, \vec{y}\right) = \frac{1-\delta}{\delta} \sum_{t=0}^{\infty} \delta^t r(x_t, y_t) ; \quad \delta \in (0, 1)$$

$\left(\vec{x}, \vec{y}\right) = \{(x_t, y_t)\}_{t=0}^{\infty}$

Reputation means choice at t is a function of $t-1$

$$y_t = \left(X^{t-1}, Y^{t-1}\right)$$

3.1 Dynamic programming square

Let V be the value to government in the first period of following the policy that the private sector had expected.

Let V_1 be the continuation value of known policy.

Let V_2 be the continuation value if the private sector believes that the government choice is not what they expect.

$$V = (1-\delta)\, u\,(x,x,y) + \delta V_1 \underset{(x,y)\in C}{\geqslant} (1-\delta)\, u\,(x,x,\eta) + \delta V_2 \;\; ; \;\; \forall\, \eta \in Y$$

A strategy profile implies a trajectory of outcome $(\overline{x}, \overline{y})$ and a value function

$$V_g\,(\sigma) = V_g\left[\overline{x}\,(\sigma)\,, \overline{y}\,(\sigma)\right]$$

and continuation profile $\sigma|_{(x,y)}$, $\sigma|_{(x^*,y^*)}$.

A strategy profile is a sub-game perfect equilibrium (SPE) of infinitely repeated economy if $\forall$ $t \geqslant 1$ and $\forall\ (x_t, y_t) \in \left(X^{t-1}, Y^{t-1}\right)$

a) $x_t = \sigma_t^h\left(X^{t-1}, Y^{t-1}\right)$ is consistent with the competitive equilibrium where $\sigma_t^g\left(X^{t-1}, Y^{t-1}\right)$

b) $\forall\ \eta \in Y$

$$(1-\delta)\,\sigma\,(x_t, y_t) + \delta V_g\left(\sigma|_{(x,y)}\right) \underset{(x,y)\in C}{\geqslant} (1-\delta)\,(x_t, \eta) + \delta V_g\left(\sigma|_{(x,\eta)}\right)$$

According to Sargent "there should be people in the model to be realistic" and "finding the state is an art" Similarly for Lucas "complete markets are all alike but each incomplete markets are incomplete in their own way". The 0dynamic problems of debt due to incomplete markets strategic interactions among households and forms requires evaluating multiple states of budgets, information reputation and commitment. For instance consider a simple economy with villagers and a money lender. Villager's objective is to maximise the expected utility $E\sum_{t=0}^{\infty}\beta^t U\,(C_t)$; $\beta\ \epsilon$ (0,1); $U'\,(.) > 0$ and $U''\,(.) < 0$ C_t^i i =1...N. y_t^i should be a random process given by the joint density. This endowment economy y_t^i iid $prob\left\{y_t^i = \overline{y} = y_s\right\}$. Complete market case is the AD style contingent commodity market and leads to complete consumption smoothing. $c_t^i = \overline{c} = \sum_{t=0}^{\infty}\overline{y}_s\pi_s$. across all individual and states. Good is not storable; three possible cases arise a) villager cannot commit but y_t^i observed, self enforcement, lack of contract b) villager can commit but y_t^i not observed. only the

money lender can borrow and c) villager can commit and save and borrow y_t^i not observed. This brings to the theory of distribution among the villages and money lenders and strategies for the government either a) chooses sequence of τ_{t+j} once and walks away and b) choosing sequence of τ_{t+j} in each period. This requires ideas of game in the modelling as above.

4 Empirical Analysis

Economic and political beliefs and circumstances keep changing in response to new opportunities and difficulties which augment theoretical controversy regarding the relationship between growth and public debt. As the public decisions affect millions of households and firms and their reactions to announced or anticipated policies vary the empirical analysis of the link becomes of great public interest. Here data on growth, deficit, current account and several macroeconomic variables are obtained for advanced countries from the World Economic Outlook database of the IMF from 2000 to 2010 including the IMF forecasts for up to 2015.[2] This data set is used here to examine whether the public deficit helpful or harmful for economic growth and whether deficit stabilises or destabilises an economy in terms of its impact on inflation and current account deficit. Regression coefficients of deficit or a set of variables including deficit multiple explanatory variables are estimated using the OLS or GLS models and examining their validity on the basis of t, F, χ^2 and R^2 tests. These empirical findings imply that:

1. Public borrowing enhances economics growth; borrowing must finance projects with positive externalities for this.

2. The relationship between the general level of prices and net public borrowing is negative when net borrowing enhances growth and positive when such borrowing funds public consumption.

3. More net borrowing deteriorates the current account balance. As economy grows imports may increase faster than exports.

Net borrowing affects growth rates and prices differently in different countries. Time series data from the World Economic Outlook of the IMF is used here to study relationships between growth rates of output and debt ratios among various groups of countries in the world.

4.1 Summary Growth Debt Ratio Regressions

The average growth rates vary significantly across groups of countries; emerging Asia grew on average by 5.1 percent but advanced economies grew by 2.6 on average. The average debt GDP ratio was lowest at 44.5 in Asia and very high at 65.5 in Africa. Maximum debt GDP ratio was

[2] http://www.imf.org/external/pubs/ft/weo/2010/01/weodata/index.aspx

recorded for Africa. Correlations between growth and debt by groups of countries are shown in the last two column. Positive correlations were more frequent than the negative correlations. Causality of debt ratio growth rate are then tested in a set of regressions for each of these countries as shown in Tables 8 to 13.

Table 1: Avege growth rate and debt ratio and the nature of growth deb ratio correltions (1991-2020)

	growth and deb ratio			Correlations		
Country Groups	g	d/y	max (d/y)	N	$\rho+$	$\rho-$
Advanced Countries	2.6	58.2	251	37	1461	1314
Emerging Asia	5.1	44.5	122	21	482	421
Eastern Europe	3.1	49.0	106	9	95	76
Middle East	4.8	63.5	454	19	434	307
Sub-Saharan Africa	4.4	65.5	786	45	2263	1832
Latin America	3.2	54.5	154	32	1133	947
Data source: Word Economic Outlook, 2015, April, IMF 1991-2020.						

Among advanced countries Hong Kong had the lowest debt ratio at most of 7 percent. Japan had it around 251 percents. Singapore, Korea, Latvia, Lithuania and Estonia grew impressively during this period while the UK and the USA grew by 4 and 4.7 percents respectively. Regression by countries provides evidence for both positive and negative coefficients. Sixteen of these advanced countries had negative and significant impact of deb ratio on growth rates. This relation was insignificant in other countries. Thus for advanced countries debt is affecting growth negatively.

Emerging Asian includes large countries such as China, India and Indonesia but also tiny small countries including Bhutan, Maldives Papua New Guinea. While the average debt ratio in Bhutan was up to 122 percent of GDP it was only 3 percent in Borneo. In contrast to regions average rate of 5.1, China was growing at 9.4 and India at 6.7 percent during the study period. Debt ratio had significant and negative impact on economic growth in ten out of twenty one countries of this region. Only Bhutan had positive and significant effect of debt ratio on growth. for others coefficient were insignificant.

Debt ratio significantly lowered growth rates in 26 out of 45 countries in Sub Sahran Africa. It had positive impact in three countries such as Benin, Cameroon and Namibia. Coefficients were not significant for other countries. There was wide volatility in growth and debt ratios over time among countries in this region. Debt ratio was more volatile than economic growth rate.

Debt ratio had negative impact on growth rates only in five out of nineteen countries in the Middle East, these countries were Algeria, Bahrain, Egypt, Pakistan and the UAE. Debt had harmful effect on growth rate in six out of nine countries in the Eastern Europe. Coefficient of debt ratio on growth regression was significant only six out of 32 Latin America and Caribbean Countries.

From these empirical analysis on grow debt ratio regression it is not possible to state definitely that higher debt ratio causes lower growth rate. Whilst the negative impact was observed in many more countries than the positive impacts, number of countries with insignificant coefficients is quite high. Is debt used for investment or consumption purposes? If it is for investment purpose higher debt does not lower the GDP growth rate though there are chances that it will raise it. If the debt is used for consumption this will have negative impacts on economic growth. Thus the analysis of debt growth relation would not be complete until the investment or consumption uses of debts are analysed explicitly. Such decomposition is beyond the scope of current analysis as getting such information for all countries included in this empirical analysis is very difficult.

4.2 Analysis of the UK economy

These estimates are tested for heteroskedasticity, autocorrelations and any restrictions as appropriate.

Regresses growth rate of output (Y_i) on net borrowing (X_i) as:

$$Y_i = \beta_1 + \beta_2 X_i + e_i \quad i = 1 \ldots T$$

Following the OLS technique to find estimators of $\widehat{\beta}_1$ and $\widehat{\beta}_2$.

$$\widehat{\beta} = (X'X)^{-1} X'Y \tag{46}$$

These estimates are subject to standard OLS assumptions on error terms normality $e_i \sim N\left(0, \sigma^2\right)$, homoskedaticity, non- autororrelation ($E(\varepsilon_i \varepsilon_j) = 0$) and independence of errors from the dependent variables, ($E(\varepsilon_i X_i) = 0$).

$$\begin{bmatrix} \widehat{\beta}_1 \\ \widehat{\beta}_2 \end{bmatrix} == \begin{bmatrix} N & \sum X_i \\ \sum X_i & \sum X_i^2 \end{bmatrix}^{-1} \begin{bmatrix} \widehat{\beta}_1 \\ \widehat{\beta}_2 \end{bmatrix} = \begin{bmatrix} 12 & -51.92 \\ -51.92 & 413.52 \end{bmatrix}^{-1} \begin{bmatrix} 21.3 \\ -26.23 \end{bmatrix} = \begin{bmatrix} 3.283 \\ 0.349 \end{bmatrix} \tag{47}$$

Where k = number of parameters in the regression; N = number of observations

Table 2: Testing overall significance by F-test

Source of Variance	Sum	Degrees of freedom	Mean	F-value
Total sum square (TSS)	56.597	12	5.145	
Regression Sum Square (RSS)	22.967	1	22.967	6.147
Sum of square error	33.629	10	3.737	

Table of results summarising all above calculations are presented as:

Table 3: Growth on net borrowing

	Coefficient	Standard Error	t-value
Intercept	3.283	0.783	4.191
Net borrowing	0.349	0.133	2.613
$R^2 = 0.406$, $F = 6.147$, $N = 12$.			

Coefficients as well as t-statistics are significant. Autocorrelation is positive because $d = 1.74 < 2$ but that is not statistically significant. The calculated DW value, $d = 1.74$ is clearly out of the inconclusive region as it does not fall in the range of $[0.971, 1.331]$ of the Durbin-Watson table. White test or ARCH and AR test suggest there is slight problem of heteroskedasticity in the errors in this model. However, heteroskedasticity is more serious for cross section than for time series. Therefore conclusion of above model are still valid. One way is to regress predicted square errors $\widehat{e}_i^2$ in predicated square of y, $\widehat{Y}_i^2$. The test statistics for normality of errors is $nR^2 \sim \chi^2_{df}$ with df =1.

$$\widehat{e}_i^2 = \alpha_0 + \alpha_1 \widehat{Y}_i^2 + v_i \ ; n.R^2 = 6.089 \tag{48}$$

$$\widehat{e}_i^2 = \alpha_0 + \alpha_1 X_{1,i} + \alpha_2 X_{2,i} + \alpha_3 X_{1,i}^2 + \alpha_4 X_{2,i}^2 + \alpha_5 X_{1,i} X_{2,i} + v_i \tag{49}$$

Null hypothesis of homoskedasticity is rejected as $nR^2 = 6.089 > \chi^2_{df} = 2.7055$.

Table 4: Price index on net borrowing

	Coefficient	Standard Error	t-value
Intercept	102.5	1.603	63.9
Net borrowing	-1.85	0.273	-6.76
$R^2 = 0.82$, $F = 45.7$ [0.00] , $N = 12$, $DW = 1.09$			

Table 5: Current account balance on net borrowing

	Coefficient	Standard Error	t-value
Intercept	-2.44	0.225	-10.8
Net borrowing	-0.008	0.038	-2.20
$R^2 = 0.33$, $F = 4.9$ [0.05] , $N = 12$, $DW = 1.03$			

Prices were relatively stable despite fiscal expansion during the study period as the monetary policy mainly concerned in achieving the target inflation, had been complementary to the fiscal policy in UK in the period of study Table 4. However higher borrowing had caused slight deterioration in the current account, as both consumers and producers tend to import more in response to higher income they received from fiscal expansion. There is weak evidence on simultaneity between growth

and deficit in UK in last ten years. Past records like this may or may not apply for projecting the impacts of current debt reduction plans in the future years; these require analysis of the impacts of such deficit in the path of economy under dynamic general equilibrium system or under the DSGE or VAR frameworks. One important concept in the literature that handles this issue is the dynamic programming squared presented briefly in the next section.

4.3 Conclusion

There is a controversy in the literature about the economic contribution of public deficit. Keynesian economists generally argue that by spending more on goods and services and infrastructure possible, the public deficit is helpful to create more jobs, reduce unemployment rate and raise the economic growth rate of the economy. Neoclassical economists are worried about the adverse consequences of public deficit on capital accumulation and the long run growth rate. Classical Ricardian equivalence proposition does not match well with the empirical evidences on adverse consequences of budget deficit on inflation, current account balances and redistribution of income.

Empirical evidence is found for a positive or a negative or no effect of debt on growth. Debt promote growth if it is used for investment and harms growth if it is used for consumption. Whether debt is more for investment or consumption depends on economic and political circumstances of a country.

In practice this is essentially an empirical issue, evidence suggests that the role of deficit largely depends on economic circumstances. Empirical estimates in this paper show that deficit has contributed for growth in UK; 1 percent increase in net borrowing would raise growth rate by 0.34 percent between 2000 and 2010. In other words statistical and econometric evidence clearly suggests that reducing deficit will lower the growth rate; proposed deficit reduction plan will clearly slow down the growth rates.

References

[1] Aiyagari S. Rao, Albert Marcet, Thomas J. Sargent, Juha Seppälä (2002) Optimal Taxation without State-Contingent Debt, *Journal of Political Economy*, ' 110, 6 Dec., 1220-1254

[2] Alesina, Alberto, and Dani Rodrik, Distributive Politics and Economic Growth, *Quarterly Journal of Economics*, May 1994 465-489.

[3] Atkinson A. B.and N. H. Stern (1974) Pigou, Taxation and Public Goods, *Review of Economic Studies*, 41:1:119-128.

[4] Auerbach A.J.and L. Kotlikoff (1987) *Dynamic Fiscal Policy*, Cambridge University Press.

[5] Bank of England (2015) *Inflation Report*, May, 2015.

[6] Barro, R. J. (1974), Are Government Bonds Net Wealth?, *Journal of Political Economy, 82: Nov.,* 1095-1117.

[7] Barro Robert J. (1989) The Ricardian Approach to Budget Deficits, *Journal of Economic Perspectives*, 3: 2: Spring, 37-54

[8] Bean Charles (2009) the meaning of internal balance' Thirty years on, *Economic Journal*, 119 (November), F442–F460.

[9] Bean Charles (1998) The New UK Monetary Arrangements: A View from the Literature, *Economic Journal,* 108:451: Nov. 1795-1809

[10] Beetsma R and M. Giuliodori (2011) The effects of government purchanges shocks: review and estimates for the EU, *Economic Journal*, 121-550: F4-F32.

[11] Bernheim B. Douglas (1989) A Neoclassical Perspective on Budget Deficits, *Journal of Economic Perspectives*, 3:2:Spring:55-72

[12] Besley Tim (2001) From micro to macro: public policies and aggregate economic performance, *Fiscal Studies*, 22: 3: September.

[13] Bhattarai K. (2015) Advanced Macroeconomics, University of Hull, Business School.

[14] Bhattarai K (2010) Taxes, public spending and growth in OECD countries, *Problems and Perspective in Management*, 8:1: 14-30.

[15] Blake A. P. and M. Weale (1998) Costs of Separating Budgetary Policy from Control of Inflation: A Neglected Aspect of Central Bank Independence, *Oxford Economic Papers*, 50, 3, 449-467.

[16] Blanchard, O. and Perotti, R. (2002). _An empirical characterization of the dynamic effects of changes in government spending and taxes on output_, *Quarterly Journal of Economics*, 117(4) : Nov.:1329–68.

[17] Buchanan, J., 1958, *Public principles of public debt* (Irwin: Homewood, Illinois).

[18] Burnside, C., Eichenbaum, M. and Fisher, J. D. (2004). Fiscal shocks and their consequences, *Journal of Economic Theory,*115: 89–117.

[19] Brauninger Michael (2005) The budget deficit, public debt, and endogenous growth ,*Journal of Public Economic Theory*, 7 (5): 827–840.

[20] Calvo G. A. (1988) Servicing the Public Debt: The Role of Expectations, *American Economic Review*, 78, 4, 647-661

[21] Cole H. L. , T. J. Kehoe (2000) Self-Fulfilling Debt Crises, *Review of Economic Studies*, 67, 1, 91-116.

[22] Diamond, P.A., 1965, National debt in a neoclassical growth model, *American Economic Review* 55, 112551150.

[23] Diamond P, Douglas W. and Dybvig, Philip H. (1983) Bank Runs, Deposit Insurance,and Liquidity, *Journal of Political Economy*, 401-419.

[24] Fisher Jonas D.M. and Ryan Peters (2010) Using Stock Returns to Identify Government Spending Shocks, *Economic Journal,* 120: :544: May,

[25] Feldstein M (1985) Debt and taxes in the theory of public finance, *Journal of Public Economics*, 28:233-46

[26] Feldstein M (1982) Government deficits and aggregate demand, *Journal of Monetary Economics* 9 (1982) 1-20

[27] HM Treasury (2010) Pre-Budget Report, October 2010.

[28] Jordi Galí, J. David López-Salido and Javier Vallés (2007) Understanding the effects of government spending on consumption, *Journal of European Economic Association*, 5:1:277-270.

[29] Kirsanova Tatiana, Campbell Leith and Simon Wren-Lewis (2009) Monetary and fiscal policy interaction: The current consensus assignment in the light Of recent developments, *Economic Journal*,119:Nov,F482–F496.

[30] Kydland F.E and E.C. Prescott (1977) Rules rather than discretions: the Inconsistency of Optimal Plans, *Journal of Political Economy*, 85:3: 473-491.

[31] Meade, J.E. (1958), Is the national debt a burden? *Oxford Economic Papers* IO, 1633183.

[32] Modigliani, F., 1961, Long run implications of alternative fiscal policies and the burden of the national debt, *Economic Journal* 71, 728755.

[33] Monacelli T and R. Perotti (2010) Fiscal Policy, the Real Exchange Rate and Traded Goods, *Economic Journal*, 120(May), 437-461.

[34] Ni Shawn and X Wang (1995) Balanced government budgets versus deficit finance in a growth economy, *Canadian Journal of economics*, XXVIII: 4b:1120-1134.

[35] Obstfeld, Maurice, Jay C. Shambaugh and Alan M. Taylor. (2010) Financial Stability, the Trilemma, and International Reserves, *American Economic Journal: Macroeconomics*: 2:2, April ,

[36] Rankin Neil (1992) Imperfect competition, expectations and the multiple effects of monetary growth, *Economic Journal* 102: 743-753.

[37] Rankin N. (1986) Debt policy under fixed and flexible prices, *Oxford Economic Papers* 38 (3): 481-500

[38] Samuelson P. A. (1954) Pure Theory of Public Expenditure, *Review of Economic Statistics*, 36:387-9/

[39] Sefton J, van de Ven J, M. Weale (2008) Means Testing Retirement Benefits: Fostering Equity or Discouraging Savings?, *Economic Journal*, 118, 528, 556-590

[40] Tekin-koru Ayc a and Erdal O¨zmen (2003) Budget deficits, money growth and inflation: the Turkish evidence, *Applied Economics*, 35, 591–596

[41] Turnovsky S. J. and M. H. Miller (1984) The Effects of Government Expenditure on the Term Structure of Interest, *Journal of Money, Credit and Banking*, 161, 16-33

A Appendix

A.1 A: Blake-Weale (1994) model of debt

Fiscal policy makers choose the tax rate that is consistent to the target level of debt and take the actions of central bank as given; the monetary policy makers choose the interest rate in order to stabilise the price level taking the choice of the fiscal authority as given. This is a simple but very powerful model to explain the time path of debt (D_t) in the economy.

$$D_t = R_t D_{t-1} + E_t - T_t \tag{1}$$

Expenditure (E_t) is proportional to income

$$E_t = \Gamma Y_t \tag{2}$$

Expenditure (E_t) is proportional to income

$$T_t = S_t Y_t \tag{3}$$

Output:

$$Y_t = \overline{Y}_t \left(R_t - \overline{R}_t\right)^{-\alpha} \left(S_t - \overline{S}_t\right)^{-\beta} \tag{4}$$

Phillip's curve

$$\pi_t = \pi_t^e + \theta \frac{Y_t}{\overline{Y}_t} \tag{5}$$

Inflation expectation

$$\pi_t = \pi_{t-1} \tag{6}$$

Steady state output

$$\overline{Y}_t = \overline{Y}_0 e^{gt} \tag{7}$$

By substitutions

$$\pi_t = \pi_{t-1} - \delta s_t - \mu r_t \tag{8}$$

log of expenditure, tax revenue and output functions:

$$e_t = \gamma + y_t \tag{9}$$

$$t_t = s_t + y_t \tag{10}$$

$$\Delta y_t = g - \alpha \Delta r_t - \beta \Delta s_t \tag{11}$$

By defining ratios of debt and tax revenue $B = \frac{D}{E}; K = \frac{T}{E}$ and log of debt as:

$$d_t = \eta + \frac{1+\overline{r}}{1+g} d_{t-1} + \frac{1}{B}\left(e_t - K t_t\right) + \frac{1}{1+g} r_t \tag{12}$$

where

$$\eta = \frac{gB + (1-K)(b-g) + kK}{B} - \frac{\overline{r}}{1+g} \tag{13}$$

Proof for this statement:

$$D_t = R_t D_{t-1} + E_t - T_t = (1+r_t) D_{t-1} + E_t - T_t \tag{14}$$

$$\frac{D_t}{D_{t-1}} - (1+r_t) = \frac{\Delta E_t + E_{t-1}}{E_{t-1}} \frac{E_{t-1}}{D_{t-1}} \left(1 - \frac{T_t}{E_t}\right) \tag{15}$$

$$\frac{D_t}{D_{t-1}} - (1+r_t) = \frac{\Delta E_t + E_{t-1}}{E_{t-1}} \frac{E_{t-1}}{D_{t-1}} \left(1 - \frac{T_t}{E_t}\right) \tag{16}$$

$$(1+g) - (1+\overline{r}) = (1+g)\frac{1}{B}(1-K) \tag{17}$$

$$\frac{\overline{r} - g}{(1-K)} = \frac{(1+g)}{B} \tag{18}$$

Dynamic efficiency requires that $\overline{r} > g$.
Taylor approximation:

$$g - b + \frac{1+g}{g-\overline{r}}(\Delta d_t - g) + \frac{1}{g-\overline{r}}(r_t - \overline{r}) + \frac{K}{1-K}(t_t - e_t - k) \simeq e_t - d_{t-1} \tag{19}$$

$$d_t = \eta + \frac{1+\overline{r}}{1+g} d_{t-1} + \frac{1}{B}\left(e_t - K t_t\right) + \frac{1}{1+g} r_t \tag{20}$$

Stochastic optimal control method and learning

A.2 B: Cole-Kehoe (2000) model of self fulfilling debt crisis

Cole and Kehoe (2000) use a dynamic stochastic general equilibrium model in which self-fulfilling crisis may arise. They say that "Because of the government's need to roll over its debt, a liquidity crunch induced by the inability to sell new debt can lead to a self-fulfilling default" and "if fundamentals like the level of the government's debt, its maturity structure, and the private capital stock, lie within a particular range (the crisis zone), then the probability of default is determined by the beliefs of market participants."

It is "also related to the literature on how the government's inability to commit to future policy choices can generate multiple equilibria."

Household:

$$E\sum_{t=0}^{\infty}\beta^t\left(C_t + V(g_t)\right)) \tag{1}$$

$$c_t + k_{t+1} < (1-\theta)a_t f(k_t) \tag{2}$$

Banker:

$$E\sum_{t=0}^{\infty}\beta^t x_t \tag{3}$$

$$x_t \leqq \overline{x} + z_t b_t - q_t b_{t+1} \tag{4}$$

Government budget constraint:

$$g_t + z_t B_t \leqq a_t \theta_t f(k_t) + q_t B_{t+1} \tag{5}$$

Timing. The timing of actions within each period is the following.

1. The sunspot variable ξ_t is realized, and the aggregate state is $s_t = (B_t, K_t, a_{t-1}, \xi_t)$
2. The government, taking the price schedule $q_t = q(s_t, B_{t+1})$ as given, chooses B_{t+1}.
3. The international bankers, taking q_t as given, choose b_t.
4. The government chooses whether or not to default, z_t, and how much to consume, g_t
5. The consumers, taking at as given, choose c_t and k_{t+1}.

Consumer's dynamic problem:

$$V_c(k, s, B', g, z) = \underset{c,k\prime}{max}\ c + v(g) + \beta E V_c(k', s', B'(s'), g', z') \tag{6}$$

subject to

$$c + k' \leqq (1-\theta)a(s,z)f(k) \tag{7}$$

$$c, k' \geqslant 0 \tag{8}$$

$$s = (B', K'(s, B', g, z), a(s, z), c'), \tag{9}$$

$$g' = g(s', B'(s'), q(s', B'(s'))), \tag{10}$$

$$z = z(s', B'(s'), q(s', B'(s'))) \tag{11}$$

The representative banker's value function is defined by the functional equation

$$V_b(b, s, B') = \max_{b\prime} \ \overline{x} + z(s, B', q(s, B'))b - q(s, B')b' + \beta E V_b(b', s', B'(s')), \tag{12}$$

subject to

$$q(s, B')b' \leqq \overline{x} \tag{13}$$

$$b' > -A, \tag{14}$$

$$s = (B', K'(s, B', g, z), a(s, z), c') \tag{15}$$

The government's value function is defined by the functional equation

$$V_g(s) = \max_{B\prime} \ c(K, s, B', g, z) + v(g) + \beta E V_g(s'), \tag{16}$$

subject to

$$g = g(s, B', q(s, B')), \tag{17}$$

$$z = z(s, B', q(s, B')) \tag{18}$$

$$s = (B', K'(s, B', g, z), a(s, z), c') \tag{19}$$

Later in the period, the government makes its default choice z, which in turn determines the level of productivity a and, through its budget constraint, the level of government spending g. Given the government's initial value function, $V_g(s)$, they define the policy functions $g(s, B', q)$ and $z(s, B', q)$ as the solutions to the problem

$$\max_{g,z} \; c(K, s, B', g, z) + v(g) + \beta E V_g(s') \tag{20}$$

subject to

$$g + zB \leqq \theta a(s, z) f(K) + qB', \tag{21}$$

$$z = 0 \; or \; z = 1 \tag{22}$$

$$g \geqslant 0 \tag{23}$$

$$s' = (B', K'(s, B', g, z), a(s, z), \xi') \tag{24}$$

Definition of an equilibrium. An equilibrium is a list of value functions V_c for the representative consumer, V_b for the representative banker, and V_g for the government;policy functions c and k' for the consumer, b' for the banker, and B', g, and z for the government; a price function q; and an equation of motion for the aggregate capital stock K' such that:

1. Given $B^{'}$, g, and z, V_c is the value function for the solution to the representative consumer's problem, and c and k' are the maximizing choices;

2. Given B', q, and z, V_b is the value function for the solution to the representative banker's problem, and the value of B' chosen by the government solves the problem when$b = B$;

3. Given q, c, K', g, and z, V_g is the value function for the solution to the government's first problem (), and B' is the maximizing choice. Furthermore, given

C, K', V_g, and B', g and z solve the government's second problem ();

4. $B'(s) \in b'(B, s, B')$;

5. $K'(s, B', g, z) = k'(K, s, B', g, z)$.

A.3 Regression analysis : growth rates on debt GDP ratios

Table 6: Growth rate of output on debt gdp ratio in advanced countries, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Australia	-0.014	0.521	0.015	0.521	3.420	0.000
Austria	-0.084	0.001	0.311	0.001	7.977	0.000
Belgium	0.005	0.803	0.002	0.803	1.216	0.544
Canada	0.000	0.998	0.000	0.999	2.246	0.469
Cyprus	-0.099	0.001	0.482	0.000	9.556	0.000
Czech Republic	-0.052	0.333	0.043	0.332	3.962	0.032
Denmark	0.031	0.275	0.044	0.275	0.036	0.980
Estonia	-0.792	0.111	0.102	0.111	9.586	0.012
Finland	-0.050	0.391	0.026	0.391	3.946	0.171
France	-0.022	0.100	0.094	0.100	3.134	0.003
Germany	-0.077	0.032	0.154	0.032	6.342	0.006
Greece	-0.069	0.001	0.352	0.001	9.410	0.000
Hong Kong SAR	-0.464	0.405	0.039	0.405	6.354	0.049
Iceland	-0.069	0.013	0.200	0.013	6.520	0.000
Ireland	-0.057	0.007	0.232	0.370	8.328	0.000
Israel	-0.045	0.370	0.043	0.370	6.983	0.076
Italy	-0.053	0.046	0.135	0.046	6.719	0.027
Japan	-0.077	0.032	0.154	0.032	6.342	0.006
Korea	-0.045	0.002	0.290	0.002	9.357	0.000
Latvia	-0.296	0.000	0.431	0.001	11.560	0.000
Lithuania	-0.279	0.023	0.244	0.023	12.168	0.002
Luxembourg	-0.124	0.039	0.166	0.039	5.071	0.000
Malta	-0.061	0.595	0.017	0.595	6.438	0.402
Netherlands	-0.059	0.190	0.070	0.190	5.301	0.051
New Zealand	-0.051	0.100	0.094	0.100	4.326	0.000
Norway	-0.021	0.509	0.016	0.509	3.062	0.128
Portugal	-0.040	0.002	0.290	0.002	4.805	0.000
San Marino	-0.094	0.712	0.009	0.712	1.209	0.814
Singapore	-0.124	0.047	0.134	0.047	16.687	0.004
Slovak Republic	-0.211	0.001	0.382	0.001	13.014	0.000
Slovenia	-0.051	0.019	0.210	0.019	4.857	0.000
Spain	-0.042	0.018	0.184	0.018	4.856	0.000
Sweden	0.005	0.898	0.000	0.898	2.103	0.232
Switzerland	0.007	0.852	0.001	0.852	1.282	0.232
Taiwan Province of China	-0.127	0.284	0.052	0.284	8.464	0.365
United Kingdom	-0.016	0.289	0.043	0.269	2.941	0.002
United States	-0.011	0.510	0.025	0.510	3.110	0.053

Table 7: Growth rate of output on debt gdp ratio in Asian countries, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Bangladesh	-0.065	0.008	0.362	0.008	8.586	0.000
Bhutan	0.028	0.084	0.110	0.084	5.090	0.000
Brunei Darussalam	-0.106	0.819	0.002	0.819	2.239	0.005
Cambodia	0.089	0.453	0.025	0.452	4.690	0.227
China	-0.212	0.000	0.622	0.000	16.944	0.000
Fiji	-0.009	0.901	0.001	0.901	2.970	0.418
India	-0.072	0.201	0.060	0.202	11.829	0.006
Indonesia	-0.056	0.000	0.636	0.000	7.340	0.000
Kiribati	0.296	0.145	0.077	0.145	-1.976	0.402
Lao P.D.R.	-0.043	0.000	0.715	0.000	10.501	0.000
Malaysia	0.001	0.994	0.000	0.994	5.642	0.172
Maldives	-0.041	0.258	0.047	0.258	8.371	0.000
Nepal	-0.021	0.291	0.058	0.291	5.181	0.000
Papua New Guinea	-0.144	0.032	0.170	0.033	11.262	0.001
Philippines	-0.073	0.012	0.227	0.012	8.385	0.000
Samoa	-0.076	0.302	0.051	0.302	5.634	0.124
Sri Lanka	-0.134	0.027	0.168	0.027	17.632	0.002
Thailand	-0.206	0.029	0.190	0.029	12.909	0.005
Vanuatu	-0.160	0.082	0.126	0.082	7.019	0.010
Vietnam	-0.048	0.000	0.527	0.000	8.730	0.000

Table 8: Growth rate of output on debt gdp ratio in Middle Eastern Countries, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Algeria	-0.024	0.040	0.147	0.040	3.993	0.003
Bahrain	-0.046	0.018	0.191	0.018	5.861	0.000
Djibouti	0.045	0.992	0.024	0.493	6.933	0.072
Egypt	-0.097	0.009	0.336	0.009	12.545	0.000
Jordan	-0.004	0.874	0.001	0.874	5.314	0.027
Kuwait	0.134	0.176	0.067	0.176	1.648	0.727
Lebanon	-0.004	0.911	0.001	0.910	4.418	0.466
Libya	-0.050	0.766	0.003	0.766	6.306	0.438
Mauritania	-0.018	0.239	0.072	0.239	7.059	0.007
Morocco	-0.079	0.311	0.038	0.311	9.144	0.081
Oman	-0.010	0.852	0.001	0.851	3.718	0.000
Pakistan	-0.123	0.015	0.215	0.015	12.301	0.005
Qatar	-0.009	0.921	0.000	0.921	9.324	0.010
Saudi Arabia	-0.023	0.173	0.091	0.173	5.030	0.000
Sudan	0.019	0.453	0.021	0.453	5.549	0.189
Syria	0.000	0.993	0.000	0.994	4.758	0.048
Tunisia	0.046	0.224	0.054	0.224	1.576	0.460
UAE	-0.275	0.021	0.238	0.021	7.432	0.000

Table 9: Growth rate of output on debt gdp ratio in Eastern European Countries, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Albania	-0.218	0.020	0.268	0.020	18.197	0.003
Bosnia and Herz.	-0.156	0.040	0.214	0.040	9.022	0.003
Bulgaria	0.005	0.986	0.000	0.986	2.990	0.077
Croatia	-0.088	0.007	0.361	0.006	6.968	0.001
Hungary	-0.187	0.002	0.416	0.002	15.244	0.001
Poland	-0.002	0.985	0.000	0.985	3.720	0.361
Romania	-0.195	0.016	0.283	0.016	9.102	0.001
Serbia	-0.151	0.002	0.423	0.002	11.784	0.000
Turkey	-0.084	0.232	0.078	0.232	7.492	0.029

Table 10: Growth rate of output on debt gdp ratio in Sub-Saharan Africa, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Angola	-0.155	0.020	0.254	0.020	14.708	0.000
Benin	0.047	0.060	0.174	0.060	3.005	0.002
Botswana	-0.218	0.235	0.066	0.235	7.565	0.002
Burkina Faso	-0.012	0.813	0.003	0.058	6.363	0.001
Burundi	-0.021	0.013	0.427	0.001	5.305	0.000
Cabo Verde	-0.067	0.027	0.258	0.027	10.440	0.001
Cameroon	0.017	0.077	0.156	0.077	3.487	0.000
Central African Republic	0.009	0.891	0.001	0.891	0.384	0.940
Chad	-0.067	0.536	0.019	0.536	9.200	0.016
Comoros	-0.023	0.029	0.227	0.029	3.729	0.000
Congo (DR)	-0.068	0.000	0.643	0.000	9.604	0.000
Republic of Congo	-0.021	0.003	0.279	0.003	6.267	0.000
Côte d'Ivoire	-0.069	0.022	0.217	0.022	8.171	0.001
Equatorial Guinea	0.082	0.491	0.018	0.491	13.673	0.086
Eritrea	-0.057	0.346	0.047	0.346	9.215	0.273
Ethiopia	-0.065	0.005	0.261	0.005	11.176	0.000
Gabon	-0.055	0.072	0.115	0.072	5.476	0.002
The Gambia	-0.161	0.533	0.021	0.533	5.796	0.039
Ghana	-0.383	0.034	0.156	0.034	8.218	0.000
Guinea	-0.016	0.141	0.079	0.141	4.922	0.000
Guinea-Bissau	-0.001	0.906	0.001	0.906	3.480	0.008
Kenya	-0.178	0.034	0.198	0.034	13.276	0.002
Lesotho	-0.013	0.358	0.031	0.358	5.053	0.000
Liberia	-0.012	0.079	0.017	0.079	7.355	0.008
Madagascar	-0.010	0.779	0.004	0.779	3.957	0.081
Malawi	-0.036	0.025	0.261	0.025	7.267	0.000
Mali	-0.026	0.413	0.036	0.413	5.726	0.001
Mauritius	-0.238	0.001	0.449	0.001	16.306	0.001
Mozambique	0.004	0.846	0.002	0.846	7.502	0.000
Namibia	0.212	0.045	0.145	0.045	-0.258	0.091
Niger	-0.039	0.123	0.100	0.123	7.410	0.000
Nigeria	-0.007	0.804	0.003	0.804	7.055	0.000
Rwanda	-0.069	0.265	0.051	0.265	10.663	0.014
São Tomé and Príncipe	-0.005	0.089	0.152	0.089	5.591	0.000
Senegal	0.016	0.571	0.017	0.571	3.644	0.014
Seychelles	-0.017	0.322	0.036	0.322	5.737	0.011
Sierra Leone	0.013	0.717	0.007	0.717	6.178	0.077
South Africa	-0.095	0.023	0.244	0.023	6.734	0.000
South Sudan	3.105	0.089	0.404	0.090	-66.676	0.101
Swaziland	-0.076	0.041	0.151	0.041	3.763	0.000
Tanzania	-0.011	0.706	0.008	0.706	6.931	0.000
Togo	-0.081	0.000	0.600	0.000	9.426	0.000
Uganda	-0.214	0.463	0.025	0.463	7.462	0.000
Zambia	-0.081	0.210	0.081	0.210	8.743	0.000
Zimbabwe	-0.026	0.925	0.000	0.925	3.138	0.837

Table 11: Growth rate of output on debt gdp ratio in Sub-Saharan Africa, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Equatorial Guinea	0.082	0.491	0.018	0.491	13.673	0.086
Eritrea	-0.057	0.346	0.047	0.346	9.215	0.273
Ethiopia	-0.065	0.005	0.261	0.005	11.176	0.000
Gabon	-0.055	0.072	0.115	0.072	5.476	0.002
The Gambia	-0.161	0.533	0.021	0.533	5.796	0.039
Ghana	-0.383	0.034	0.156	0.034	8.218	0.000
Guinea	-0.016	0.141	0.079	0.141	4.922	0.000
Guinea-Bissau	-0.001	0.906	0.001	0.906	3.480	0.008
Kenya	-0.178	0.034	0.198	0.034	13.276	0.002
Lesotho	-0.013	0.358	0.031	0.358	5.053	0.000
Liberia	-0.012	0.079	0.017	0.079	7.355	0.008
Madagascar	-0.010	0.779	0.004	0.779	3.957	0.081
Malawi	-0.036	0.025	0.261	0.025	7.267	0.000
Mali	-0.026	0.413	0.036	0.413	5.726	0.001
Mauritius	-0.238	0.001	0.449	0.001	16.306	0.001
Mozambique	0.004	0.846	0.002	0.846	7.502	0.000
Namibia	0.212	0.045	0.145	0.045	-0.258	0.091
Niger	-0.039	0.123	0.100	0.123	7.410	0.000
Nigeria	-0.007	0.804	0.003	0.804	7.055	0.000
Rwanda	-0.069	0.265	0.051	0.265	10.663	0.014
São Tomé and Príncipe	-0.005	0.089	0.152	0.089	5.591	0.000
Senegal	0.016	0.571	0.017	0.571	3.644	0.014
Seychelles	-0.017	0.322	0.036	0.322	5.737	0.011
Sierra Leone	0.013	0.717	0.007	0.717	6.178	0.077
South Africa	-0.095	0.023	0.244	0.023	6.734	0.000
South Sudan	3.105	0.089	0.404	0.090	-66.676	0.101
Swaziland	-0.076	0.041	0.151	0.041	3.763	0.000
Tanzania	-0.011	0.706	0.008	0.706	6.931	0.000
Togo	-0.081	0.000	0.600	0.000	9.426	0.000
Uganda	-0.214	0.463	0.025	0.463	7.462	0.000
Zambia	-0.081	0.210	0.081	0.210	8.743	0.000
Zimbabwe	-0.026	0.925	0.000	0.925	3.138	0.837

Table 12: Growth rate of output on debt gdp ratio in Latin America and Carrebean Countries, 1991-2020

	Coefficient	t-prob	R2	F-prob	Constant	t-prob
Antigua and Barbuda	-0.014	0.835	0.002	0.835	3.798	0.582
Argentina	-0.104	0.004	0.268	0.005	8.823	0.000
The Bahamas	0.055	0.224	0.056	0.224	3.954	0.042
Barbados	-0.02	0.261	0.05	0.261	2.443	0.065
Belize	0.12	0.187	0.095	0.187	-6.222	0.422
Bolivia	-0.056	0.001	0.426	0.001	6.84	0.000
Brazil	-0.038	0.766	0.005	0.766	5.139	0.546
Chile	-0.065	0.51	0.02	0.509	3.97	0.011
Colombia	-0.087	0.358	0.037	0.359	6.788	0.056
Costa Rica	-0.077	0.287	0.059	0.287	7.544	0.013
Dominica	-0.028	0.439	0.023	0.439	4.123	0.124
Dominican Republic	-0.109	0.101	0.118	0.101	7.961	0.000
Ecuador	-0.131	0.012	0.302	0.012	7.992	0.001
El Salvador	-0.074	0.008	0.243	0.008	6.202	0.000
Grenada	-0.05	0.143	0.08	0.143	6.484	0.024
Guatemala	0.026	0.81	0.003	0.06	2.973	0.239
Guyana	-0.02	0.305	0.048	0.305	5.085	0.010
Haiti	-0.019	0.682	0.008	0.682	2.95	0.119
Honduras	-0.048	0.176	0.094	0.176	5.905	0.002
Jamaica	-0.019	0.382	0.034	0.382	2.992	0.256
Mexico	0.084	0.558	0.015	0.558	-1.049	0.870
Nicaragua	0.004	0.755	0.004	0.776	3.826	0.001
Panama	-0.058	0.12	0.09	0.12	9.793	0.001
Paraguay	-0.177	0.012	0.216	0.013	7.89	0.002
Peru	-0.132	0.019	0.256	0.019	8.724	0.000
St. Kitts and Nevis	-0.025	0.196	0.072	0.196	5.522	0.014
St. Lucia	-0.024	0.278	0.045	0.278	3.225	0.033
St. Vincent and the Grenadines	-0.041	0.404	0.027	0.404	5.285	0.105
Suriname	-0.012	0.744	0.004	0.744	3.851	0.010
Trinidad and Tobago	-0.035	0.7	0.008	0.7	6.009	0.146
Uruguay	-0.159	0.002	0.4	0.003	14.255	0.000
Venezuela	0.002	0.989	0	0.989	1.277	0.800