Some Amendments to the Algebraic Representation and Empirical Estimation of the Fiscal Multipliers

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Abstract

Conventional algebraic estimate of the fiscal multipliers ignores the concept of velocity of money and mistakenly assumes that money changes hands an infinite number of times during a given year while we know money only has a finite velocity. Apart from the velocity of money, fiscal multipliers tend to depend on average propensity to consume and average propensity to import of the economy as a whole and also on average tax rate among other things which are not reflected in the modern SVAR based estimation. Here, in the first place, we amend the algebraic definition of the fiscal multipliers considering the impact of velocity of money, provide a micro-foundation relating fiscal multipliers with money velocity and other macro variables and later propose a modification in the conventional SVAR set up by incorporating aforesaid macro variables arranged in a logical manner. Proposed amendments to the SVAR set up entail relatively stable estimates of the fiscal multipliers as can be seen from empirical estimation of the multiplier values for US and UK data during the period 1972-2018.

1 Introduction

History of economic multipliers can be traced back to eighteenth century when the French economist Francois Quesnay first proposed the *Tableau Economique* (Economic Table) [21]. However, It's the Keynes and Henderson who brought about the idea of economic multipliers to modern economic analysis and formally laid the foundation of multiplier theory during the height of the great depression [25]. Keynes and Henderson were advocates of generous government spending targeted to slash unemployment and through these they intended to reinstate the economy to its full employment level defying the rages of the great depression of the 1930s. However, the Keynesian idea of curbing unemployment through government intervention was rejected outright by the office of the Chancellor of Exchequer of the United Kingdom claiming very little additional employment could in fact be created by state funding [36]. This view of the *Her Majesty's Treasury* regarding the role of government spending to uplift the economy from deep down is famously known as the 'Treasury View' which suggests any increase in government spending will necessarily crowd out an equal amount of private spending or investment and thus has no net impact on economic activity. However, economic ideas are often inconclusively debatable and Keynes and others downplayed the 'Treasury View' by formally introducing the concept of fiscal multipliers in the context of government spending. Richard Kahn in his famous paper "The Relation of Home Investment to Unemployment" [24] analyzed the impact of enhanced government spending on unemployment in the presence of spare capacity, monetary accommodation and sticky prices. Kahn's idea was further refined and extended by Jens Warming [39] who introduced the concept of consumption functions in the analysis of economic multiplier. The first coherent presentation by Keynes in the context of economic multipliers was in a series of four articles published in The Times in March 1933 entitled "The Means to Prosperity" followed by an article in the New Statesman in April entitled "The Multiplier" [36]. Keynes further argued in favour of the multiplier effect in his famous book "The General Theory of Employment, Interest, and Money" [26].

The idea of economic multiplier since its modern inception back in 1930s received mixed response from the economic community and economists around the globe are still deeply divided about how well or indeed whether such (fiscal) stimulus works [13]. Nowadays, research on economic multiplier hinges around its empirical estimation and its effectiveness to downplay recession. For example, the performance of *American Recovery and Reinvestment Act of 2009* which was indeed a stimulus package enacted by the 111th U.S. Congress in response to counter great recession of 2008 following the burst of housing bubble was analyzed using the theories fiscal multipliers. White House Council of Economic Advisers (CEA) estimated that the stimulus package provided within the framework of ARRA 2009 was supposed to create between 2.5 and 3.6 million new jobs as of the second quarter of 2010 and at that point outlays and tax cuts would be totaled to $257 and $223 billion respectively (See for example, Council of Economic Advisers (2010)) [12]. The current literature on fiscal multiplier is somewhat policy oriented which helps government choose the best policy options available based upon sophisticated econometric techniques including impulse response analysis under structural VAR framework which attempts to capture the dynamic response of output to various government stimulus, tax cut and different combinations of the two. As the focus shifted to more practical side the theoretical derivation of the fiscal multiplier lacks proper attention. In the algebraic derivation of the fiscal multiplier it is assumed that one simple stimulus provided in the form of government spending triggers an infinite series of spending/consumption in the economy. The limiting value of the infinite geometric progression of spending/consumption thus created is treated as the value of fiscal multiplier. However, as we know from the concept of velocity of money, money will only change finite number of hands in a given year. So, if we do not overlook the concept of velocity of money, the infinite geometric progression used for the closed form algebraic approximation of the fiscal multiplier will only become a finite geometric series. Moreover, the real impact of fiscal stimulus will also depend (among others) upon the average propensity to consume and average propensity to import of the consumers and average tax rate as set out in the fiscal policy. The more the consumers spend on locally produced goods and services the more pronounced will be the effect of fiscal stimulus. On the other hand, if the consumers prefer savings to consumption or if they are more inclined to purchasing imported goods and services, the less will be impact of stimulus package. On the other hand, higher the tax rate, the lower will be the disposable income of the consumers which eventually entails smaller multiplier values. In the modern structural VAR based estimation of the fiscal multipliers all these facts are totally ignored. Here, we incorporate all the aforementioned facts in the algebraic and empirical estimation of the fiscal multipliers and compare our results with traditional SVAR approach using US and UK data during the period 1972-2018. The subsequent sections of this article are organized as follows. Section: 2 briefly describes the vast literature relating to the fiscal multipliers and different empirical approaches to measure it. Section: 3 introduces the definitions of different kinds of fiscal multipliers currently in use. Section: 4 discusses the conventional algebraic calculation of the fiscal multiplier. Section: 5 makes the proposed amendments to the algebraic estimation of the fiscal multipliers presented in Section: 4. Section: 6 provides a micro-foundation of the intuitive arguments presented in Section: 5. Section: 7 diffuses the modified algebraic representation of the multipliers as presented in Section: 5 into structural VAR set up and elaborates the methodology followed for the empirical estimation of the government spending multipliers in this modified experimental set up. Data sources used in the analysis are also discussed in this section. Section: 8 presents the results of empirical analysis and compares the performance of our proposed model to the conventional one. Section: 9 discusses the policy implication and the limitation of the current study. Finally, Section: 10 makes some concluding remarks.

2 Literature Review

Modern approaches of estimating a reasonable size of the fiscal multipliers include impulse response analysis under structural VAR framework isnpired by seminal work of Blanchard and Perotti (2002) [7] and the narrative approach popularized by Romer and Romer (2010) [34]. However, the multipliers calculated empirically using these approaches in different countries during different time frames vary considerably. For example, Blanchard and Perotti (2002) [7] estimate the multiplier values to be close to 1 for government purchases in United States under structural VAR framework. However, Perotti (2004) [31], in a sample of 5 OECD countries has shown that the effects of fiscal policy on GDP tend to be small: government spending multipliers larger than 1 can only be estimated in the US in the pre-1980 period. Mountford and Uhlig (2009) [29] have shown that the impact multipliers corresponding to deficit financed tax cut for US data vary between 0.29 to 5.25 at different time periods. However, in long run, i.e., after period 20 it becomes negative. For deficit spending, the corresponding impact multipliers are found within the range -2.07 to 0.65 in different quarters. Based on a survey carried out by Mineshima et al (2014) [28], it can be noted that first year fiscal multipliers amount on average to 0.75 for government spending and 0.25 for tax revenue in advanced economies. However, these modern results have been challenged by some recent studies and it has been observed that the multipliers can exceed 1 under abnormal circumstances when the economy is facing severe downturn and the monetary policy transmission mechanism has been impaired to some extent [4]. Meanwhile, small sample size of macroeconomic data available for each individual country lures researchers towards a panel VAR approach. For example, Beetsma et al (2008) [6] estimates the fiscal multiplier for EU countries in a Panel VAR and finds a peak multiplier value of 1.6.

Another approach to measuring fiscal multipliers commonly known as the narrative approach provides a methodological improvement upon the traditional measurement of fiscal shocks. Unlike the structural VAR approach, narrative approach seeks to identify exogenous fiscal shocks directly. Some studies using narrative approach have used news about US military spending as a measure of exogenous shocks and estimate US government spending multipliers to be within the range 1.1-1.2 (Ramey, 2011b [33]). Using US defense spending news during the period 1917-2006, Barro and Redlick (2011) [3] has found that the government spending multipliers vary within the range of 0.4-0.6 where lower multiplier values are obtained for temporary spending changes and higher values are obtained for permanent spending changes. Using US defense spending news during 1930-2008, Hall (2009) [19] has estimated the government spending multipliers to be roughly 0.6. Using narrative approaches of identifying exogenous fiscal shocks, Owyang, Ramey and Zubairy (2013) [30] estimate US government spending multipliers to be 0.8 and for Canadian data their obtained values are within the range 0.4-1.6. Higher multiplier values for Canadian data are obtained during periods of high unemployment. Numerous other studies have been conducted aiming to estimate a *credible size* of the fiscal multipliers and a comprehensive survey of this huge volume of literature is provided in the technical notes of IMF [4].

From the above discussion we can conclude that the estimates of the fiscal multipliers depend heavily upon the techniques used in estimation i.e., SVAR approach or narrative approach. In general SVAR approach entails relatively small multiplier values as compared to the narrative approach [10]. Differences in the estimates stem from the fact that the two approaches differ fundamentally in at least two specific dimensions [10]. In the first place, the transmission mechanism deployed by the SVAR approach comprises a multi-equation, multivariate autoregressive system in which the fiscal variables (government spending and/or tax) evolve jointly with other endogenous macroeconomic variables in the system. On the other hand, the narrative approach uses a single equation where output is represented as a linear function of current and lagged values of the exogenous fiscal shocks. The second dimension in which the two approaches differ is the identification of the fiscal shocks. While the SVAR approach imposes a number of restrictions on the variance-covariance matrix of the vector of shocks under consideration, the narrative approach analyzes historical records, presidential speeches, congressional reports etcetera to identify exogenous fiscal shocks. It has been argued that the differences in the two estimates of the fiscal multipliers are (partly) due to the failure of the two models to identify the same fiscal shock [10].

We now know that due to the misspecification of the fiscal shocks, SVAR approach and narrative approach may entail different estimates of the fiscal multipliers. However, estimation of the fiscal multipliers using single strategy i.e., SVAR or narrative approach rarely results into consistent estimates. In the SVAR context, number of endogenous and exogenous variables in the SVAR framework, choice of variables, time horizon in which the multiplier is reported and size of the sample can influence the empirical estimation of the fiscal multipliers (See Gechert (2015) [17] and Rusnak (2011) [35] for details). Moreover, data composition, data transformation and methodology used for fiscal data collection can also have a profound impact on the multiplier estimates [9]. For example, Capek and Cuaresma (2019) [9] has shown that using Harmonized Index of Consumer Prices (HICP) to deflate nominal variables instead of GDP deflator and following European System of National and Regional Accounts (ESA) 95 rather than ESA 2010 result into significantly larger estimates of the fiscal multipliers.

Given the wide range within which fiscal multipliers tend to oscillate, it is important to know upon which circumstances fiscal multipliers work well in stimulating the economy. Multipliers tend to vary depending upon the exchange rate regime, amount of government debt and financial crisis among other things. Corsetti et al (2011) [11] shows that the multipliers are larger under fixed exchange rate regime, lower when public debt is higher and larger during periods of financial crisis. Auerbach and Gorodnichenko (2011, 2012) [1], [2] use semi-annual data of a panel of industrialized countries to compare the effectiveness of government spending during economic booms and busts. As anticipated, their study finds evidence in favour of the fiscal multipliers being more active during periods of economic downturn. Using a panel of 44 countries segregated into developing and developed ones, Ilzetzki et al (2013) [22] shows that fiscal multipliers are larger in developed than in developing countries, larger in the countries with a predetermined exchange rates and smaller in open economies than in closed ones. On the contrary, they have found that fiscal multipliers are negative in highly indebted countries.

Literatures relating to fiscal multipliers are vast and are still growing. However, that are cited above (and that are not) do not tend to consider money velocity, average propensity to consume, average propensity to import and average tax rate as some of the determinants of the fiscal multipliers. These macroeconomic variables are surprisingly missing in all of the SVAR based modern estimation of the fiscal multipliers which, we argue, limits our possibility of obtaining a reasonable estimate of the multipliers using empirical techniques. Here, we first propose a modification to the algebraic definition of the fiscal multipliers by gently dispersing the concept of finite velocity of money into the multiplier theory and then amend the conventional SVAR framework used in the estimation by adding the above-mentioned variables in an intuitive manner that complies with the amended algebraic representation of the fiscal multipliers.

3 Fiscal multipliers: Definitions and Types

Fiscal multiplier is the amount of changes in real GDP or any other measures of real output brought about by a unit change in any of the fiscal variables like government consumption, government investment, government taxes etcetera. Depending upon the choice of the fiscal variables, the value and sign of the fiscal multipliers vary significantly. For example, government consumption and investment are supposed to have a positive effect on real output while government taxes may have a negative one. Here, we are more interested in the estimation of government consumption multiplier and all through the text whenever we mention the term fiscal multiplier we mean government consumption multiplier. Government consumption multipliers can be further classified into impact and cumulative multipliers which are defined as follows.

- Impact multiplier: If a ΔGC amount of change in government consumption brings about ΔGDP changes in output then impact multiplier for government consumption is defined as follows:
$$IM = \frac{\Delta GDP}{\Delta GC}$$
- Cumulative multiplier: Impact multipliers capture the response of real output in response to shocks in government consumption for a particular period of time. However, the effect of shocks in government consumption may be pronounced over subsequent time periods after the shock is applied and hence it is reasonable to define a cumulative version of government consumption multiplier which can be defined as follows:
$$CM_T = \frac{\sum_{t=0}^{T}(1+i)^{-t} \times \Delta GDP_t}{\sum_{t=0}^{T}(1+i)^{-t} \times \Delta GC_t}$$
where CM_T is the cumulative multiplier at time T and i the discounting rate.

4 Conventional Algebraic Derivation of the Fiscal Multiplier

Before we proceed, a few preliminary definitions of some quantities along with their inter-relation with the fiscal multipliers are on the way:

- Average propensity to consume: Average propensity to consume is the fraction of the total income of an entity that is spent in consumption. Another portion of the income is saved and subsequently invested. To measure average propensity to consume for a whole country we divide the total amount of consumption of that country in a year by its Gross Domestic Product (GDP) in the same year. Average propensity to consume is supposed to have a positive correlation with the effectiveness of the fiscal stimulus. If the beneficiaries of government consumption spend a significant portion of their income then the contribution of government consumption on GDP will be much more pronounced. On the other hand, if the beneficiaries choose to save a significant portion of it rather than spending then the effectiveness of government stimulus package would be much lower than what is anticipated.
- Average propensity to import: Average propensity to import of an entity is the fraction of its total income that is spent on purchasing imported goods and services. For a country, average propensity to import can be calculated by dividing its yearly import by its Gross Domestic Product (GDP). As import has an adversarial relation with the GDP, a higher value of average propensity to import will result into a lower value of fiscal multiplier i.e., the stimulus package fails to boost up the economy through enhanced production. In this case, people tend to be more interested on importing goods and services rather than producing them locally. Thus a lower value of average propensity to import is desirable for the fiscal stimulus to work effectively towards boosting up the economy.
- Average tax rate: Average tax rate is the fraction of total income of an entity that is paid as taxes to the government. An entity can pay taxes in many different forms e.g., housing tax, motor car tax, personal income tax, source tax on bank deposits, excise duty, corporate taxes etcetera. Then the average tax rate for that entity can be calculated by dividing its total tax payment in multifarious formats by its total income. For a country as a whole, average tax rate in a year can be calculated by dividing the total tax revenue collected by the government during the year by its GDP in the same year. A higher value of average tax rate will partly nullify the effect of fiscal stimulus as the government tends to pump in a significant portion of the money it spent as stimulus through revenue collection.

To begin with, let us now assume ΔGC be any exogenous change in government consumption intended to work as fiscal stimuli. Then ΔGC will be received as wages by the workers, rents by the land owners, salaries by the employees, social security benefits by the elderly and the unemployed etcetera. If the average tax rate is given by ATR then the increase in disposable income of the beneficiaries who receive ΔGC as payment is given by $(1 - ATR) \times \Delta GC$. A part of this disposable income will be spent in consumption while the rest is saved. If the average propensity to consume of the economy as whole is given by APC then the amount spent in consumption (both in locally produced and imported goods and services) will be given by $APC \times (1 - ATR) \times \Delta GC$. If the average propensity to import is given by API then the amount of spending in locally produced goods and services is given by $APC \times (1 - ATR) \times \Delta GC -$

$API \times \Delta GC = (APC \times (1 - ATR) - API) \times \Delta GC$. Let, the quantity $(APC \times (1 - ATR) - API)$ be given by c. So, the aggregate contribution on total output resulting from these two rounds of consumption initiated by the initial fiscal stimuli ΔGC is given by:

$$= \Delta GC + \Delta GC \times c$$
$$= (1 + c) \times \Delta GC$$

The second round of consumption expenditure namely $c \times \Delta GC$ will be received by the producers of goods and services as sales revenue which triggers further consumption of $c \times c \times \Delta GC$ or $c^2 \Delta GC$. In the same manner, the successive consumption and savings continue inside the economy and we get an infinite geometric series as the aggregate impact of an initial fiscal stimuli of ΔGC on the total output:

$$\Delta GDP = \Delta GC \times (1 + c + c^2 + c^3 + ...)$$

$$\Delta GDP = \Delta GC \times \frac{1}{1 - c} \tag{1}$$

5 Amendment to the Algebraic Calculation of the Fiscal Multiplier

While deriving Equation: 1 it is assumed that the initial fiscal stimulus ΔGC triggers an infinite progression of subsequent consumptions inside the economy. It may be true in the very long run. But, in short run or to be more precise within one year of time horizon its contribution will be finite. In reality, money paid as wages, rents, salaries etcetera can only change a finite number of hands during a given year. The number of times money changes hands in a particular year is known as the velocity of money. Let, the velocity of money be denoted by v. If we consider a finite velocity v of money then the total contribution of initial government consumption expenditure of ΔGC working as a stimulus to the economy will become the summation of a finite geometric series instead of an infinite one and it is given by the following:

$$\begin{aligned} \Delta GDP &= \Delta GC \times (1 + c + c^2 + c^3 + ... + c^{v-1}) \\ &= \Delta GC \times \frac{1 - c^v}{1 - c} \end{aligned} \tag{2}$$

6 Microfoundations

- **Determination of optimal consumption sequence**

  To begin with let us assume that our simplistic endowment economy is habitated by some finitely lived identical households who live for n years. Each year $i, \forall_{1 \leq i \leq n}$ households receive Y_i amount of endowment and T_i of amount of transfer payments. Households intend to maximize their overall lifetime utility through consumption by optimally splitting their income into consumptions and savings in different time periods. Savings made during any year i are entitled to interest payment at the rate r_{i+k} during the year $(i+k), \forall_{i+k \leq n, k \in N \cup \{0\}}$. Let us also assume that households savings are entitled to simple interest only i.e., there is no interest on interest. Moreover, we also assume that the government imposes some distortionary taxes on consumption and it is levied upon consumption as $TC\%$ point basis. That means if the households make C_p amount of consumption during any arbitrary period p then the amount of tax levied upon them is given by $TC \times C_p$. Following the above definition of our simplistic endowment economy we will determine the optimal level of consumption and savings made by the households during different years, define and calculate annual output and finally we calculate the responsiveness of annual output with respect to changes in government transfer payment which is popularly known as government spending multiplier. For simplicity we assume government spending comprises transfer payments only i.e., the government neither consume nor invest. Last but not the least we allow money velocity to change keeping all other things unchanged and show how the annual fiscal multipliers vary as an eventual consequence of the said maneuver. Through out the analysis we assume that periodic endowments Y_i , transfer payments T_i and interest rate r_i at any arbitrary period $i, 1 \le i \le n$ are exogenously determined and are independent of each other. Moreover, they are also assumed to be independent of their own lagged and future values.

During the last year of the households' finite life span, they need to eat up their entire periodic endowment, transfer payment and interest income received during the period as well as any accumulated savings along with any interest there on as anything left after n-th year will be of no avail towards households' utility maximization through consumption. This fact can be written in the notational form in the following manner.

$$(1 + TC)C_n = Y_n + T_n + I_n + S_{n-1}$$

where C_n is the total household consumption made during period n, TC is the pre-fixed tax rate on consumption, Y_n and T_n represent periodic endowment and transfer payment received by the households during period n, I_n is the interest income received by the households during period n and S_{n-1} represents households' accumulated savings with (simple) interest there on up to period $(n - 1)$. Here, interest income I_n in period n can be calculated by multiplying households' total gross principal savings up to period n by the prevailing interest rate at period n. On the other hand, contributions of households' gross principal savings $Y_i + T_i - (1 + TC)C_i$ made during any period i to S_{n-1} can be calculated by multiplying $Y_i + T_i - (1 + TC)C_i$ by r_i, r_{i+1}, r_{i+2} up to r_{n-1} and then adding the multiplication results together. We repeat the above procedure for all $i, 1 \le i \le (n - 1)$ and add up all the contributions of gross principal savings to calculate S_{n-1}. Using the above definitions of interest income and accumulated savings the aforementioned equation can be rewritten as follows:

$$(1+TC)C_n = Y_n+T_n+r_n \times \sum_{i=1}^{n}[Y_i+T_i-(1+TC)C_i]+\sum_{i=1}^{n-1}[Y_i+T_i-(1+TC)C_i][1+\sum_{j=i}^{n-1} r_j]$$

Separating Y_i, T_i from $(1 + TC)C_i$ under the summation sign and then simple rearranging yields households' life time budget constraint:

$$\sum_{i=1}^{n}(1 + TC) \times C_i \times \left[1 + \sum_{j=i}^{n} r_j\right] = \sum_{i=1}^{n}(Y_i + T_i) \times [1 + \sum_{j=i}^{n} r_j] \tag{3}$$

Let us assume that the households' life time utility function be given by:

$$U(C)=\sum_{i=1}^{n}\beta^{i-1}\times\frac{C_i^{1-\sigma}}{1-\sigma}$$

where β is the discounting factor and σ is coefficient of Constant Relative Risk Aversion (CRRA) factor. Upon the assumption of the above objective function households' optimization problem takes the following form:

$$Max\sum_{i=1}^{n}\beta^{i-1}\times\frac{C_i^{1-\sigma}}{1-\sigma}$$
$$S.T.\sum_{i=1}^{n}(1+TC)\times C_i\times\left[1+\sum_{j=i}^{n}r_j\right]-\sum_{i=1}^{n}(Y_i+T_i)\times[1+\sum_{j=i}^{n}r_j]=0$$

Taking the Lagrangian of the above optimization problem we get:

$$L=\sum_{i=1}^{n}\beta^{i-1}\times\frac{C_i^{1-\sigma}}{1-\sigma}-\lambda\times\left[\sum_{i=1}^{n}(1+TC)\times C_i\times\left[1+\sum_{j=i}^{n}r_j\right]-\sum_{i=1}^{n}(Y_i+T_i)\times[1+\sum_{j=i}^{n}r_j]\right]$$

Differentiating the above Lagrangian with respect to C_i and setting it to zero as the first order optimality condition we get:

$$\beta^{i-1}\times C_i^{-\sigma}=\lambda\times(1+TC)\times[1+\sum_{j=i}^{n}r_j]$$

Solving for C_i yields the following:

$$C_i=\lambda^{-\frac{1}{\sigma}}\times\left[\frac{(1+TC)\times\left[1+\sum_{j=i}^{n}r_j\right]}{\beta^{i-1}}\right]^{-\frac{1}{\sigma}}\tag{4}$$

Now differentiating the Lagrangian with respect to λ and setting it to zero as another first order optimality condition we can get an expression for λ which must be satisfied at optimality. Doing so what we get is eventually the households' life time budget constraint. So substituting the value of C_i from Equation: 4 into the households' life time budget constraint we get the following:

$$\sum_{i=1}^{n}(1+TC)\lambda^{-\frac{1}{\sigma}}\left[\frac{(1+TC)\left[1+\sum_{j=i}^{n}r_j\right]}{\beta^{i-1}}\right]^{-\frac{1}{\sigma}}\left[1+\sum_{j=i}^{n}r_j\right]=\sum_{i=1}^{n}(Y_i+T_i)\left[1+\sum_{j=i}^{n}r_j\right]$$

Rearranging the above expression and solving for λ yields:

$$\lambda=\left[\frac{\sum_{i=1}^{n}(Y_i+T_i)\left[1+\sum_{j=i}^{n}r_j\right]}{\sum_{i=1}^{n}\beta^{\frac{i-1}{\sigma}}(1+TC)^{\frac{\sigma-1}{\sigma}}\left[1+\sum_{j=i}^{n}r_j\right]^{\frac{\sigma-1}{\sigma}}}\right]^{-\sigma}$$

Now substituting the above value of λ into Equation: 4 we get a precise representation for optimal consumption C_i at period i:

$$C_i = \frac{\left[1+\sum_{j=i}^{n} r_j\right]^{-\frac{1}{\sigma}} \times \beta^{\frac{i-1}{\sigma}} \times \sum_{i=1}^{n}(Y_i+T_i)\left[1+\sum_{j=i}^{n} r_j\right]}{(1+TC)\times \sum_{i=1}^{n} \beta^{\frac{i-1}{\sigma}}\left[1+\sum_{j=i}^{n} r_j\right]^{\frac{\sigma-1}{\sigma}}}$$

So for any arbitrary period p optimal level of household consumption C_p at that period is given by:

$$C_p = \frac{\left[1+\sum_{j=p}^{n} r_j\right]^{-\frac{1}{\sigma}} \times \beta^{\frac{p-1}{\sigma}} \times \sum_{i=1}^{n}(Y_i+T_i)\left[1+\sum_{j=i}^{n} r_j\right]}{(1+TC)\times \sum_{i=1}^{n} \beta^{\frac{i-1}{\sigma}}\left[1+\sum_{j=i}^{n} r_j\right]^{\frac{\sigma-1}{\sigma}}} \tag{5}$$

- **Determining optimal savings sequence**

  In the previous step we have calculated the optimal consumption sequence taken by the households in order to maximize their life time utility through consumption under budget constraint i.e., we have determined the optimal level of consumption made by the households at any arbitrary period $p, 1 \leq p \leq n$. This time we are interested to determine the gross savings made by the households during period p. If the accumulated savings with (simple) interest there on of the households up to period p is given by S_p then we have the following identity:

$$C_p + S_p = Y_p + T_p + I_p + S_{p-1}$$

  where S_{p-1} is the accumulated savings with interest there on up to period $(p-1)$ and I_p is the interest payment received by the households during period p. In plain text the above equation simply implies that the total fund inflow for the households during any arbitrary period p must equate their total outflow. That means the consumption and total accumulated savings made by the household during period p must be sourced from its periodic endowment, transfer payment and interest income received at period p as well as from the accumulated savings made up to period $(p-1)$. So the gross savings made by the households during period p can be obtained by subtracting S_{p-1} from S_p. Rearranging the above equation we get:

$$GS_p = S_p - S_{p-1} = Y_p + T_p + I_p - C_p \tag{6}$$

- **Determining optimal output**

  In our representative endowment economy output produced in any given period is defined to be the summation of consumption and gross savings made during the same period. As we assume a closed economy there is no export/import. So, the total GDP of our closed endowment economy at period p is given by the following:

$$GDP_p = C_p + GS_p$$

  Substituting the value of GS_p from Equation: 6 we get:

$$GDP_p = Y_p + T_p + I_p \tag{7}$$

  From the above equation we can see that periodic output is significantly different from the simple summation of Y_p and T_p as the households either recieve interest on their accumulated savings up to period p which adds to total output or pay interest on their accumulated debt up to period p which is subtracted from total output. Now let us quantify the amount of interest income received by the households during period p. At period p households receive simple interest on their total gross principal savings up to period p at the existing interest rate r_p. So, Equation:7 turns out to be:

$$GDP_p = Y_p + T_p + r_p \times \left[\sum_{i=1}^{p} Y_i + T_i - (1+TC)C_i \right] \tag{8}$$

- **Determining the government spending multipliers**

Government spending multiplier is defined to be the changes in output in response to unit change in government spending. In reality, changes in government spending can be brought about by changing government consumption, investment and transfer payments. As we have previously assumed, in our simplistic economy government spending only consists of transfer payments. Including government consumption and investments as components of government spending would irrevocably break the analytical structure of the problem and would bring us to the realm of general equilibrium analysis which heavily relies upon simulation under some rather subjectively determined parameter settings. By now we prefer an analytical solution of the problem we are exposed to over a general equilibrium analysis using simulations. So in the context of our simplistic endowment economy we can define government spending multiplier as the rate of change of total output with respect to changes in government transfer payments. To do so we differentiate Equation: 8 with respect to T_p and we get the following expression:

$$\frac{\partial GDP_p}{\partial T_p} = 1 + r_p \times \left[1 - (1+TC) \times \sum_{i=1}^{p} \frac{\partial C_i}{\partial T_p} \right] \tag{9}$$

In the derivation of the above expression we have utilized the fact that the periodic endowment Y_i are exogenously determined and does not depend upon any other exogenous/endogenous variables in the system. So differentiating Y_P with respect to T_p entails zero. Moreover, according to our initial assumption transfer payment at any period is independent of transfer payment in any other period. Hence differentiating transfer payment in any period other than p with respect to transfer payment at period p entails zero and differentiating T_p with respect to T_p entails one. Finally, as we have assumed at the beginning of our analysis Y_p, T_p and r_p are independent of one another and also independent of their own lagged/future terms, we can take r_p as constant while (partially) differentiating any expression with respect to T_p. Now we are left with determining the partial derivative of optimal consumption sequence $C_k, \forall_{1 \le k \le p}$ with respect to transfer payment T_p at times p.

Now for any $k, 1 \le k \le p$ we can get the optimal consumption C_k from Equation: **??**:

$$C_k = \frac{\left[1 + \sum_{j=k}^{n} r_j\right]^{-\frac{1}{\sigma}} \times \beta^{\frac{k-1}{\sigma}} \times \sum_{i=1}^{n} (Y_i + T_i) \left[1 + \sum_{j=i}^{n} r_j\right]}{(1+TC) \times \sum_{i=1}^{n} \beta^{\frac{i-1}{\sigma}} \left[1 + \sum_{j=i}^{n} r_j\right]^{\frac{\sigma-1}{\sigma}}}$$

Differentiating the above expression with respect to T_p yields:

$$\frac{\partial C_k}{\partial T_p} = \frac{\left[1+\sum_{j=k}^{n} r_j\right]^{-\frac{1}{\sigma}} \times \beta^{\frac{k-1}{\sigma}} \times \left[1+\sum_{j=p}^{n} r_j\right]}{(1+TC) \times \sum_{i=1}^{n} \beta^{\frac{i-1}{\sigma}} \left[1+\sum_{j=i}^{n} r_j\right]^{\frac{\sigma-1}{\sigma}}} \tag{10}$$

Substituting the value of $\frac{\partial C_k}{\partial T_p}$ for all $1 \leq k \leq p$ into Equation: 9 we can get an algebraic expression for government spending multiplier $\frac{\partial GDP_p}{\partial T_p}$.

- **Fiscal multipliers when money velocity is changed**

  In each year i in our simplistic endowment economy each of the following transactions takes place.

  - Households receive their periodic endowment Y_i.
  - Apart from periodic endowments Y_i households also receive their annual transfer payment T_i.
  - Households receive interest income I_i on their total gross principal savings up to year i.
  - Households pay for their annual consumption C_i. Apart from consumption households also pay the tax $TC \times C_i$ levied upon consumption

  If the total money stock at year i is given by M_i then the velocity of money is given by the following construct:

$$v_i = \frac{[Y_i + T_i + I_i + (1+TC)C_i] \times 1 + [M_i - Y_i - T_i - I_i - (1+TC)C_i] \times 0}{M_i}$$

$$v_i = \frac{[Y_i + T_i + I_i + (1+TC)C_i] \times 1}{M_i}$$

Now let us investigate what happens if the money velocity is simply doubled while all other things being held unchanged. Doubling the money velocity while keeping all other variables constant implies that now 02 (two) consecutive sets of the aforementioned 04(four) transactions will take place in a year. Apart from doubling the above set of transactions we have no other way to accomodate the increased velocity of money. So, there will be two sets of consumption, two sets of periodic endowment and transfer payments and also two sets of transactions regarding the receipt of interest income will occur in a year. It seems that the production cycle has simply reduced to half in time. Now everything completes with in just half of the time previously required to complete everything. We can further extend our idea for arbitrarily higher values of the velocity of money. Let us assume that the money velocity has been increased $m, m \in N$ times which means by now m set of the above mentioned 04 (four) transactions will take place in a given year. So, the transfer payment T_p made by the government during period p instead of influencing C_p only will now have a stake on all the sequential consumptions that will take place within 01 (one) year starting from p. Hence, $C_p, C_{p+1}, C_{p+2}, ..., C_{p+m-1}$ will be effected by T_p within a one year bound. In doing so here we recall and utilize the definition of the fiscal multipliers that captures all the variations in output brought about within one year bound by unit change in government spending. As $C_p, C_{p+1}, C_{p+2}, ..., C_{p+m-1}$ are influenced by T_p so will be $GS_p, GS_{p+1}, GS_{p+2}, ..., GS_{p+m-1}$. Now, as the households' gross savings change so will be the interest income and following Equation: 7 we can say that GDP also changes. So, the total output (TO) produced during year starting at p will now correspond to the summation of previous outputs of $GDP_p, GDP_{p+1}, GDP_{p+2}, ..., GDP_{p+m-1}$ and is given by the following construct:

$$TO_p = \sum_{k=0}^{m-1} GDP_{p+k}$$

Now differentiating the above expression with respect to T_p we get the updated measurement of the fiscal multipliers:

$$\frac{\partial TO_p}{\partial T_p} = \sum_{k=0}^{m-1} \frac{\partial GDP_{p+k}}{\partial T_p} \tag{11}$$

So for all $k, 0 \leq k \leq (m-1)$ we need to calculate the values of $\frac{\partial GDP_{p+k}}{\partial T_p}$. When $k = 0$ $\frac{\partial GDP_{p+k}}{\partial T_p}$ turns out to be $\frac{\partial GDP_p}{\partial T_p}$ which can be calculated using Equation: 9 and 10. For all other values of k we rewrite Equation: 8 by substituting p with $(p+k)$.

$$GDP_{p+k} = Y_{p+k} + T_{p+k} + r_{p+k} \times \left[\sum_{i=1}^{p+k} Y_i + T_i - (1+TC)C_i \right]$$

Differentiating the above expression with respect to T_p we get:

$$\frac{\partial GDP_{p+k}}{\partial T_p} = r_{p+k} \times \left[1 - (1+TC) \times \sum_{i=1}^{p+k} \frac{\partial C_i}{\partial T_p} \right] \tag{12}$$

For different values of $i, 1 \leq i \leq (p+k)$ the values of $\frac{\partial C_i}{\partial T_p}$ can be obtained from Equation: 10. So for all $k, 0 \leq k \leq (m-1)$ the values of $\frac{\partial GDP_p+k}{\partial T_p}$ can be calculated using Equation: 12 and 9. Substituting the values of $\frac{\partial GDP_p+k}{\partial T_p}$ for all $k, 0 \leq k \leq (m-1)$ into Equation: 11 we can estimate the values of the fiscal multipliers in the modified experimental set up i.e., when money velocity undergoes an m-fold increase.

7 Methodology and Data

VAR methodology has been predominantly used in the empirical estimation of the fiscal multipliers since as early as 2001, see for example, Fatas and Mihov (2001) [14], Blanchard and Perotti (2002) [7], Mountford and Uhlig (2009) [29], Burriel et al (2010) [8], Ilzetzki et al (2013) [22] etcetera. Following Ilzetzki et al (2013), our baseline VAR model takes the following form:

$$AY_t = \sum_{k=1}^{K} C_k Y_{t-k} + Bu_t \tag{13}$$

where Y_t is the vector of endogenous variables, C_k is the coefficients of the autoregressive terms of Y_t and matrix B is a diagonal matrix so that u_t is a vector of orthogonal, independent and identically distributed shocks to the endogenous variables such that $E[u_t] = 0$ and $E[u_t u_t']$ is an identity matrix. To implement our proposed model and to compare its performance with the conventional estimation of the government spending multipliers the following steps are followed.

- At first, we must determine which variables should comprise Y in our proposed approach and in the conventional estimation. To do so we take logarithms on both side of Equation: 2:

$$ln(\Delta GDP) = ln(\Delta GC) + ln\left(\frac{1-c^v}{1-c}\right)$$

From the above equation, it can be seen that the logarithm of changes in GDP is a linear combination of logarithm of changes in government consumption and logarithm of $(1-c^v)/(1-c)$. It can be easily seen that when velocity of money increases the numerator of $(1-c^v)/(1-c)$ increases and hence the quantity $(1-c^v)/(1-c)$ increases as a whole. Moreover, when c increases then the numerator of $(1-c^v)/(1-c)$ increases and at the same time the denominator decreases and the quantity $(1-c^v)/(1-c)$ increases as a whole. In fact, $(1-c^v)/(1-c)$ is the quantity that embodies the combined effect of average propensity to consume, average propensity to import, average tax rate and velocity of money on fiscal stimulus. The above observations provide us enough justification to include the quantity $(1-c^v)/(1-c)$ along with all other conventional variables in the structural VAR setup with a view to estimate government spending multipliers more precisely than the conventional approach. So, $(1-c^v)/(1-c)$, GDP and government consumption are the three variables that should enter our model at the first place. Moreover, following Ilzetzki et al (2013) [22] we include two additional variables namely current account to GDP ratio and real effective exchange rate into our model as endogenous variables. Hence, in our proposed model Y comprises $(1-c^v)/(1-c)$, GDP, government consumption, current account to GDP ratio and real effective exchange rate while the conventional estimation requires all the above variables except $(1-c^v)/(1-c)$.

- The next step is to choose an appropriate ordering of the endogenous variables. Following Blanchard and Perotti (2002) [7], we assume changes in government consumption require at least one quarter to respond to innovations in other macroeconomic variables and hence we place government consumption before GDP. Placing government consumption before GDP implies that GDP will respond contemporaneously to any change in government spending but not the vice versa. The ordering of current account to GDP ratio and real effective exchange rate after GDP and placing current account to GDP ratio before real effective exchange rate are inspired from Kim and Roubini (2008) [27] and Ilzetzki et al (2013) [22] among others. Now, we are left with one more variable namely $(1-c^v)/(1-c)$ and we place it before GDP. This is inspired from the fact that higher value of $(1-c^v)/(1-c)$ will induce greater consumption of locally produced goods and services within a year which results into a bigger GDP but not the vice versa.
- One prerequisite before we can formally proceed with our model is to check for the order of integration of our underlying time series. At the first step, we de-trend the data using Hodrick-Prescott filter and check the order of integration of the de-trended time series using Augmented Dickey Fuller (ADF) unit root test and Phillips-Perron test. We will use these de-trended series in our analysis.
- Another prerequisite is to determine appropriate number of lags of the endogenous variables in the structural VAR model. The lag length that minimizes different information criteria including Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwartz Criteria (SC) and Hannan-Quinn information criterion (HQ) is selected. If different information criteria entail different results then we go for each of the different lag lengths suggested.
- After we are done with all the prerequisites we build a structural VAR model with appropriate number of lags of the endogenous variables. For our proposed model,

endogenous variables include government consumption, $(1-c^v)/(1-c)$, GDP, current account to GDP ratio and real effective exchange rate appearing in the same order as mentioned. For the conventional estimation, we build a VAR with government consumption, GDP, current account to GDP ratio and real effective exchange rate as endogenous variables appearing in the same order as mentioned.

- Once the model is built we provide one standard deviation Cholesky shock in government consumption and $(1-c^v)/(1-c)$ and note down both the impact and cumulative responses of GDP. Impact and cumulative response of government consumption to its own shock are noted as well. Moreover, the cumulative responses are appropriately discounted using the respective risk free rates. Then we divide the impact (appropriately discounted cumulative) response of GDP to shocks in government consumption by the impact (appropriately discounted cumulative) response of government consumption to its own shock to estimate the corresponding impact (cumulative) multipliers at different time periods. As we use the data in their natural logarithmic form the multipliers thus calculated also have the same unit and we need to convert them back to their original multiplier unit. To do so, we divide the multipliers thus calculated by the average value government consumption to GDP ratio in the sample used to estimate the results (See for example Gonzalez-Garcia et al (2013) [18]). Multipliers thus obtained are named as adjusted impact (cumulative) multipliers all through the text.

- After we are done with the estimation of government spending multiplier we resort to variance decomposition of GDP with respect to other endogenous variables. We compare how much of the variance in GDP is attributed to different endogenous variables in the system and we check it for both in the long and short run.

Once the methodology has been set we collect relevant data for SVAR estimation. US and UK data regarding total and private consumption, GDP, current account to GDP ratio, real effective exchange rate, tax revenue as percentage of GDP and import as percentage of GDP during the period 1972-2018 are collected from the World Bank data warehouse which are publicly available through the URL: `https://databank.worldbank.org/home.aspx` (World Bank (2020)). Government consumption expenditure is calculated by subtracting private consumption from total consumption. Moreover, to discount US and UK data we use 3M treasury bill rates which are available through the economic database prepared and maintained by Federal Reserve Bank of St. Louis (Fed St. Louis (2020) [15]) for US data and the web database maintained at investing.com for UK data (See, Investing (2020) [23]).

8 Results and Discussion

We begin our analysis by performing unit root test on all the time series data. We apply both Augmented Dickey Fuller (ADF) test and Phillips-Perron test to test for unit roots in the underlying time series. Although not reported here all the data series are found to be integrated of order one, i.g., $I(1)$. Then we apply Hodrick-Prescott filter on the data in order to segregate them into trend and cyclical components. We again apply unit root test on the de-trended time series data and this time all the series are found to be stationary at level. The results of the unit root tests on both the original and de-trended data are available upon request.

In the next step, we determine the appropriate lag length for the structural VAR models to be built and the results are presented in Table: 1, 2, 3 and 4. From Table: 1 and 2, it can be seen that four out of five information criteria namely LR, FPE, AIC and HQ suggest taking 6 (six) lags for US data under proposed and conventional framework while SC suggests 2 (two) lags instead. For UK data, three out of five information criteria namely LR, FPE and AIC suggest 06 (six) lags while the other two criteria SC and HQ suggest 02 (two) lags instead for both proposed and conventional framework (see Table: 3 and 4).

As different information criteria suggest different lags for VAR models to be constructed we build a model for each of the suggested lag lengths. To begin with, we build our first structural VAR model following our proposed framework having US government consumption, $(1 - c^v)/(1 - c)$, GDP, current account to GDP ratio and real effective exchange rate as endogenous variables with 02 (two) lags for each of them. Then we apply one standard deviation Cholesky shock in government consumption and $(1 - c^v)/(1 - c)$ and note down the impact and cumulative response of GDP. Response of GDP to shocks in government consumption and $(1 - c^v)/(1 - c)$ are depicted in Figs: 1 and 2 respectively. From Fig: 1, it can be seen that GDP responds positively at least for the first ten periods to any change in government consumption. Moreover, from Fig: 2, we can see that GDP also positively responds to any shocks in $(1 - c^v)/(1 - c)$ and response reaches a constant steady state level even before period 10. Fig: 3 captures the response of government consumption to its own shock and it is positive as well. These responses are then used to calculate the corresponding impact and cumulative multipliers for US data and the results are presented in Table: 5. Adjusted impact and cumulative multipliers are presented in column 11 and column 12 of Table: 5. From column 11 of Table: 5, it can be seen that the impact multipliers vary between 1.75 to 3.21 in different time periods while the cumulative multipliers vary within the range $2.60 - 3.08$. It is noticeable that all the impact and cumulative multipliers are positive which complies with the theoretical underpinning of it. To compare the performance of our model to the conventional one, this time we build a structural VAR model with government consumption, GDP, current account to GDP ratio and real effective exchange rate for US data during the period 1972-2018 and provide one standard deviation Cholesky shock in government consumption. Response of GDP to shocks in government consumption and response of government consumption to its own shock are noted and they are pictorially depicted in Figs: 4 and 5 respectively. Both the responses are positive and have almost the same shape as for our proposed model. The corresponding impact and cumulative multipliers are presented in column 11 and column 12 of Table: 6. From column 11 of Table: 6, it can be seen that the impact multipliers move between 1.00-2.67 while cumulative multipliers vary between 2.02-2.60. So, multipliers in our proposed model are found to be somewhat higher than its conventional counterpart.

Next, we build a VAR model with our proposed framework with 06 (six) lags for each of the endogenous variables. After the model is built we provide one standard deviation shock in government consumption and $(1 - c^v)/(1 - c)$ and note down the response of GDP. The impact response of GDP to shocks in government consumption and $(1 - c^v)/(1 - c)$ are graphically shown in Figs: 6 and 7 respectively. Moreover, responses of US government consumption to its own shock are presented in Fig: 8. From these figures, it can be seen that GDP responds positively to shocks in government consumption and shocks in $(1 - c^v)/(1 - c)$ as well. The corresponding multiplier values are presented in column 11 and column 12 of Table: 7. From column 11 of Table: 7, it is seen that the impact multipliers move in between 0.64 to 2.66 in different time periods while the cumulative multipliers are found within the range 1.30-2.33. Like our proposed model with 02 (two) lags, all the multipliers are found to be positive. For comparison purpose, we now build a VAR model under conventional framework with 06 (six) lags for each of the endogenous variables and note down the response of GDP to shocks in government consumption and response of government consumption to its own shock as well and the responses are pictorially depicted in Figs: 9 and 10. From Fig: 9, it can be seen that from period 6 the response of GDP to shocks in government consumption becomes negative. If we compare Fig: 9 and Fig: 6 then we can notice one striking similarity between them: Shapes of the two figure are almost same and Fig: 6 is indeed an upward shifted version of Fig: 9. So, including $(1-c^v)/(1-c)$ into the VAR representation simply shifts the response of GDP to shocks in government consumption a bit upward and allows us to obtain consistent positive multiplier values. However, without $(1-c^v)/(1-c)$ the multiplier estimates are not consistent and move between positive and negative values as can be seen from column 11 and column 12 of Table: 8.

Once we are done with the US data, we go on building VAR model with UK data during the period 1972-2018. At the first place, we build a structural VAR model under our proposed framework with government consumption, $(1-c^v)/(1-c)$, GDP, current account to GDP ratio and real effective exchange rate as endogenous variables with 2 lags. After the VAR model is constructed we provide one standard deviation shock in government consumption and $(1-c^v)/(1-c)$ and note down the response of GDP. Impact response of GDP in response to shocks in government consumption and $(1-c^v)/(1-c)$ are pictorially represented in Figs: 11 and 12 respectively. From Fig: 11, it can be seen that GDP responds positively to shocks in government consumption for at least 10 consecutive periods. On the other hand, from Fig: 12 it can be seen that response of GDP to shocks in $(1-c^v)/(1-c)$ is negative for the first 10 periods. However, trend of the response curve depicts that it will eventually become positive for some period immediately after 10. Moreover, response of government consumption to its own shock is depicted in Fig: 13. The corresponding impact and cumulative multiplier values are tabulated in column 11 and column 12 of Table: 9. From column 11 of Table: 9 it can be seen that the impact multipliers start from 0.84 at period 1 and eventually reache 1.33 at period 10. In the interim period it reaches its local maxima of 1.39 at period 8. On the other hand, the cumulative multipliers vary between 0.84 and 1.26. To compare the performance of our model with the conventional estimation we now build a structural VAR with government consumption, GDP, current account to GDP ratio and real effective exchange rate each having 02 (two) lags and perform impulse response analysis by giving one standard deviation shock in government consumption. Response of GDP to shocks in government consumption and response of government consumption to its own shock are noted down in Figs: 14 and 15 respectively. Like the US data, response of GDP is found to be shifted a bit downward due to the exclusion of the term $(1-c^v)/(1-c)$ as an endogenous variable. Hence, the multiplier values estimated in the conventional approach using the same number of lags are supposed to be lower than that of the proposed approach and it is evident from column 11 and column 12 of Table: 10. From column 11, it can be seen that the impact multipliers in conventional approach vary between 0.79 to 1.14 in different time periods while the cumulative multipliers move in between 0.79 to 1.06.

Next, we compare the performance of our model to conventional one by using 06 (six) lags for the endogenous variables in the structural VAR framework. We first consturct structural VAR under our proposed framework and note down the response of GDP to shocks in government consumption and $(1-c^v)/(1-c)$. These responses are graphically presented in Figs: 16 and 17 respectively. From Fig: 16, it can be seen that GDP responds positively to shocks in government consumption and negatively to shocks in $(1-c^v)/(1-c)$ and the patterns are comparable to the ones we have noted for model with 02 (two) lags. Moreover, the responses of government consumption to its own shock are noted in Fig: 18. Corresponding multiplier values are noted down in column 11 and column 12 of Table: 11. From column 11 and column 12 of Table: 11 it can be seen that the impact multipliers vary between 0.39 to 1.70 while the cumulative multipliers move in between 0.41 to 0.80. To compare the performance of our model to the conventional one we now build a structural VAR model using government consumption, GDP, current account to GDP ratio and real effective exchange rate as endogenous variables each having 06 (six) lags. After the model is built we provide one standard deviation Cholesky shock in government consumption and note down the responses of GDP and government consumption. Responses of GDP to shocks in government consumption and responses of government consumption to its own shock are represented in Figs: 19 and 20 respectively. Corresponding multiplier values are depicted in column 11 and column 12 of Table: 12. It is evident from Table: 12 that the impact multipliers vary between 0.34 to 1.12 while the cumulative multipliers vary from 0.48 to 0.62. So, also in this case, our estimated values of the fiscal multipliers are a bit larger than its conventional estimates.

After we are done with the impulse response analysis we now check how much of the variance in GDP can be explained in terms of different endogenous variables included into the SVAR analysis. Results of variance decomposition of US GDP under proposed framework with 02 (two) lags are presented in Table: 13. From Table: 13, it can be seen that 6.29% variance of US GDP is attributed to government consumption while 15.81%, 0.00% and 0.00% of the variance are due to $(1-c^v)/(1-c)$, current account to GDP ratio and real effective exchange rate at period 1. Hence, majority of the variance of GDP is attributed to $(1-c^v)/(1-c)$ at period 1. However, as times passes by contribution of $(1-c^v)/(1-c)$ to the variance of US GDP declines gradually and at period 10, it becomes 5.65%. Nevertheless, the contribution of $(1-c^v)/(1-c)$ to the variance of GDP is still greater than that of real effective exchange rate which is widely included into the SVAR analysis of the fiscal multipliers. Moreover, variance decomposition of US GDP when we discard $(1-c^v)/(1-c)$ from the SVAR model are presented in Table: 14. From Table: 14, we can see that the contribution of current account to GDP ratio and real effective exchange rate to the variance in GDP are still 0.00 (zero) at period 1. It is not hard to notice that when we eliminate $(1-c^v)/(1-c)$ from our model, its contribution (15.81%) to the variance in GDP is simply added back to GDP itself and at period 1, 94.93% of the variance in US GDP is attributed to GDP itself. Moreover, at period 10, 11.26%, 6.01% and 3.00% of the variance in GDP are attributed to government consumption, current account to GDP ratio and real effective exchange rate as can be seen from Table: 14. These contributions are substantially lower than the contributions they have made under our proposed model using the same number of lags. Hence, adding $(1-c^v)/(1-c)$ into SVAR simply enhances the ability of other variables in the system to more clearly capture the variance in US GDP than ever before.

Next, variance decompositions of US GDP under our proposed and conventional framework using 06 (six) lags are presented in Table: 15 and 16 respectively. From Table: 15, we can see that 7.68% variance of the US GDP is attributed to $(1-c^v)/(1-c)$ at period 1 which is greater than the contribution of any other variables in the model. At period 10, $(1-c^v)/(1-c)$ can explain 5.73% of the variance in GDP which is still greater than the contribution of government consumption, current account to GDP ratio and real effective exchange rate. For the conventional model when we discard $(1-c^v)/(1-c)$ as an endogenous variable we can see that the ability of government consumption and current account to GDP ratio in explaining variance in GDP are reduced substantially while the capacity of real effective exchange rate in this regard enhances a little bit (See the last row of Table: 16).

Variance decomposition of UK GDP under our proposed framework with 02 lags are presented at Table: 17. We can see from Table: 17 that at period 1, 2.59% of the variance in GDP is attributed to $(1-c^v)/(1-c)$ which is greater than the contribution of government consumption, current account to GDP ratio and real effective exchange rate. On the other hand at period 10, contribution of $(1-c^v)/(1-c)$ to the variance of UK GDP is enhanced up to 5.57% which is greater than that of current account to GDP ratio and real effective exchange rate. If we discard $(1-c^v)/(1-c)$ from our SVAR model then we can see that the contributions of government consumption, current account to GDP ratio and real effective exchange rate in explaining variance in GDP have been greatly reduced (as can be seen from Table: 18).

Next, the variance decomposition of UK GDP under our proposed framework with 06 (six) lags for the endogenous variables are presented in Table: 19. As we can see from Table: 19, 3.73% of the variance in UK GDP is due to $(1-c^v)/(1-c)$ at period 1 which is greater than the contribution of any other endogenous variable in the system. For period 10, 21.28% of the variance in GDP can be explained in terms of $(1-c^v)/(1-c)$ which is substantially greater than the contributions of government consumption, current account to GDP ratio and real effective exchange rate. On the other hand, when we discard $(1-c^v)/(1-c)$ as an endogenous variable strengths of the remaining variables in explaining variations in GDP have been greatly reduced (as can be seen from Table: 20).

9 Policy Implication and Limitation of the Current Study

Right now, the need of a reliable estimate of the fiscal multiplier is more acute than ever before. As the COVID-19 pandemic is ravaging the global economic landscape, mass lay off and winding up become common sights at the work places across the globe [37]. While the impact of the pandemic will vary from country to country it is hurting societies and economies at their very core and is likely to increase poverty and inequalities at a daunting scale [38]. To combat this unprecedented situation of unemployment and slow (or even negative) economic growth governments around the globe have come out of their austerity with generous stimulus packages aiming to reinstate the economy at its original level. For example, in March, 2020 US government has enacted the largest economic stimulus package in history worthing $2.00 trillion in corona virus aid followed by other subsequent generous stimulus bringing the US budget deficit to record level [5]. Meanwhile, the UK government has declared $37 billion stimulus package intended to boost up the local job market now trembling at the rages of the pandemic [16]. As the government spending soars on the backdrop of COVID-19 it is important to know how well such stimulus works in reviving the economy. One tool that comes in handy in this regard is the fiscal multipliers estimated through structural VAR analysis. In fact, the theories of the fiscal multipliers have been used many times in the history to gauge the efficacy of different government sponsored stimulus packages including the famous American Recovery and Reinvestment Act of 2009 after the great recession of 2007-2009 [12]. So, to know how well the stimulus works, government expenditure, GDP and other macro-economic data can be arranged in a structural VAR set up according to our proposed methodology which, we hope, will entail a relatively more reliable estimate of the fiscal multipliers that may help the governments across the globe to take a well-informed decision regarding public spending. Apart from modeling the economy as a whole, sectoral data can be put into use to judge the potency of the government sponsored stimulus program in a particular segment of the economy in terms of output and employment in the post-pandemic economic landscape.

One of the main reservations of the current study is that we only estimate the fiscal multipliers in the modified experimental set up for US and UK data only. There is a whole array of other countries for which the empirical estimation and conclusion thereon are not tested. The study can be effectively extended by including more countries in the analysis. Moreover, the dependency of the fiscal multipliers on exchange rate regime, extent of public debt, persistent financial crisis etcetera is yet to be tested which is beyond the scope of the current study.

10 Conclusion

Conventional SVAR based estimate of fiscal multiplier does not account for at least 04 (four) macroeconomic variables (if not more) namely average propensity to consume, average propensity to import, average tax rate and the velocity of money which we argue can significantly influence the estimation of the multipliers. Here, we incorporate the aforementioned variables into an SVAR set up in a logically comprehensible way and perform impulse response analysis on the modified set up. Multipliers thus obtained are then compared to their conventional peers in order to identify whether there exists a significant difference between the two. From our empirical analysis we can conclude that our estimates of the government spending multipliers are a bit higher than the one estimated under conventional SVAR framework. Moreover, in some cases, when the multipliers tend to move abruptly between positive and negative values (thus giving no clear indication regarding the implementation of stimulus packages) under conventional framework, our approach just smoothes out the divergence and provide rather consistent positive estimates for the fiscal multipliers. Last but not the least, our empirical analysis also suggests that taking $(1-c^v)/(1-c)$ as endogenous variable into the structural VAR model substantially adds to the capacity of other variables in the system to explain variance in real output.

11 Figures

713

Fig 1. Impact response of US GDP to shocks in government consumption under proposed framework using lag 2

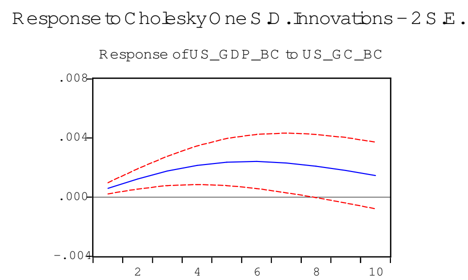


Fig 2. Impact response of US GDP to shocks in $(1 - c^v)/(1 - c)$ under proposed framework using lag 2

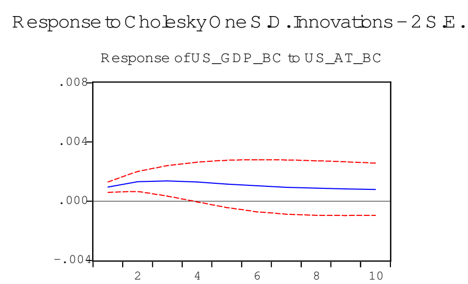


Fig 3. Impact response of US government consumption to its own shock under proposed framework using lag 2

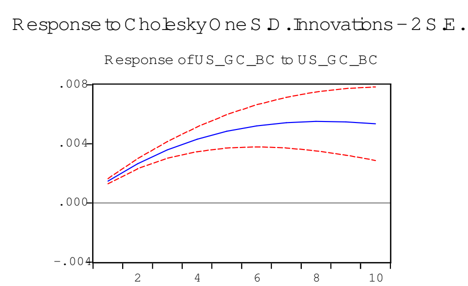


Fig 4. Impact response of US GDP to shocks in government consumption under conventional framework using lag 2

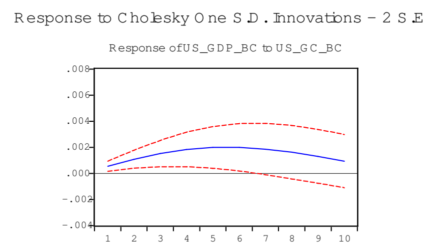


Fig 5. Impact response of US government consumption to its own shock under conventional framework using lag 2

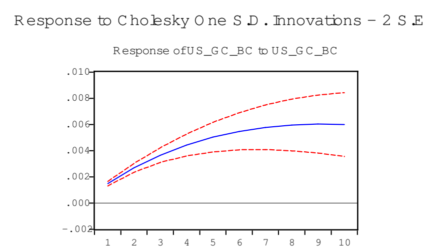


Fig 6. Impact response of US GDP to shocks in government consumption under proposed framework using lag 6

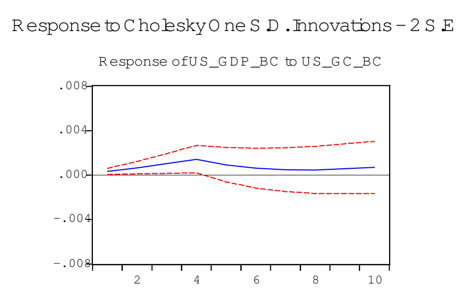


Fig 7. Impact response of US GDP to shocks in $(1-c^v)/(1-c)$ under proposed framework using lag 6

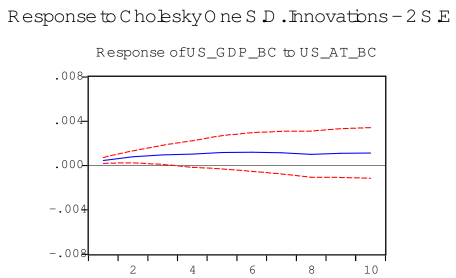


Fig 10. Impact response of US government consumption to its own shock under conventional framework using lag 6

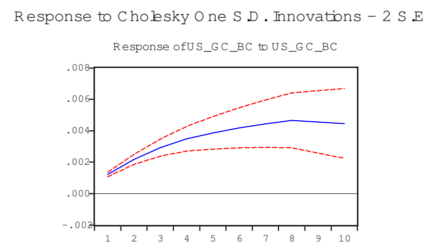


Fig 8. Impact response of US government consumption to its own shock under proposed framework using lag 6

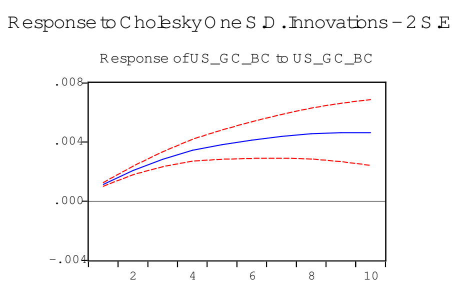


Fig 11. Impact response of UK GDP to shocks in government consumption under proposed framework using lag 2

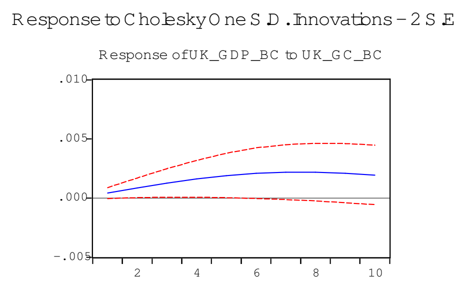


Fig 9. Impact response of US GDP to shocks in government consumption under conventional framework using lag 6

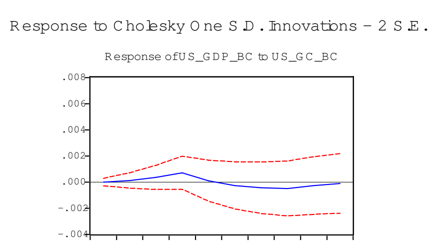


Fig 12. Impact response of UK GDP to shocks in $(1-c^v)/(1-c)$ under proposed framework using lag 2

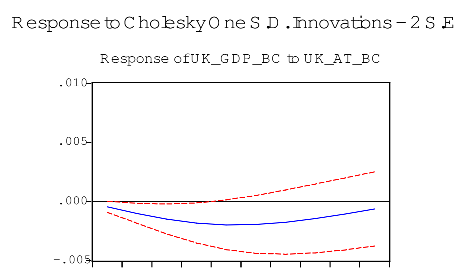


Fig 13. Impact response of UK government consumption to its own shock under proposed framework using lag 2

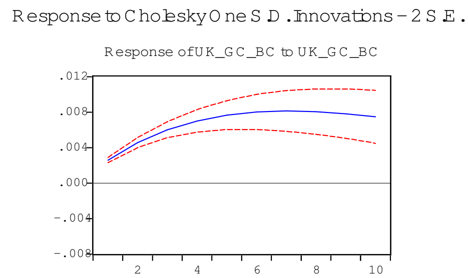


Fig 14. Impact response of UK GDP to shocks in government consumption under conventional framework using lag 2

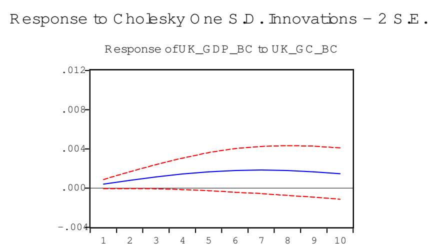


Fig 15. Impact response of UK government consumption to its own shock under conventional framework using lag 2

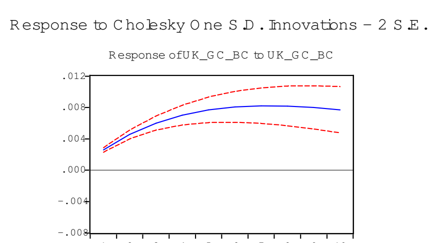


Fig 16. Impact response of UK GDP to shocks in government consumption under proposed framework using lag 6

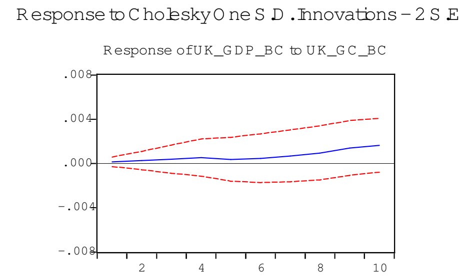


Fig 17. Impact response of UK GDP to shocks in $(1 - c^v)/(1 - c)$ under proposed framework using lag 6

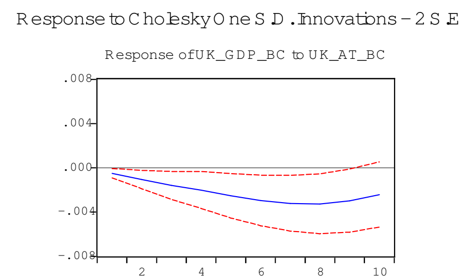


Fig 18. Impact response of UK government consumption to its own shock under proposed framework using lag 6

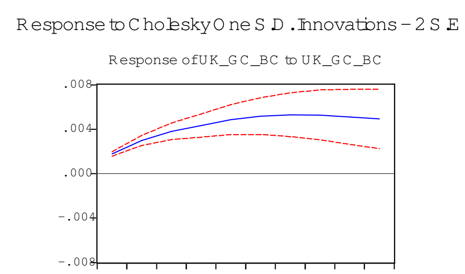


Fig 19. Impact response of UK GDP to shocks in government consumption under conventional framework using lag 6

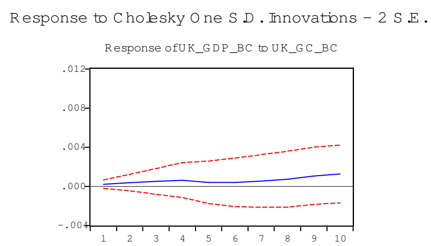
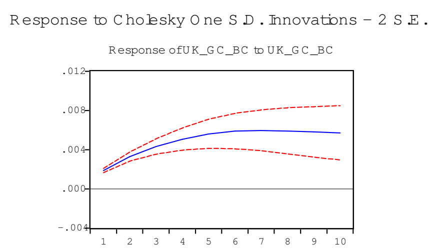


Fig 20. Impact response of UK government consumption to its own shock under conventional framework using lag 6



12 Tables

Table 1. VAR model selection for US data under proposed framework

Lag	LogL	LR	FPE	AIC	SC	HQ
0	517.4387	NA	5.86E-10	-7.06812	-6.965474	-7.026412
1	1887.331	2626.414	5.15E-18	-25.61836	-25.00248	-25.3681
2	2199.585	577.132	9.81E-20	-29.58048	-28.45138*	-29.12169
3	2205.142	9.887109	1.29E-19	-29.3123	-27.66996	-28.64496
4	2215.747	18.13885	1.58E-19	-29.11375	-26.95819	-28.23787
5	2260.251	73.04756	1.22E-19	-29.38277	-26.71397	-28.29835
6	2410.997	237.0357*	2.18e-20*	-31.11720*	-27.93518	-29.82424*
7	2416.508	8.284703	2.91E-20	-30.84838	-27.15313	-29.34687
8	2424.542	11.52439	3.77E-20	-30.61437	-26.40588	-28.90432

Table 2. VAR model selection for US data under conventional framework

Lag	LogL	LR	FPE	AIC	SC	HQ
0	136.4564	NA	1.89E-06	-1.826985	-1.744868	-1.793618
1	1190.57	2035.529	1.14E-12	-16.14579	-15.7352	-15.97895
2	1469.187	522.6481	3.06E-14	-19.7681	-19.02905*	-19.4678
3	1473.227	7.355521	3.61E-14	-19.60313	-18.53562	-19.16936
4	1480.178	12.27149	4.10E-14	-19.47831	-18.08233	-18.91108
5	1502.101	37.49663	3.79E-14	-19.56002	-17.83556	-18.85931
6	1582.074	132.3685*	1.58e-14*	-20.44240*	-18.38948	-19.60823*
7	1585.441	5.387573	1.89E-14	-20.26815	-17.88677	-19.30052
8	1590.451	7.739577	2.23E-14	-20.11657	-17.40671	-19.01546

Table 3. VAR model selection for UK data under proposed framework

Lag	LogL	LR	FPE	AIC	SC	HQ
0	285.7733	NA	1.59E-08	-3.768769	-3.667965	-3.727814
1	1509.877	2349.621	1.62E-15	-19.86412	-19.2593	-19.61839
2	1872.937	672.5142	1.74E-17	-24.40184	-23.29300*	-23.95134*
3	1878.808	10.48075	2.26E-17	-24.14507	-22.53221	-23.48979
4	1889.581	18.50977	2.75E-17	-23.95411	-21.83723	-23.09406
5	1917.64	46.32499	2.66E-17	-23.99516	-21.37427	-22.93034
6	1982.553	102.8151*	1.58e-17*	-24.53091*	-21.406	-23.26131
7	1988.564	9.117736	2.07E-17	-24.27602	-20.6471	-22.80165
8	1999.176	15.38459	2.57E-17	-24.0829	-19.94996	-22.40376

Table 4. VAR model selection for UK data under conventional framework

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.221241	NA	1.28E-05	0.083507	0.164149	0.11627
1	984.815	1907.828	2.79E-11	-12.95054	-12.54732	-12.78672
2	1292.924	578.9963	5.54E-13	-16.87146	-16.14567*	-16.57658*
3	1295.607	4.899128	6.63E-13	-16.69272	-15.64436	-16.26679
4	1300.211	8.155961	7.74E-13	-16.53974	-15.16881	-15.98275
5	1312.077	20.38735	8.21E-13	-16.48425	-14.79075	-15.79621
6	1359.282	78.56940*	5.43e-13*	-16.90311*	-14.88704	-16.08401
7	1361.743	3.963907	6.56E-13	-16.72138	-14.38273	-15.77123
8	1366.128	6.827775	7.74E-13	-16.56547	-13.90426	-15.48427

Table 5. Impulse response analysis for US data under proposed framework for SVAR with lag 2

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.000596	0.001475	0.40	0.000596	0.001475	0.000596	0.001475	0.40		2.60	2.60
2	0.001222	0.002654	0.46	0.001818	0.004129	0.001790	0.004065977	0.44		2.96	2.83
3	0.001762	0.003587	0.49	0.003580	0.007716	0.003472	0.007482253	0.46		3.16	2.98
4	0.002151	0.004308	0.50	0.005731	0.012024	0.005473	0.011481779	0.48		3.21	3.06
5	0.002364	0.004842	0.49	0.008095	0.016866	0.007612	0.015859606	0.48	15.55940053	3.14	3.08
6	0.002408	0.00521	0.46	0.010503	0.022076	0.009726	0.020441876	0.48		2.97	3.06
7	0.002306	0.005429	0.42	0.012809	0.027505	0.011680	0.025080263	0.47		2.73	2.99
8	0.002091	0.005515	0.38	0.014900	0.033020	0.013379	0.029649514	0.45		2.44	2.90
9	0.001798	0.005485	0.33	0.016698	0.038505	0.014765	0.03404691	0.43		2.11	2.79
10	0.001458	0.005353	0.27	0.018156	0.043858	0.015809	0.038188225	0.41		1.75	2.66

Table 6. Impulse response analysis for US data under conventional framework for SVAR with lag 2

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.000542	0.001475	0.37	0.000542	0.001475	0.000542	0.001475	0.37		2.36	2.36
2	0.001072	0.002678	0.40	0.001614	0.004153	0.001589	0.004089611	0.39		2.57	2.50
3	0.001516	0.003651	0.42	0.003130	0.007804	0.003035	0.007567587	0.40		2.67	2.58
4	0.001825	0.004424	0.41	0.004955	0.012228	0.004732	0.01167658	0.41		2.65	2.60
5	0.001981	0.005023	0.39	0.006936	0.017251	0.006522	0.016221633	0.40	15.55940053	2.53	2.58
6	0.001985	0.005467	0.36	0.008921	0.022718	0.008261	0.021036353	0.39		2.33	2.52
7	0.001853	0.005773	0.32	0.010774	0.028491	0.009824	0.025979341	0.38		2.06	2.43
8	0.001613	0.005954	0.27	0.012387	0.034445	0.011123	0.030929058	0.36		1.74	2.31
9	0.001295	0.006021	0.22	0.013682	0.040466	0.012098	0.035780867	0.34		1.38	2.17
10	0.00093	0.005986	0.16	0.014612	0.046452	0.012723	0.040446884	0.31		1.00	2.02

Table 7. Impulse response analysis for US data under proposed framework for SVAR with lag 6

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	3.28E-04	0.001131	0.29	0.000328	0.001131	0.000328	0.001131	0.29		1.86	1.86
2	0.000661	0.00207	0.32	0.000989	0.003201	0.000974	0.003152142	0.31		2.05	1.99
3	0.001025	0.002837	0.36	0.002014	0.006038	0.001953	0.005855086	0.33		2.32	2.14
4	0.00143	0.003451	0.41	0.003444	0.009489	0.003289	0.009061095	0.36		2.66	2.33
5	9.25E-04	0.003824	0.24	0.004369	0.013313	0.004108	0.012518613	0.33	15.55940053	1.55	2.11
6	0.00062	0.004133	0.15	0.004989	0.017446	0.004620	0.016154601	0.29		0.96	1.84
7	0.000478	0.00438	0.11	0.005467	0.021826	0.004985	0.019901902	0.25		0.70	1.61
8	0.000458	0.004569	0.10	0.005925	0.026395	0.005320	0.023700755	0.22		0.64	1.44
9	0.000582	0.004637	0.13	0.006507	0.031032	0.005754	0.02743913	0.21		0.81	1.35
10	0.000697	0.004642	0.15	0.007204	0.035674	0.006273	0.031062218	0.20		0.97	1.30

Table 8. Impulse response analysis for US data under conventional framework for SVAR with lag 6

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	-7.78E-06	0.001219	-0.01	-0.000008	0.001219	-0.000008	0.001219	-0.01		-0.04	-0.04
2	0.00011	0.00218	0.05	0.000102	0.003399	0.000101	0.00334712	0.03		0.32	0.19
3	0.000352	0.002922	0.12	0.000454	0.006321	0.000440	0.006129512	0.07		0.77	0.46
4	0.000702	0.003483	0.20	0.001156	0.009804	0.001104	0.00936189	0.12		1.30	0.76
5	9.35E-05	0.003857	0.02	0.001250	0.013661	0.001175	0.012845848	0.09	15.55940053	0.16	0.59
6	-0.000271	0.004179	-0.06	0.000979	0.017840	0.000906	0.016519436	0.05		-0.42	0.35
7	-0.000448	0.004445	-0.10	0.000531	0.022285	0.000484	0.020320438	0.02		-0.65	0.15
8	-0.000495	0.004652	-0.11	0.000036	0.026937	0.000032	0.02418743	0.00		-0.68	0.01
9	-0.000279	0.004555	-0.06	-0.000243	0.031492	-0.000215	0.027845872	-0.01		-0.39	-0.05
10	-0.000121	0.00446	-0.03	-0.000364	0.035952	-0.000317	0.031304279	-0.01		-0.17	-0.07

Table 9. Impulse response analysis for UK data under proposed framework for SVAR with lag 2

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.000423	0.002585	0.16	0.000423	0.002585	0.000423	0.002585	0.16		0.84	0.84
2	0.000854	0.004554	0.19	0.001277	0.007139	0.001267	0.007084379	0.18		0.96	0.92
3	0.001261	0.005999	0.21	0.002538	0.013138	0.002499	0.012937731	0.19		1.08	0.99
4	0.001617	0.007006	0.23	0.004155	0.020144	0.004060	0.019685163	0.21		1.18	1.06
5	0.001898	0.007653	0.25	0.006053	0.027797	0.005870	0.026956013	0.22	19.53643338	1.27	1.11
6	0.002089	0.008007	0.26	0.008142	0.035804	0.007835	0.034455115	0.23		1.34	1.16
7	0.002184	0.008123	0.27	0.010326	0.043927	0.009861	0.041948664	0.24		1.38	1.20
8	0.002185	0.008047	0.27	0.012511	0.051974	0.011856	0.049253508	0.24		1.39	1.23
9	0.002099	0.007816	0.27	0.014610	0.059790	0.013739	0.056226883	0.24		1.37	1.25
10	0.001941	0.00746	0.26	0.016551	0.067250	0.015446	0.062758445	0.25		1.33	1.26

Table 10. Impulse response analysis for UK data under conventional framework for SVAR with lag 2

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.0004	0.002584	0.15	0.000400	0.002584	0.000400	0.002584	0.15		0.79	0.79
2	0.000787	0.004553	0.17	0.001187	0.007137	0.001178	0.007082395	0.17		0.88	0.85
3	0.001139	0.006003	0.19	0.002326	0.013140	0.002291	0.012939701	0.18		0.97	0.91
4	0.001433	0.007022	0.20	0.003759	0.020162	0.003673	0.019702753	0.19		1.04	0.95
5	0.001652	0.007688	0.21	0.005411	0.027850	0.005247	0.027007409	0.19	19.53643338	1.10	0.99
6	0.001783	0.008068	0.22	0.007194	0.035918	0.006923	0.03456482	0.20		1.13	1.03
7	0.001824	0.008218	0.22	0.009018	0.044136	0.008612	0.042148251	0.20		1.14	1.05
8	0.001778	0.008182	0.22	0.010796	0.052318	0.010231	0.049579501	0.21		1.11	1.06
9	0.001653	0.007994	0.21	0.012449	0.060312	0.011707	0.056717775	0.21		1.06	1.06
10	0.001464	0.007684	0.19	0.013913	0.067996	0.012984	0.06345462	0.20		0.98	1.05

Table 11. Impulse response analysis for UK data under proposed framework for SVAR with lag 6

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.000143	0.001771	0.08	0.000143	0.001771	0.000143	0.001771	0.08		0.41	0.41
2	0.000255	0.002981	0.09	0.000398	0.004752	0.000395	0.004715642	0.08		0.44	0.43
3	0.000381	0.003793	0.10	0.000779	0.008545	0.000767	0.008414744	0.09		0.51	0.47
4	0.000537	0.004324	0.12	0.001316	0.012869	0.001286	0.012575872	0.10		0.64	0.52
5	0.000368	0.004866	0.08	0.001684	0.017735	0.001633	0.017198435	0.09	19.53643338	0.39	0.49
6	0.000461	0.005168	0.09	0.002145	0.022903	0.002064	0.022040149	0.09		0.46	0.48
7	0.000685	0.00529	0.13	0.002830	0.028193	0.002703	0.026923275	0.10		0.66	0.51
8	0.000947	0.005278	0.18	0.003777	0.033471	0.003579	0.031719016	0.11		0.92	0.58
9	0.001387	0.005103	0.27	0.005164	0.038574	0.004856	0.036275226	0.13		1.39	0.69
10	0.001636	0.004925	0.33	0.006800	0.043499	0.006346	0.040593749	0.16		1.70	0.80

Table 12. Impulse response analysis for UK data under conventional framework for SVAR with lag 6

Period	Impact responsse of GDP	Impact response of government consumption	Impact Multiplier	Cumulative responsse of GDP	Cumulative response of government consumption	Discounted cumulative response of GDP	Discounted Cumulative response of government consumption	Cumulative multiplier	Government consumption to GDP ratio	Adjusted impact multiplier	Adjusted cumulative multiplier
1	2	3	4	5	6	7	8	9	10	11	12
1	0.000212	0.001875	0.11	0.000212	0.001875	0.000212	0.001875	0.11		0.58	0.58
2	0.000367	0.003281	0.11	0.000579	0.005156	0.000575	0.005116551	0.11		0.57	0.57
3	0.000495	0.004316	0.11	0.001074	0.009472	0.001058	0.009327614	0.11		0.59	0.58
4	0.000615	0.005056	0.12	0.001689	0.014528	0.001651	0.014197083	0.12		0.62	0.60
5	0.000391	0.005604	0.07	0.002080	0.020132	0.002017	0.019522914	0.10	19.53643338	0.36	0.53
6	0.000393	0.005878	0.07	0.002473	0.026010	0.002380	0.025030096	0.10		0.34	0.49
7	0.000526	0.005956	0.09	0.002999	0.031966	0.002864	0.03052635	0.09		0.45	0.48
8	0.000716	0.005902	0.12	0.003715	0.037868	0.003521	0.035885863	0.10		0.62	0.50
9	0.001061	0.005796	0.18	0.004776	0.043664	0.004491	0.041061893	0.11		0.94	0.56
10	0.001252	0.005711	0.22	0.006028	0.049375	0.005625	0.046077297	0.12		1.12	0.62

Table 13. Variance decomposition of US GDP for the proposed SVAR with lag 2

Period	S.E.	Government Consumption	(1-c^v)/(1-c)	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.002375	6.29	15.81	77.90	0.00	0.00
2	0.004685	8.42	11.97	79.25	0.06	0.30
3	0.006904	10.39	9.48	78.97	0.28	0.88
4	0.008869	12.18	7.86	77.69	0.76	1.52
5	0.010505	13.74	6.82	75.79	1.54	2.11
6	0.011801	15.06	6.17	73.53	2.64	2.60
7	0.01278	16.09	5.81	71.12	4.00	2.98
8	0.013488	16.85	5.63	68.71	5.55	3.26
9	0.013981	17.34	5.60	66.44	7.15	3.48
10	0.014312	17.58	5.65	64.43	8.68	3.66

Table 14. Variance decomposition of US GDP for the conventional SVAR with lag 2

Period	S.E.	Government Consumption	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.002406	5.07	94.93	0.00	0.00
2	0.004761	6.37	93.43	0.01	0.19
3	0.007025	7.58	91.78	0.06	0.58
4	0.009027	8.68	90.02	0.24	1.06
5	0.010691	9.62	88.23	0.61	1.54
6	0.012	10.37	86.42	1.22	1.98
7	0.01298	10.91	84.64	2.12	2.34
8	0.013676	11.21	82.90	3.26	2.62
9	0.014148	11.32	81.25	4.59	2.84
10	0.014455	11.26	79.73	6.01	3.00

Table 15. Variance decomposition of US GDP for the proposed SVAR with lag 6

Period	S.E.	Government Consumption	(1-c^v)/(1-c)	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.00167	3.87	7.68	88.46	0.00	0.00
2	0.003502	4.44	6.74	88.74	0.03	0.05
3	0.005504	5.26	5.82	88.58	0.12	0.22
4	0.007579	6.34	4.95	87.89	0.32	0.51
5	0.009175	5.34	5.05	88.59	0.30	0.72
6	0.010476	4.45	5.21	89.03	0.31	1.00
7	0.011541	3.83	5.28	89.09	0.40	1.39
8	0.012406	3.46	5.25	88.78	0.61	1.91
9	0.013068	3.31	5.46	87.24	1.74	2.26
10	0.013607	3.32	5.73	84.76	3.69	2.51

Table 16. Variance decomposition of US GDP for the conventional SVAR with lag 6

Period	S.E.	Government Consumption	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.001777	0.00	100.00	0.00	0.00
2	0.003638	0.09	99.79	0.01	0.11
3	0.005596	0.43	99.14	0.05	0.38
4	0.007552	1.10	97.97	0.13	0.80
5	0.009188	0.76	97.95	0.12	1.17
6	0.010552	0.64	97.54	0.14	1.69
7	0.011654	0.67	96.74	0.21	2.38
8	0.012511	0.74	95.69	0.36	3.21
9	0.013207	0.71	94.31	1.30	3.68
10	0.01378	0.66	92.40	3.02	3.93

Table 17. Variance decomposition of UK GDP for the proposed SVAR with lag 2

Period	S.E.	Government Consumption	(1-c^v)/(1-c)	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.00289	2.15	2.59	95.27	0.00	0.00
2	0.005787	2.71	3.72	93.33	0.02	0.23
3	0.008656	3.33	4.66	91.26	0.07	0.67
4	0.011291	4.01	5.37	89.24	0.20	1.18
5	0.013581	4.73	5.84	87.38	0.40	1.65
6	0.015483	5.46	6.07	85.74	0.69	2.04
7	0.016996	6.18	6.11	84.34	1.04	2.33
8	0.018146	6.87	6.00	83.17	1.44	2.52
9	0.018978	7.51	5.80	82.21	1.85	2.63
10	0.019547	8.06	5.57	81.43	2.25	2.68

Table 18. Variance decomposition of UK GDP for the conventional SVAR with lag 2

Period	S.E.	Government consumption	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.002907	1.89	98.11	0.00	0.00
2	0.005869	2.26	97.58	0.01	0.14
3	0.008843	2.66	96.85	0.05	0.44
4	0.011605	3.07	96.01	0.11	0.81
5	0.014028	3.49	95.14	0.18	1.20
6	0.016052	3.90	94.29	0.26	1.55
7	0.017662	4.29	93.52	0.35	1.84
8	0.018877	4.64	92.87	0.45	2.05
9	0.019743	4.94	92.34	0.55	2.17
10	0.020318	5.18	91.96	0.64	2.22

Table 19. Variance decomposition of UK GDP for the proposed SVAR with lag 6

Period	S.E.	Government Consumption	(1-cˆv)/(1-c)	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.002606	0.30	3.73	95.97	0.00	0.00
2	0.005139	0.32	5.26	94.41	0.00	0.00
3	0.007607	0.40	6.76	92.83	0.01	0.00
4	0.009857	0.53	8.19	91.26	0.01	0.00
5	0.011564	0.49	10.77	88.10	0.14	0.50
6	0.013022	0.51	13.66	83.60	0.53	1.70
7	0.014293	0.65	16.39	78.57	1.09	3.29
8	0.015371	0.95	18.68	73.71	1.72	4.94
9	0.016137	1.60	20.34	70.38	1.89	5.79
10	0.016633	2.47	21.28	68.15	1.91	6.19

Table 20. Variance decomposition of UK GDP for the conventional SVAR with lag 6

Period	S.E.	Government consumption	GDP	Current Account to GDP	Real Effective Exchange Rate
1	0.002649	0.64	99.36	0.00	0.00
2	0.00536	0.63	99.36	0.00	0.01
3	0.008124	0.64	99.33	0.00	0.02
4	0.010763	0.69	99.27	0.00	0.04
5	0.012829	0.58	99.06	0.10	0.26
6	0.014552	0.52	98.26	0.31	0.90
7	0.015987	0.54	97.13	0.56	1.77
8	0.017143	0.65	95.87	0.78	2.70
9	0.017984	0.94	95.17	0.75	3.14
10	0.018572	1.33	94.61	0.71	3.35

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