Measuring the Output Effects of Fiscal Policy in Egypt: A Disaggregated Structural VAR Analysis.

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This research aims to quantify the effects of fiscal policy on output in Egypt by applying a Structural Vector Autoregressive analysis on quarterly time-series from 2007/8 Q1 to 2019/20 Q4. The research investigates the channels of transmission of fiscal policy by disaggregating the SVAR to analyse the effects of changes in taxation and government spending on economic growth. Results consistently show positive effects on output resulting from government spending shocks, and negative effects resulting from taxation shocks. Public investments and consumption are seen to crowd in private investments with a lag while public consumption crowds out private consumption. Taxation is seen to crowd out private investments and consumption. Overall, the results are in line with the neoclassical theory.

1. Introduction:

The macroeconomic effects of fiscal policy are of ongoing interest to academics and policymakers. A renewed interest has been developed after the post-recessionary fiscal packages undertaken by governments in 2008; not to mention the current large fiscal stimulus packages which are used as instruments to counteract the negative socio-economic spill-overs caused by the coronavirus pandemic. Divergent underpinnings on the transmission mechanisms of fiscal policy to macroeconomic variables lie between the Neo-Keynesian and the Neoclassical theories. The difference lies in the channels of transmission, and the sign and magnitude of the effects on disaggregated output variables such as the response of private consumption and investments to changes in taxation and spending. (Heppke-Falke & others, 2010; Delakorda & others, 2011).

On the one hand, the Neo-Keynesian theory predicts that increased government consumption should increase private consumption in the short run. This emphasises the effects through the aggregate demand channel. Consumers are assumed to have consumption that is equal to their labour income. A rise in government spending which is financed by increased taxes would increase labour demand by firms, thus increasing real wages, which would encourage more private spending and in turn raise private consumption in the short run. The Neo-Keynesian theory is not clear on the effects of fiscal variables on private investments, as it depends on the relative strengths of the effects of fiscal as opposed to other variables such as interest rates in monetary policy. (Linnemann & Schabert, 2000; Blanchard & Perotti, 2002; Gali & others, 2007; Heppke-Falke & others, 2010).

On the other hand, Neoclassical theory emphasises the aggregate supply channel and postulates that a positive government spending shock which is financed by increases in taxation, would trigger negative wealth effects on rational economic agents, as they would anticipate future tax increases[1]. By anticipating the future increases in taxes, economic agents limit current consumption and increase labour supply (which in turn decreases wages); this, in turn, would boost aggregate output through the marginal production channel and boost private capital formation in the short run. (Baxter & King, 1993; Linneman & Schabert, 2000; Monacelli & Perotti, 2008; Gali & others, 2007)

From an empirical viewpoint, there are a variety of methodologies to investigate the abovementioned effects. The literature on identifying Structural Vector Autoregressive models in fiscal policy[2,3], in specific - the literature which disaggregates the effects of fiscal on macro variables - rely on the Blanchard & Perotti (2002) approach. (Caldara & Kamps, 2017; Hollmayr & Kuckuck, 2018)

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[1] This follows the Ricardian equivalence theory which models forward-looking consumers who anticipate future tax increases resulting from increased current public expenditures, and which translates to reduced current private consumption.

[2] Since the work of Sims (1980), the use of VARs has become standard in macro econometric modelling. In specific, the use of structural VARs following the seminal work of Blanchard & Perotti (2002) using institutional information as exogenous elasticities in identification has become standard in fiscal policy research. See Caldara & Kamps (2017) on SVAR identification in fiscal policy.

[3] See Kilian & Lutkepohl (2017) on SVAR identification.

2. Methodology:

This research aims to contribute to the empirical literature on fiscal multipliers in Egypt[4]. More specifically, we aim to empirically characterise the dynamic effects of disaggregated revenue and expenditure items on gross domestic product components.

2.1 VAR Specification:

The benchmark specification is a five-dimensional VAR in natural logs of quarterly real output (y_t), quarterly GDP deflator (i_t) and interbank interest rates[5] (r_t), and of real government expenditures (x_t) and real taxes (t_t)[6]. The reduced form VAR is defined by the following dynamic equation:

$$X_t = C(L)X_{t-1} + U_t, \qquad t = 1, \dots, T,$$

where $X_t \equiv [y_t\ i_t\ r_t\ x_t\ t_t]'$ is an N × 1 vector of the endogenous variables, $C(L)$ is an N×N matrix of the autoregressive lagged polynomials, and $U_t \equiv [u_t^y\ u_t^i\ u_t^r\ u_t^x\ u_t^t]'$ is an N×1 vector of the reduced-form innovations, which are assumed to be independent and identically distributed with a variance-covariance matrix. We use quarterly data ranging from 2007/8:1 – 2019/20:4[7].

2.2 SVAR Identification:

The identification is based on the strategy of Blanchard & Perotti, 2002 and proceeds in four steps following Perotti (2005), de Castro & de Cos (2006), and Giordano, Perotti & others 2008. The first step is to estimate the reduced form VAR and extract the vector of reduced-form residuals U_t. The innovations in the fiscal variables, u_t^x and u_t^t are thought of as linear combinations of 1) the automatic response of fiscal variables to changes in real GDP, prices, and interest rates; 2) the discretionary fiscal policy responses in response to changes in real GDP, prices and interest rates; and 3) the remainder shocks to the fiscal variables, which are the exogenous "structural" shocks to be identified (Giordano, Perotti & others, 2008; Heppke-Falke & others, 2010). More explicitly, the last two specifications for the innovations in the vector U_t (u_t^x and u_t^t) are modelled as follows:

$$u_t^x = \alpha_y^x u_t^y + \alpha_i^x u_t^i + \alpha_r^x u_t^r + \beta_t^x e_t^t + e_t^x$$

$$u_t^t = \alpha_y^t u_t^y + \alpha_i^t u_t^i + \alpha_r^t u_t^r + \beta_x^t e_t^x + e_t^t$$

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[4] See Al-Nashar, 2017 among others.

[5] The variables i_t and r_t control for developments in the real and monetary sectors, respectively.

[6] Real values are computed at constant prices in fiscal year 2016/2017 to control for the devaluation of the EGP.

[7] We use official statistics which are gathered from the Ministry of Finance, the Central Bank of Egypt (3-month interest rate), and the Ministry of Planning and Economic Development (Real GDP). Real values and GDP deflators for the quarterly time series were computed where necessary. The log-transformed data were also detrended using the classical additive moving average decomposition.

Where e_t^t and e_t^x are the exogenous structural shocks which are to be estimated, and the alphas (α) and betas (β) represent the contemporaneous relationships matrix, and the reaction to structural shocks matrix, respectively. OLS estimates from the above equations would not be feasible as the reduced form innovations are correlated with the structural shocks. To identify the above system of equations with $N(N+1)/2$ unknown parameters, we would have to impose restrictions on at least $N(N-1)/2$ parameters. In the baseline case of a 5-dimensional VAR above we would have to impose at least 10 restrictions on the above model (on both the A & B matrices).

We start by plugging exogenous elasticities[8] in the matrix of contemporaneous relationships to estimate the cyclically adjusted reduced-form innovations for u_t^x and u_t^t. Through utilising the A-B model[9], the cyclically adjusted reduced form fiscal policy shocks are recast as follows:

$$u_t^{x,CA} = u_t^x - \alpha_y^x u_t^y - \alpha_i^x u_t^i - \alpha_r^x u_t^r = \beta_t^x e_t^t + e_t^x$$

$$u_t^{t,CA} = u_t^t - \alpha_y^t u_t^y - \alpha_i^t u_t^i - \alpha_r^t u_t^r = \beta_x^t e_t^x + e_t^t$$

We assume that the vector $V_t \equiv [e_t^y \; e_t^i \; e_t^r \; e_t^x \; e_t^t]'$ of structural shocks are orthogonal (uncorrelated to each other), and we furthermore impose restrictions on $\beta_t^x = 0$ which allows for an immediate response of revenue shocks to spending shocks which is realistic in practice. We are then able to estimate β_x^t by OLS, and therefore estimate the structural shocks to the fiscal variables e_t^x and e_t^t as follows:

$$u_t^{x,CA} = e_t^x$$

$$u_t^{t,CA} = \beta_x^t e_t^x + e_t^t$$

The final step estimates the remaining unknown parameters in the SVAR through instrumental variables where e_t^x and e_t^t are used as instruments to estimate the remaining equations in the system (i.e., u_t^y, u_t^i and u_t^r):

$$u_t^y = \alpha_x^y u_t^x + \alpha_t^y u_t^t + e_t^y$$

$$u_t^i = \alpha_x^i u_t^x + \alpha_t^y u_t^t + \alpha_y^i u_t^y + e_t^i$$

$$u_t^r = \alpha_x^r u_t^x + \alpha_t^r u_t^t + \alpha_y^r u_t^r + \alpha_i^r e_t^i + e_t^r$$

[8] Elaborated in the following section.

[9] Amisano and Gianini (1997) propose the A-B model for identifying systems of reduced-form equations, which suggests an equality between the reduced-form innovations and the exogenous structural shocks (AU_t=BV_t). A is the matrix of contemporaneous effects (alphas) which is multiplied by the vector of the reduced form innovations U_t, and B is the matrix of reactions to be multiplied by the vector of structural shocks V_t; which are assumed to be orthogonal in order to investigate the impact of one single structural shock in isolation on the system as a whole (Heppke-Falke and others, 2010).

These four steps yield all the sufficient information to construct the necessary impositions on the A & B matrices in the baseline 5-dimensional specification[10]:

$$\begin{bmatrix} 1 & 0 & 0 & -\alpha_x^y & -\alpha_t^y \\ -\alpha_y^i & 1 & 0 & -\alpha_x^i & -\alpha_t^i \\ -\alpha_y^r & -\alpha_i^r & 1 & -\alpha_x^r & -\alpha_t^r \\ -\alpha_y^x & -\alpha_i^x & -\alpha_r^x & 1 & 0 \\ -\alpha_y^t & -\alpha_i^t & -\alpha_r^t & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^y \\ u_t^i \\ u_t^r \\ u_t^x \\ u_t^t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & \beta_x^t & 1 \end{bmatrix} \begin{bmatrix} e_t^y \\ e_t^i \\ e_t^r \\ e_t^x \\ e_t^t \end{bmatrix}$$

2.2.1 Exogenous Elasticities

To estimate the matrix A of contemporaneous relationships of budgetary items to output, we compute these exogenous elasticities of spending and taxation on output using log-log models on real values at 2016/2017 constant prices. We also estimate the elasticities to the GDP deflator simply as the elasticity of the fiscal variable to GDP less 1. We also assume contemporaneous independence from monetary policy by setting the elasticities of fiscal variables to interest rates as zero[11]. (Heppke-Falke & others, 2010).

2.2.2 Structural Impulse Response Functions and Cumulative Multipliers

Having identified the exogenous fiscal policy shocks, we can estimate[12] the responses of each element in the vector X_t to a one-time impulse in the structural shock under investigation. Since we estimate VAR in-levels[13] we limit our forecast to assume 10 quarters ahead and we furthermore compute the cumulative structural shocks over the same time horizon. We plot 95% confidence intervals based on bootstrapping[14] (Heppke-Falke & others, 2010; Kilian & Lutkepohl, 2017).

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[10] We estimate a total of 15 parameters, which makes the model just-identified (Heppke-Falke & others, 2010). For clarification, the first model is displayed in matrix notation; the rest of the SVAR models are fundamentally the same.

[11] Changing interest rates does not have immediate effect on government interest payments as only a fraction of debt is rolled over in a given quarter, while most are rolled over with a significant lag .

[12] Through Moving-average representations (see Kilian & Lutkepohl, 2017 pp111).

[13] We estimate a system with integrated variables containing unit-roots after performing the Augmented Dicky-Fuller tests. We stress the fact that we estimate VAR in levels as it would be difficult to find cointegration vectors for specifying separate error correction models for disaggregation purposes (Heppke-Falke & others, 2010). Furthermore, the analysis is interested in the short-run relationships through impulse response analysis and ignores any longer-run relationships between the variables, which is another reason to keep the information in levels.

[14] Sampling with replacement to account for estimation uncertainties. See Efron and Tibshirani (1993) on bootstrapping.

3. Results

3.1 Baseline Model

A shock[15] to budget expenditures has a positive effect on output, as is seen in both impulse and cumulative response analyses. On the other hand, tax revenue increases have a negative effect on output. These results are consistent with economic theory. To disentangle the abovementioned results for expenditures, and to investigate the significance of budget expenditure items on output, we will divide budget expenditures into three components (wages and salaries, budget investments, and purchases of goods and services including subsidies) and extend the model as follows to analyse their effects on output separately.

3.2 Disaggregating Budget Expenditures to Output

The disaggregated analysis of budget expenditures shows positive impulse and cumulative multipliers for other expenditures (purchases of goods and services including subsidies). Wages and salaries show positive, however weak, effects on output. Budget investments initially negatively affects output, however, a positive effect is observed after 4 quarters which suggests a crowding-in effect with a lag. We also analyse the effects of budget investments on private investments, which shows positive effects as seen in both impulse and cumulative multipliers and confirms a crowding-in effect to private investments with a lag and which is consistent with the neoclassical theory.

3.3 Disaggregating Public Expenditures to Private Investments

Since budget spending does not include all public sector spending, we will also include the effects of public sector investments and analyse their impact on private investments[16]. Government investments seem to initially crowd out private investments, however, the dynamics change to positive after 5 quarters indicating a mild effect on crowding in private investments. We also analyse the effect of government consumption on private investments which is also observed to initially crowd out private investments for up to 7 quarters before showing positive effects on private investments.

3.4 Disaggregating Public Expenditures to Private Consumption

We also investigate the effects of public sector spending on private consumption. Government consumption tends to crowd out private consumption in the short run, however, government investments tend to crowd in private consumption. This is consistent with the neoclassical theory as seen in Baxter and King (1993).

[15] An impulse shock is expressed in standard deviations from the mean, which after log-linearisation, corresponds to log deviations from equilibrium. In other words, this equates to a percentage deviation of the impulse variable from the normalised steady state (Ziets, 2006).

[16] In principle, we follow the work of Hollmayr & Kuckuck, 2018.

We then turn to disaggregate tax revenue components to investigate their relationship to private investments. We distinguish between taxes relating to economic activity (taxes on profits which include corporate taxes) and taxes not relating to economic activity (non-profit taxes which includes taxes on domestic goods and services) as follows:

3.5 Disaggregating Tax Components to Private Investments

We analyse the effects of taxation on private investments. An increase in taxes on profits tends to crowd out private investments (increasing taxation drives private capital formation down as companies start divesting following tax increases). Interestingly, an increase in non-profit taxes (including on domestic goods and services) tends to have a positive effect on investment, possibly through the aggregate supply channel where companies are incentivised to produce more at higher selling prices.

3.6 Disaggregating Tax Components to Private Consumption

Finally, we analyse the effects of taxation on private consumption. Results indicate that a tax hike results in a negative effect on private consumption, whether resulting from an increase in profit or non-profit taxes. This confirms the negative wealth effects on households and firms as is predicted by the neoclassical theory.

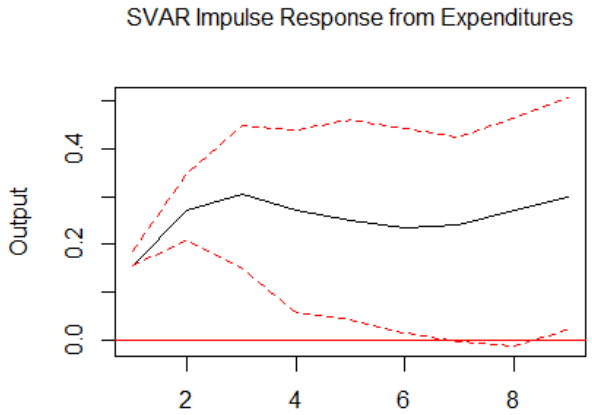
4. Conclusion

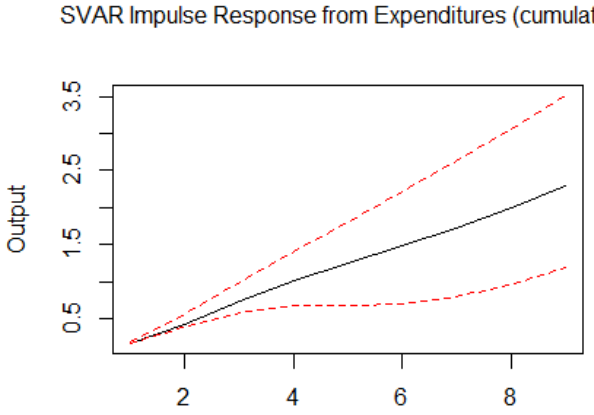
This research aims to contribute to the empirical literature on fiscal multipliers in Egypt by applying an SVAR on quarterly time series to quantify the effects of fiscal policy on economic growth through impulse response analysis. A disaggregated analysis was also performed so that the effects on output components are analysed. Results consistently show positive effects on output resulting from government spending shocks, and negative effects resulting from taxation shocks. Public investments and consumption are seen to crowd in private investments with a lag. Public consumption crowds out private consumption, however, crowds in private consumption. Taxation on profits (including corporate profits) is seen to crowd out private investments, however, taxes not relating to profits (including taxes on domestic goods and services) tends to have a positive effect on private capital formation. Lastly, taxation increases show a negative effect on private consumption. Overall, the results are in line with the neoclassical theory.

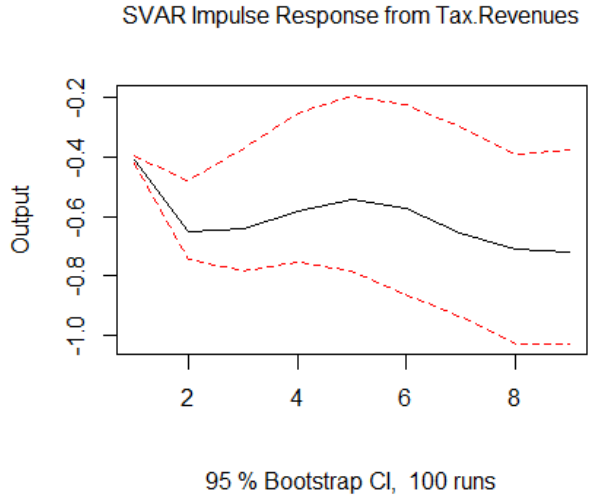
Recent research has emphasised the importance of incorporating regime shifts in financial and economic time-series due to structural changes in the underlying data (arising from non-linearities) (Ibrahim, 2019). Additionally, the non-linear effects of fiscal policy in Egypt are highlighted by Abdel-Latif & Mishra (2016); perhaps an SVAR with regime shifts for identifying periods of recessions versus expansions would be the topic for future research (Auerbach & Gorodnichenko, 2012; Kilian & Lutkepohl, 2017).

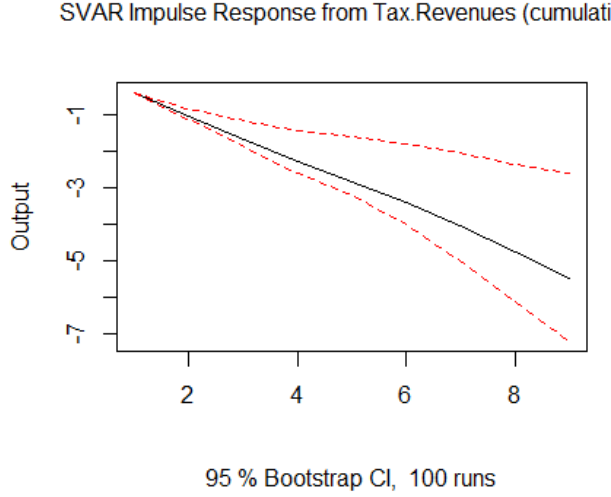
Impulse Response Functions and Cumulative Multipliers:

Baseline Model:

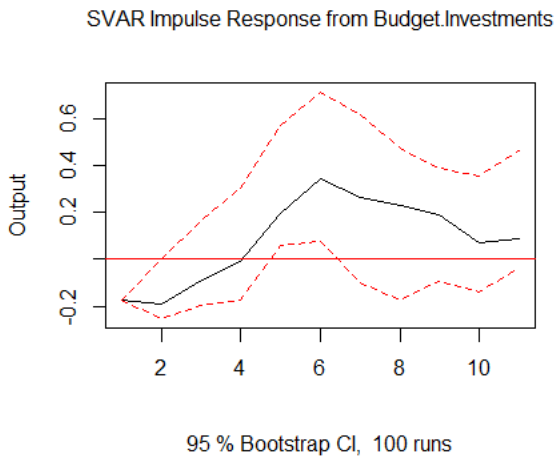


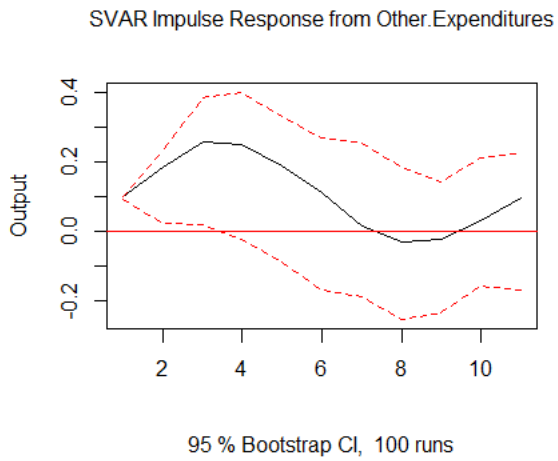


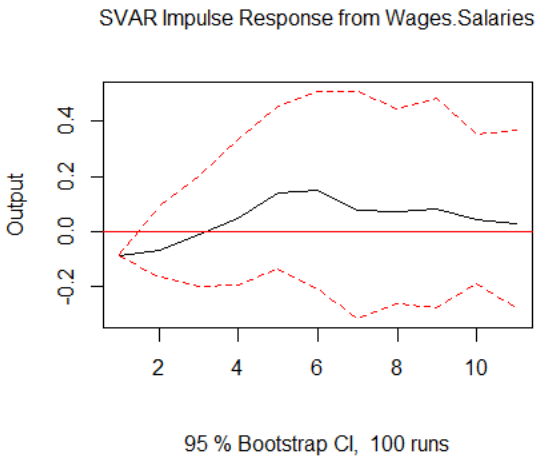


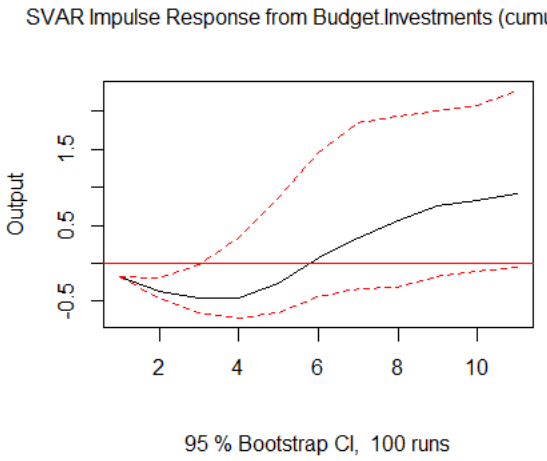


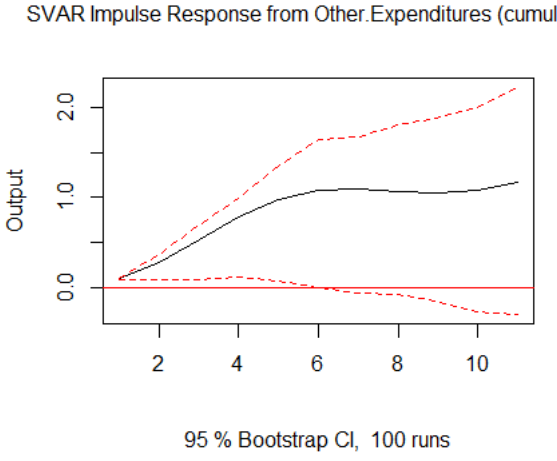
Disaggregating Budget Expenditures to Output:

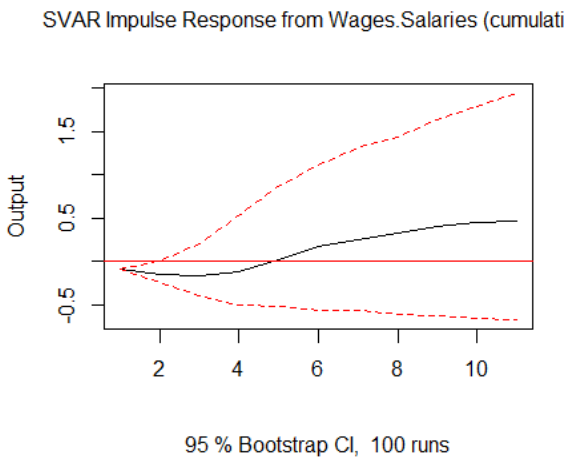












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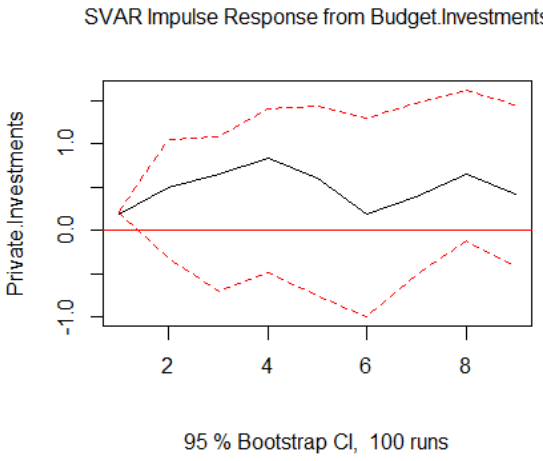

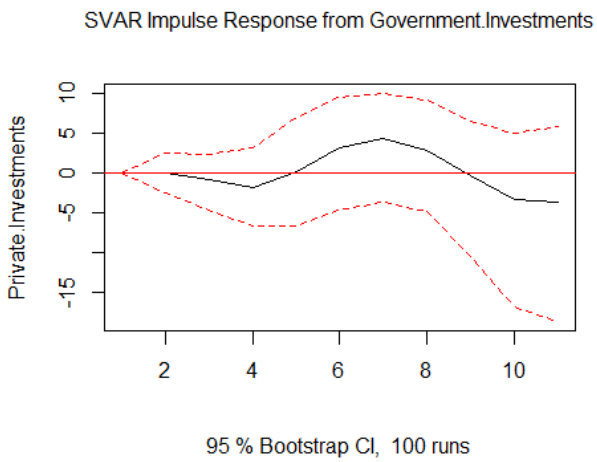

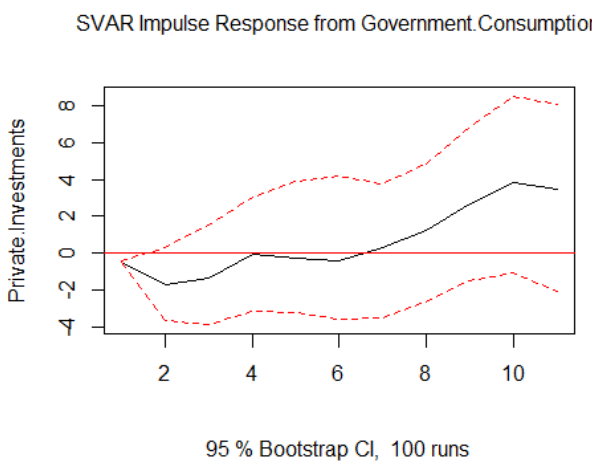

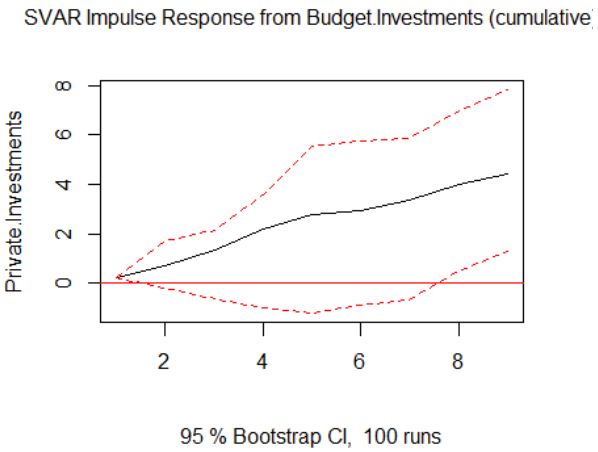

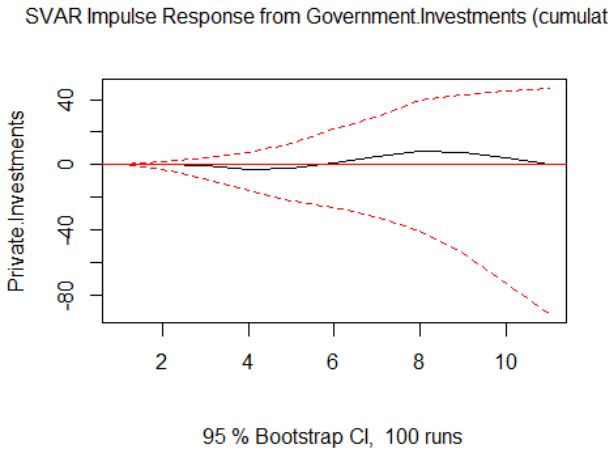

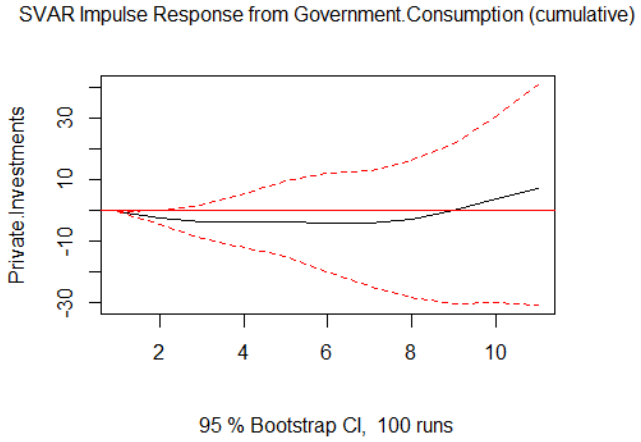

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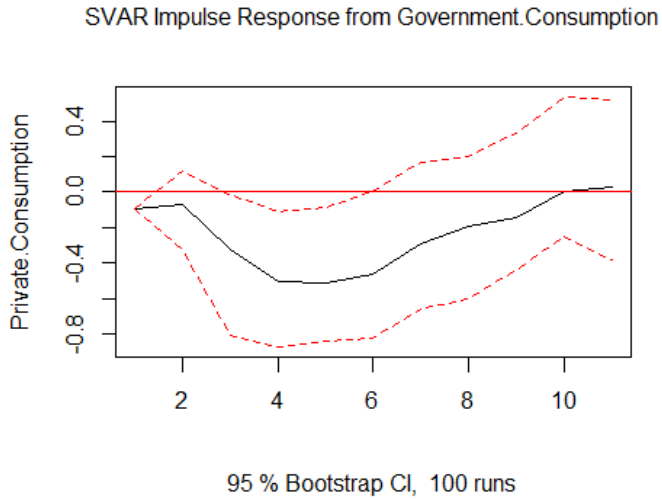

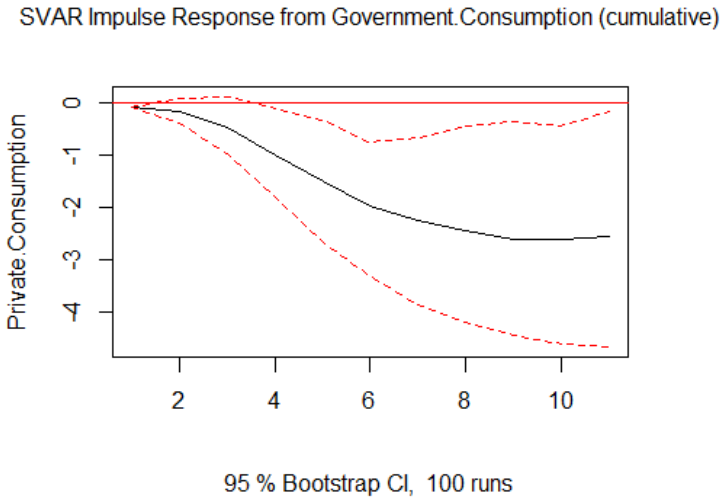

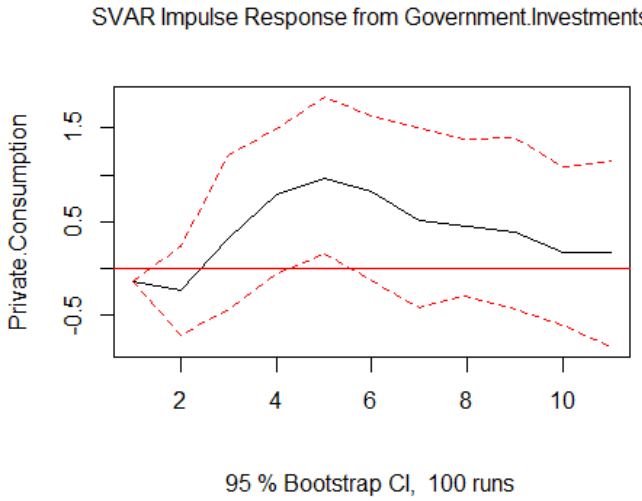

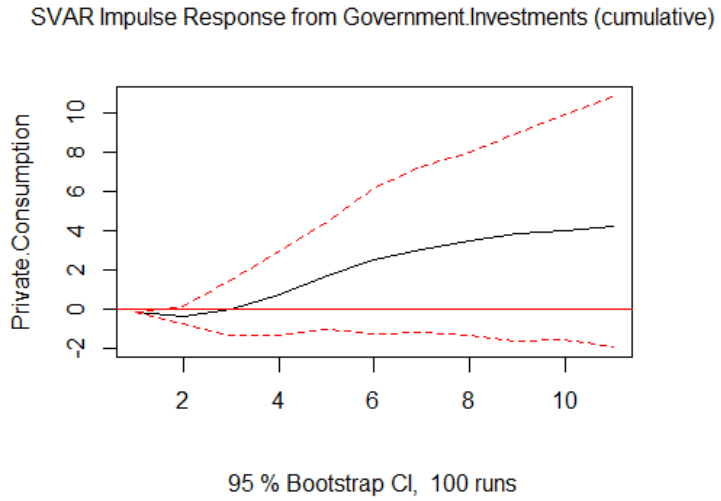

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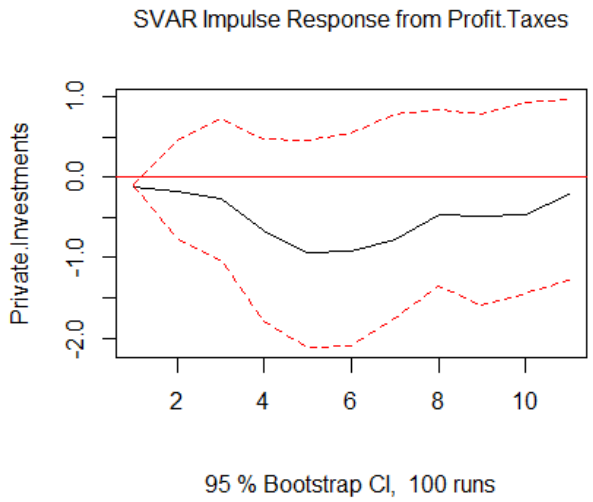

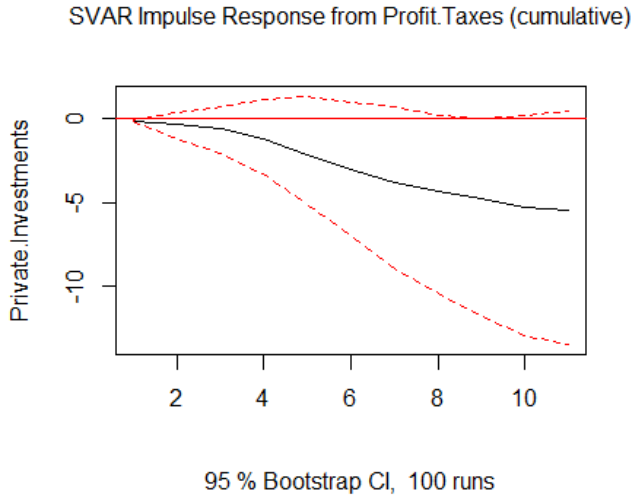

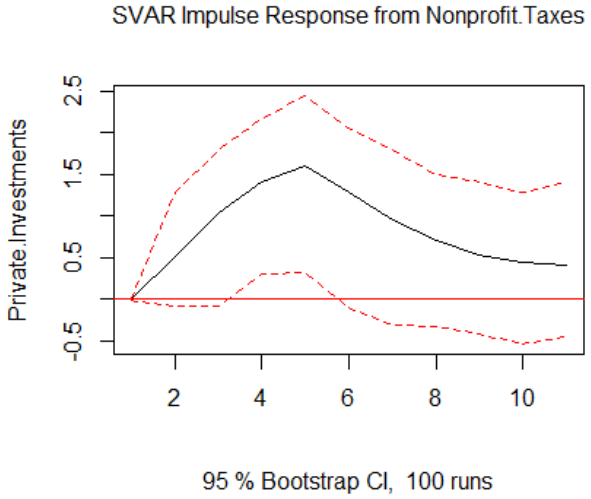

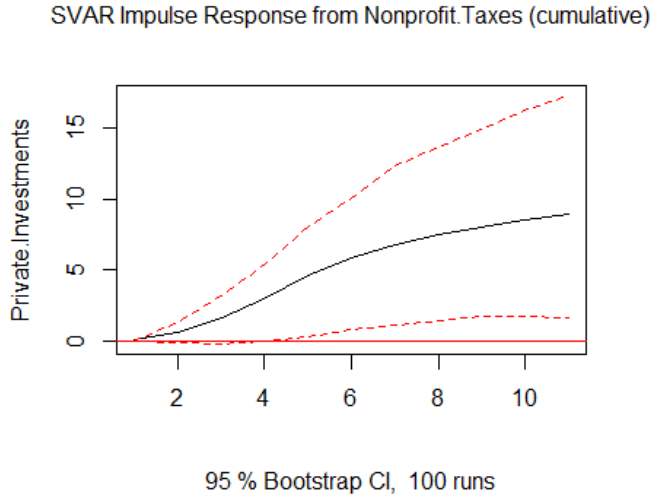

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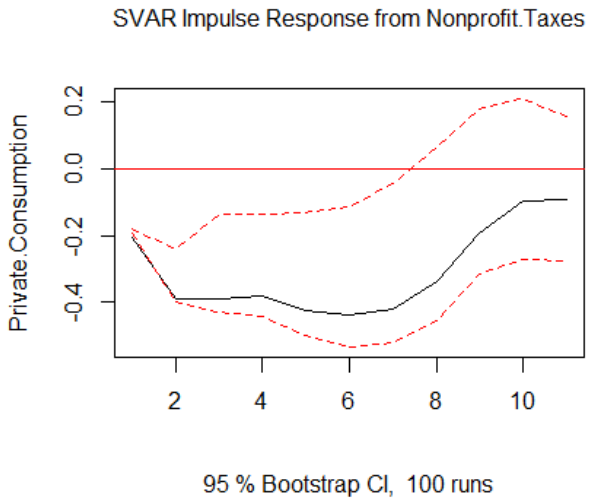

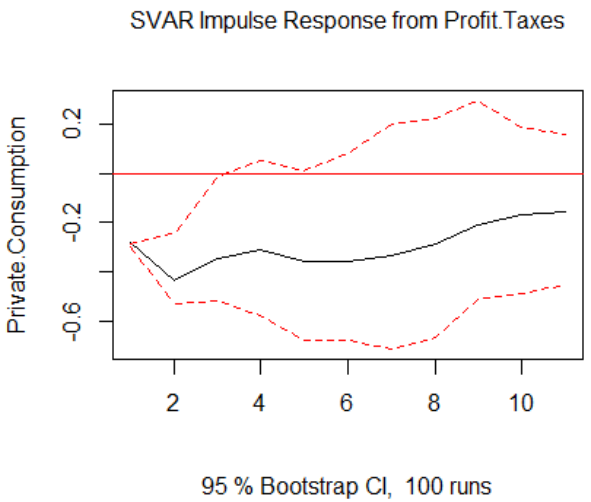

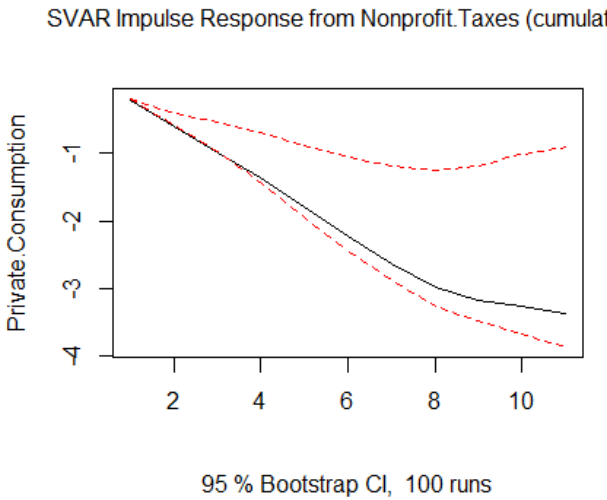

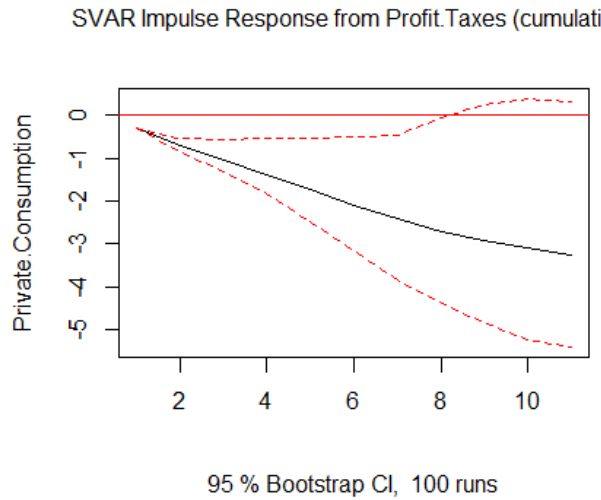

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