Banco de Guatemala
Economic Research Department

The Impact of Government Spending on the Main Macroeconomic Variables*

Juan Carlos Arriaza

August 23, 2021

Abstract

This study re-examines the macroeconomic effects of government spending in the case of Guatemala by estimating a Vector Autoregressive Model with exogenous variables (VAR-X) with quarterly data spanning from 2011q1 to 2019q4. The study found empirical evidence that government spending has a positive impact on output, private consumption, and gross capital formation.However, there is not statistical evidence that government spending increase neither exports nor openness to trade in the case of Guatemala.

***Classification* JEL**: E20, E62.
Key Words: VAR-X, Fiscal Policy, Guatemala.

*The opinions expressed in this document are the exclusive responsibility of the author and do not necessarily represent the opinion of the Banco de Guatemala or its authorities.

Contents

1 Introduction

The macroeconomic effects of government spending is still an open question which deserves more research. In this study, it is re-examined the impact of government spending on the main macroeconomic variables such that GDP, private consumption, exports, openness to trade, and gross capital formation with a set of control variables with an estimation of a VAR-X model, in the case of Guatemala.

The contribution of government spending to GDP has been explored from previous literature by estimating different types of models as Structural Vector Autoregressive, Vector Autoregressive with Exogenous Variables (VAR-X), Bayesian Vector Autoregressive, Global Vector Autoregressive, panel data, and Dynamic Stochastic General Equilibrium (DSGE). While some researches found a positive macroeconomic effect of government spending, others found either a negative or null impact. For this reason, it is still important to analyze the relationship between GDP and government spending in the case of Guatemala.

The behaviour of the variations of real GDP and real government spending from 2011 to 2019 seems to be very similar in most of the sample with the exception of some periods of time such that 2012. It seems that there is a positive correlation between them (See Appendix A, figure (3). In this study, it is re-examined the possible relation between both GDP and government spending with the estimation of a VAR-X model. The choice of the VAR-X model is because it allows to include exogenous variables such that US GDP and Inflation among others that explains the patterns of the domestic variables due to the commercial linkages between Guatemala and United States of America.

The study found empirical evidence that the increase in both government primary and government total spending contribute to increase GDP, private consumption and gross capital formation. However, there is not statistical evidence that an increase in government primary spending generates an increase in neither exports nor openness to trade in the case of Guatemala.

The content of the paper is as follow: Section 2 presents a brief literature review of the previous studies of government spending. Section 3 the data and the model specification of the VAR-X model. Section 4 shows the main results of the implementation of the model and a robustness analysis. Finally, section 5 shows the final remarks of the study.

2 Literature Review

In this section, there is a brief literature review about previous studies which evaluate the macroeconomic effects of the government spending. There are two approaches mainly used by previous researchers.

Both approaches analyze the impact of government spending on GDP. However, the second approach considers other macroeconomic variables such that private consumption, openness to trade, gross capital formation, inflation, exchange rate among others.

Also, the previous literature estimates different macroeconomic and macroeconometrics models to test the macroeconomic impact of government spending in their studies such that structural VAR (SVAR), VAR with exogenous variables (VAR-X), Global VAR with exogenous variables (GVAR-X), Bayesian VAR, panel data, and Dynamic Stochastic General Equilibrium (DSGE) model.

The first approach is to estimate an empirical model by using GDP and only fiscal variables such that taxes and government spending (Blanchard and Perotti (2002), Perotti (2005), Monacelli and Perotti (2008) and Van Aarle et al. (2003)).

Blanchard and Perotti (2002) estimated a mixed model, a structural VAR and event study, in the case of USA economy with quarterly data from 1947q1 to 1997q4 in order to analyze the effects of fiscal policy. The model contained only three variables: government spending, net taxes, GDP. The main results were that a positive shock in government spending had a positive effect on output but a positive shock in net taxes had a negative effect on it.

Similarly with the previous study, Perotti (2005) analyzed the effects of fiscal policy in the case of USA, West Germany, United Kingdom, Canada y Australia , with the estimation of a structural VAR with for each country with quarterly data from 1960 to 2001 . As a difference with Blanchard and Perotti (2002), the model included prices and interest rates with GDP, and there is not a study case. They found a positive but weaker effect of government spending on GDP and prices.

Also, Van Aarle et al. (2003) estimated a SVAR model to analyze the monetary and fiscal policy transmission in the case of Euro Area with quarterly data from 1980q1 to 2001q4 and compares the results with those from Japan and the USA. The variables of the system of equations were real output, real government revenue, real government spending, short-term interest rates and prices. They found main cross-country differences in the linkages between macroeconomic policy instruments and large differences in the country adjustments are induced by monetary and fiscal policy innovations.

The second approach is to estimate an empirical model by including macroeconomic variables alongside with GDP (Afonso and Sousa (2012), Pesaran and Smith (2006), Galí et al. (2007), Sinevičienė (2015) and Klein and Linnemann (2019)).

First, Afonso and Sousa (2012) estimated a Bayesian Structural VAR model to analyzed the macroeconomic effects of fiscal policy with quarterly data in the case of USA, United Kingdom, Germany and Italy. The variables included in the study were GDP, private consumption, private investment, wages, productivity, a housing price index, profits, money growth rate, real exchange rate, the S&P 500 Index, the FTSE-All shares Index, and the MSCI Index, and government spending. They found that a government spending shock generates a positive small response on GDP, crowding out effects on private consumption and investment, and a small effect on both housing prices and stock prices.

Also, Klein and Linnemann (2019) estimated a time varying VAR model with quarterly U.S. macroeconomic data from 1960q1 to 2015q4 to analyze if the macroeconomic effects of government spending varies over the sample. The main variables included in the model were growth rate of real government spending, growth rate of real GDP, taxes as a fraction of GDP, the shadow nominal federal funds rate, the spread between corporate bond yields, the 10-year government bond yields, and government debt as a ratio of GDP, government deficit as a ratio of GDP, investment as a ratio of GDP, unemployment, and private consumption as a ratio of GDP. They found that after 2000q1 there is a positive impact of government spending of private consumption and unemployment which is statistically significant. However, in the case of private investment, the response is positive but not statistically significant. Before 2000q1, the impact of government spending on private consumption, private investment, and unemployment was negative but not statistically significant.

Finally, Sinevičienė (2015) test the relationship between government expenditure and private investment in the case of Bulgaria, Estonia, Latvia, Lithuania and Slovenia with annual data spanning from 1996 to 2012.The methodology approaches applied in the study were both cross-correlations and Granger causality tests. The variables included in the study were GDP, investment as percentage of GDP, gross fixed capital formation, general government total expenditure, and trade as a percentage of GDP. The author found that with the exception of Bulgaria, government spending crowds out private investment.

This study chose the VAR-X model because it allows the use of external variables, as a exogenous, which have an important impact of the Guatemalan economy. By including these exogenous variables, it is possible to model in a better way the patterns of the macroeconomic variables by taking into account the relationship of the domestic and foreign variables.

In the following section, it is explained the methodology to compile the data and the model specification in this study.

3 Methodology

The next section explains the methodology considered in this study to address the contribution of the government spending on the main macroeconomic variables in the case of Guatemala.

In the first subsection, it is explained the choice of the sample, and the selection and treatment of the variables in the study. In the second subsection, it is justified the model specification chosen in the study.

3.1 Sample and Variables Selection

The study considers a quarterly data with a sample spanning from 2011Q1 to 2019Q4 with both domestic and foreign variables. The reason to start from year 2011 is to almost avoid the effects of the global financial crisis 2008-2009 and the no inclusion of year 2020 is to stay away from the effects of the coronavirus outbreak which generated a decrease in the output around the world. The use of quarterly data helps to reduce the volatility of the time series.

The data set consists in fiscal, macroeconomic, and control variables. The fiscal variables includes are government primary spending, gp_t, internal debt, di_t, external debt, de_t and government revenue, it_t.

The main macroeconomic variables used in this research are GDP, y_t, exports, $export_t$, gross capital formation, inv_t, private consumption, c_t, and openness to trade, $openness_t$, instead of exports.

Finally, the set of control variables, which are consider exogenous in the study, are private remittances, rem_t, USA GDP, y_t^*, US CPI, CPI_t^*, and libor rate, $libor_t$.

The main testable hypothesis is that the government spending has a positive impact on output and the other macroeconomic variables. In this study, primary and total public government spending is used as the main explanatory variables.

The nominal variables were transformed to real variables using the implicit GDP deflator with base year 2013. In addition, all variables are expressed in annualized inter-annual variations.

In appendix A, table (3), it is shown a summary of the variables and their sources employed in this study.

3.2 Model Specification

This subsection explains the specification of a VAR-X model that is used to estimate the macroeconomic effects of public spending in the case of Guatemala.

3.2.1 SVAR Model Specification

First, it is shown the setup of a Structural Vector Autoregresive model (SVAR). Hamilton (1994) set up the SVAR model as follow

$$\xi_t = \mathbf{F}\xi_{\mathbf{t-1}} + \varepsilon_{\mathbf{t}} \tag{1}$$

Where

$$E(\varepsilon_t \varepsilon_\tau') = \begin{cases} \mathbf{Q} & \text{para } t = \tau \\ \mathbf{0} & \text{in other case} \end{cases}$$

And,

$$\mathbf{Q} = \begin{bmatrix} \mathbf{\Omega} & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots \\ 0 & 0 & \cdots & 0 \end{bmatrix}$$

Also, ξ_t is a vector of matrix which contains the data without the mean, $\mathbf{F}$ is matrix of coefficients and $\mathbf{\Omega}$ is the covariance matrix of the residuals.

In addition, the model is estimated with equation (1) as follow

$$\xi_t = \begin{bmatrix} \mathbf{y_t} - \mu \\ \mathbf{y_{t-1}} - \mu \end{bmatrix}; \qquad \mathbf{y_t} = \begin{bmatrix} gp_t - \mu \\ export_t - \mu \\ inv_t - \mu \\ c_t - \mu \\ it_t - \mu \\ di_t - \mu \end{bmatrix}; \qquad \varepsilon_t = \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^{export} \\ \varepsilon_t^{inv} \\ \varepsilon_t^c \\ \varepsilon_t^{it} \\ \varepsilon_t^{di} \end{bmatrix}$$

3.2.2 VAR-X Model Specification

Second, it is estimated a VAR-X model in order to add exogenous variables to characterize in a better way the patterns of system of equations. Following Lütkepohl (2005), the setup of the model is as follow

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + B_0 x_t + B_1 x_{t-1} + B_2 x_{t-2} + ... + B_s y_{t-s} + \varepsilon_t \quad (2)$$

Then, equation (2) can be written as

$$A(L) y_t = B_L x_t + \varepsilon_t \quad (3)$$

Where $A(L)$ and $B(L)$ are the matrix polynomials in the lag operation defined as

$A(L) = I_k$ - $A_1 L$ - .... - $A_p L^p$ and $B(L) = B_0$ - $B_1 L$ - .... - $B_s L^s$

Finally, equation (3) can be expressed in a reduced form as

$$y_t = AY_{t-1} + BX_{t-1} + B_0 x_t + \varepsilon_t \tag{4}$$

Where $A = [A_1, ..., A_p]$ and $B = [B_1, ..., B_s]$

$$\mathbf{Y_t} = \begin{bmatrix} y_t \\ \vdots \\ y_{t-p+1} \end{bmatrix}; \qquad X_t = \begin{bmatrix} x_t \\ \vdots \\ x_{t-s+1} \end{bmatrix}$$

Where Y_t is the matrix of the endogenous variables and Y_t is the matrix which contains the exogenous variables. Also, it is assumed that ε_t be a standard white noise with nonsingular covariance matrix.

Finally, in this study, it is imposed that matrix B be a matrix which contains only zeros in every position since there will no be lagged exogenous variables but only in contemporaneous time. Therefore, matrix B_0 will contain the coefficients of the exogenous variables of the study.

In the next section, it is estimated a VAR-X model by following equation(4).

4 Main Results

In this section, there are shown the results of the best VAR-X model estimated in the case of Guatemala. The identification scheme is the cholesky decomposition.

First, it is estimated a VAR-X model with GDP and the main fiscal variables which is the standard methodology in the previous literature. Second, it is estimated the model by including private consumption, gross capital formation, exports, and openness to trade to test if there is a positive impact of government spending on the previous variables.

4.1 Estimation of the VAR-X model 1

First, we estimate the VAR-X model including only GDP and fiscal variables as it is the standard approach in the previous literature using a cholesky decomposition as identification scheme. The endogenous variables chosen in the model are GDP, y_t, government primary spending, gp_t, income tax, it_t, internal debt di_t and external debt de_t.In addition, the exogenous variables included are US CPI, π_t^*, USA GDP, y_t^* and libor rate, $libor_t$. The model is estimated with two lags according with Akaike and Schwarz information criterion.

The results of the model are shown in table (1). There are only shown the equations of the VAR-X model associated with the main variables.

The R^2 is higher than 0.90 in the case of the equations of government primary spending, GDP, and government revenue while is higher than 0.67 in both the equation of internal debt and external debt. Also, the coefficient of both the first and second lag of government spending are statistically significant at 1 percentage level of significance in the GDP equation.

In addition, the model is stable because all inverse roots are inside the unit circle which guarantee a convergence to the steady state of all variables (see Appendix C, figure 4).

Also, the model satisfy the main statistical properties.First,the joint residuals behave as multivariate normally distributed because it is not possible reject the null hypothesis that the multivariate residuals are normally distributed.(see Appendix C, table (4)). Second, the residuals of the model do not show a trace of autocorrelation at lag h, therefore; it is not possible reject the null hypothesis that there is no autocorrelation with both the Edgeworth expansion corrected likelihood ratio statistic and Rao F-test (see Appendix C, table (5)). Finally,the residuals of the model keep the same variance, because it is not possible reject the null hypothesis that the variance of them remains the same with the chi-square test (see Appendix C, table (6)).

Table 1: VAR-X Model

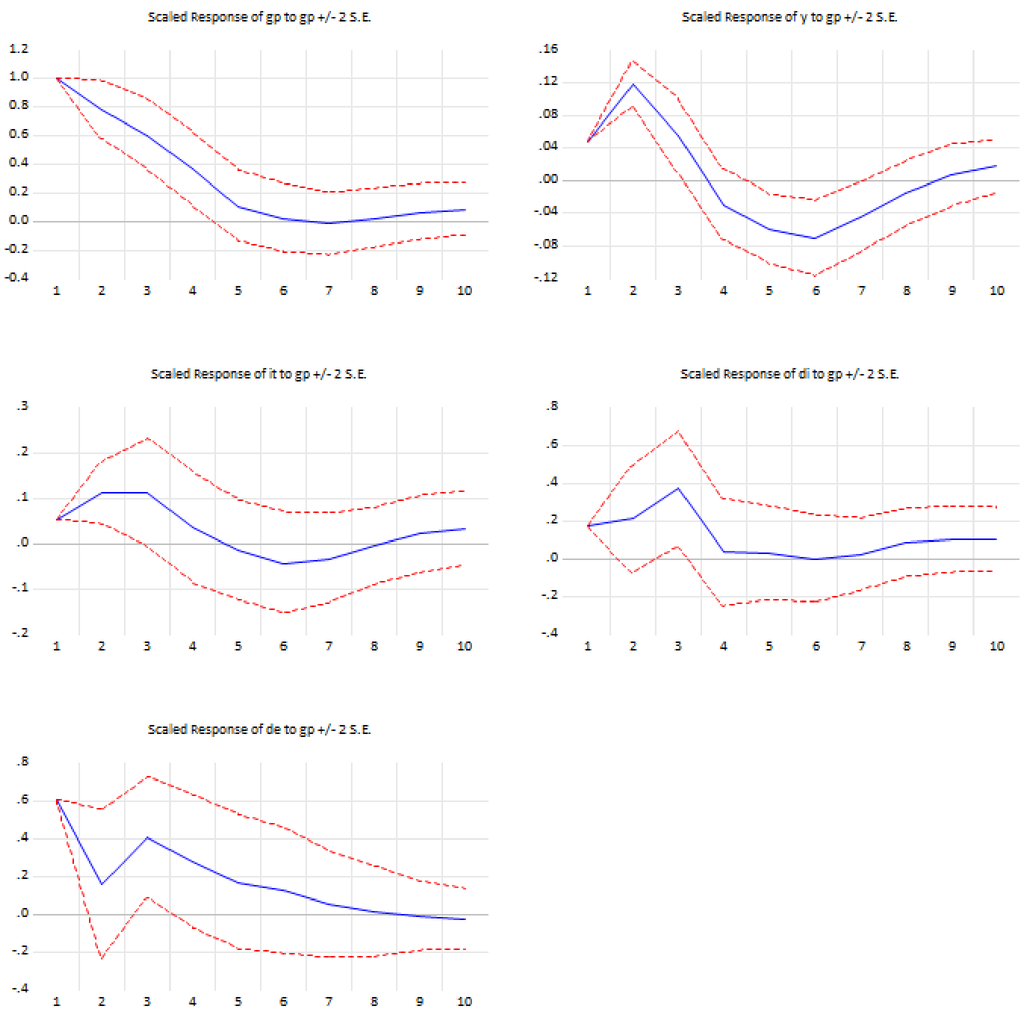
Variables	gp_t	y_t	it_t	di_t	de_t
gp_{t-1}	0.4130	0.1136***	0.1739**	0.3751	0.2212
	(0.2702)	(0.0363)	(0.0893)	(1.3789)	(0.5197)
gp_{t-2}	-0.1239	-0.0782***	-0.0721	-0.0296	0.3100
	(0.1658)	(0.0223)	(0.0548)	(0.2325)	(0.3189)
y_{t-1}	1.8097*	0.8141***	-0.4349	-0.2137	-0.0835*
	(1.0184)	(0.1367)	(0.3366)	(1.4281)	(-0.0426)
y_{t-2}	-1.6383*	-0.3496***	0.3417	-0.5970	1.1579**
	(0.1007)	(0.2480)	(0.3119)	(1.3234)	(1.8152)
it_{t-1}	1.0927*	-0.0867	1.0133***	1.1229	-1.1068
	(0.5795)	(0.0778)	(0.1915)	(0.8126)	(1.1146)
it_{t-2}	0.07130	-0.0974	-0.0871***	-1.5694	-1.1068
	(0.7502)	(0.1007)	(0.2480)	(1.0520)	(1.4429)
di_{t-1}	0.0820	-0.0406	-0.0085	0.08891	0.0332
	(0.2234)	(0.0300)	(0.0738)	(0.3133)	(0.4298)
di_{t-2}	-0.0667	0.0738***	0.0426	0.2276	-0.2369
	(0.1602)	(0.0215)	(0.0530)	(0.2247)	(0.3082)
de_{t-1}	0.3411*	-0.0375*	-0.1580***	-0.3817	-0.0113
	(0.1808)	(0.0243)	(0.0597)	(0.2535)	(0.3477)
de_{t-2}	0.1472	-0.0321	0.06091	0.2100	0.1270
	(0.1834)	(0.0246)	(0.0606)	(0.2572)	(0.3527)
constant	-0.0912	0.0282***	0.0727***	-0.0062	0.2121
	(0.0974)	(0.01301)	(0.0322)	(0.1366)	(0.1874)
y_t^*	1.1003	-0.2323**	-1.5123	4.0292	-5.2400
	(2.5980)	(0.3485)	(0.8586)	(3.6429)	(4.9967)
π_t^*	0.0904	0.4601	2.1805	-0.6843	-0.4178
	(0.1723)	(0.4243)	(1.8002)	(2.4692)	(1.32837)
$libor_t$	0.0297	-0.0026	-0.0090	-0.02391	-0.0094
	(0.0154)	(0.0021)	(0.0051)	(0.0216)	(0.0297)
Observations	36	36	36	36	36
R-squared	0.9026	0.9544	0.9505	0.7741	0.6742

Note: Asterisks denote significant coefficients, with ***, **, * indicating significance at 1%, 5% and 10% level respectively. Standard deviations reported in parenthesis

Source: Own elaboration.

Next, they are shown the responses of the main variables to a government primary spending shock.

Figure 1: Impulse-Response Functions, Model 1



Source: Own elaboration.

From figure (1), an increase in one percentage point of government primary spending increases in approximately 0.12 percentages points of GDP and the response is statistically significant in the first two quarters.

Also, an increase of one percentage point of government primary spending increases in approximately 0.10 percentage points the government revenue and the response is statistically significant in the first two quarters.

It seems that government spending has a relevant contribution on GDP in the case of

Guatemala. In the next subsection, we re-estimate the model with the main macroeconomic variables instead of GDP.

4.2 Estimation of the VAR-X model 2

Now, it is included in the model the main macroeconomic variables considered in this study: private consumption,c_t, gross capital formation, inv_t, and exports, $exports_t$, instead of GDP, y_t, in order to test if any of them have a positive response from a government spending shock.

The results of the model are shown in table (2). There are only shown the equations of the VAR-X model associated with the main variables.

In addition of the previous exogenous variables included in the previous model, it is aggregated private remittances, rem_t because of the possible contribution of them to private consumption and gross capital formation.

The R^2 is higher than 0.90 every equations of the system which means that the model specification is better than the previous model. Also, the coefficient of the first lag of government consumption in both private consumption and gross capital formation equations is statistically significant at 1 percentage level of significance and in the equation of exports is statistically significant the second lag of government spending at 1 percentage level of significance too.

Also, the model is stable because all inverse roots are inside the unit circle which guarantee a smooth convergence to the steady state of all variables (see Appendix C, figure 5).

Moreover, the model satisfy the main statistical properties.First,the joint residuals behave as multivariate normally distributed because it is not possible reject the null hypothesis that the multivariate residuals are normally distributed.(see Appendix C, table (7)). Second, the residuals of the model do not show a trace of autocorrelation at lag h, because it is not possible reject the null hypothesis that there is no autocorrelation with both the Edgeworth expansion corrected likelihood ratio statistic and Rao F-test (see Appendix C, table (8)). Finally,the residuals of the model keep the same variance, because it is not possible reject the null hypothesis that the variance of them remains the same with the chi-square test (see Appendix C, table (9)).

Table 2: VAR-X Model 2

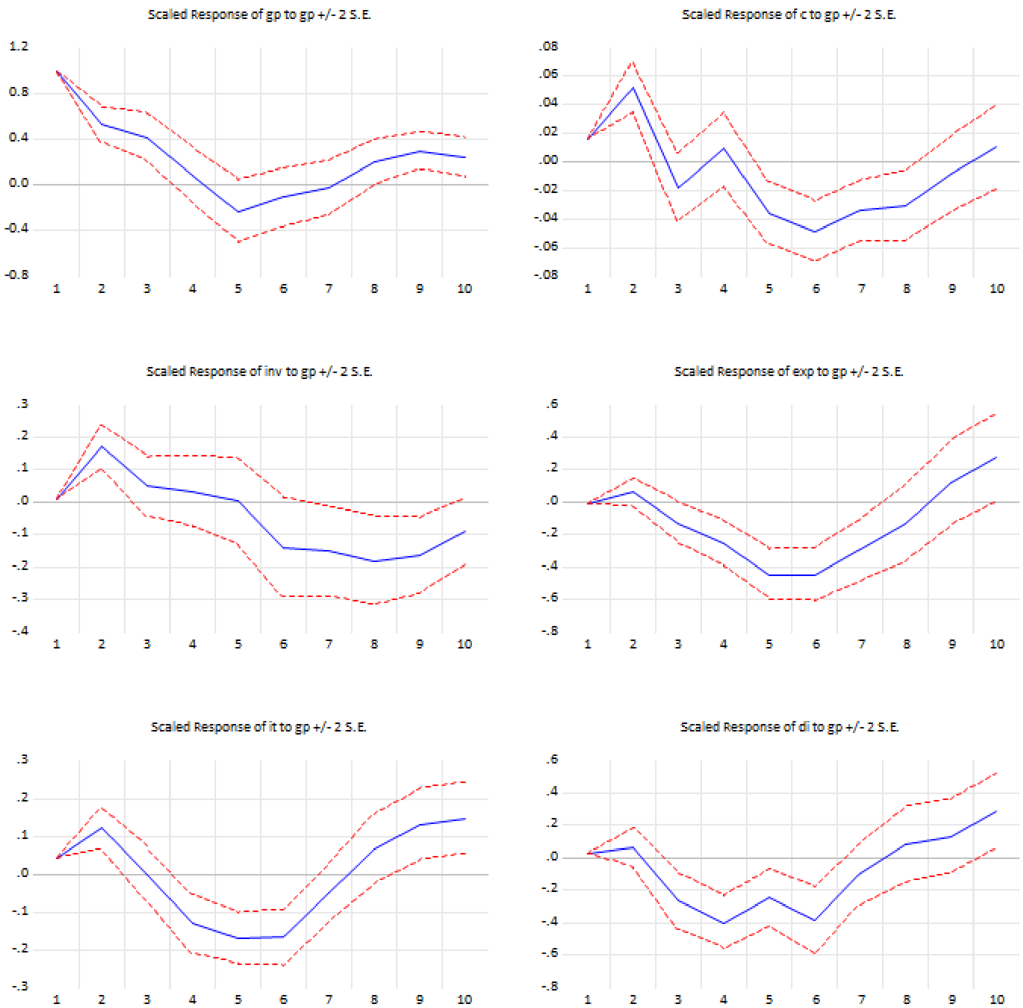
Variables	gp_t	c_t	inv_t	exp_t	it_t	di_t
gp_{t-1}	0.5472***	0.0567***	0.1869***	0.08460	0.0957*	0.1246
	(0.1655)	(0.0186)	(0.0698)	(0.0967)	(0.0571)	(0.1320)
gp_{t-2}	-0.1400	-0.0321	-0.1471*	-0.2594***	-0.12957**	-0.2842*
	(0.1925)	(0.0216)	(0.0812)	(0.1125)	(0.0664)	(0.1535)
c_{t-1}	-2.6592***	-0.1128	0.0353	-2.1759***	-0.4154	-2.6242***
	(1.2304)	(0.1379)	(0.5188)	(0.7192)	(0.4246)	(0.9811)
c_{t-2}	2.3522**	0.3936	-0.2341	-0.0286	-0.3820	-2.0828***
	(1.2112)	(0.1358)	(0.5108)	(0.7082)	(0.4181)	(0.9661)
inv_{t-1}	1.3197***	-0.0926*	0.7067***	0.6172***	0.1236	0.5282
	(0.4325)	(0.0485)	(0.1823)	(0.2528)	(0.4181)	(0.9661)
inv_{t-2}	-0.3022	-0.02071	-0.0227	-0.9126***	-0.2711**	-1.2534***
	(0.3870)	(0.0434)	(0.1632)	(0.2262)	(0.1336)	(0.3086)
exp_{t-1}	0.5130	0.1250***	0.3577	0.5403**	0.1704	1.1389
	(0.4448)	(0.0499)	(0.1875)	(0.2600)	(0.1535)	(0.3547)
exp_{t-2}	-1.1095***	0.0605*	0.0118	-0.3555*	-0.0761	-0.0828
	(0.3189)	(0.0358)	(0.1345)	(0.1864)	(0.1100)	(0.2543)
it_{t-1}	1.1229	0.0203*	-0.3100	0.1548	0.8199***	0.0873
	(0.6990)	(0.0784)	(0.2947)	(0.4086)	(0.2412)	(0.5574)
it_{t-2}	-0.6208*	-0.1174	0.1846	0.4575	-0.4149**	-0.1800
	(0.5782)	(0.0648)	(0.2438)	(0.3380)	(0.1994)	(0.4611)
di_{t-1}	0.1357	-0.0602***	-0.1558	0.2039	-0.0896	-0.4610***
	(0.2306)	(0.0259)	(0.0972)	(0.1348)	(0.0796)	(0.1839)
di_{t-2}	-0.0182	-0.0124	-0.0364***	0.4130	0.0448	0.0093
	(0.2337)	(0.0259)	(0.0985)	(0.1366)	(0.0806)	(0.1864)
Constant	-0.0840	0.0316***	0.0160	-0.0222	0.0734***	0.1815***
	(0.0819)	(0.0092)	(0.0345)	(0.0478)	(0.0283)	(0.065)
y_t^*	2.1049	0.5037**	-0.1103	2.1583*	-0.6767	5.7758***
	(0.0152)	(0.0017)	(0.00640)	(0.0089)	(0.0052)	(0.0121)
$libor_t$	0.0052	-0.0052***	-0.0049	-0.0162*	-0.0031	0.0042
	(0.01519)	(0.0017)	(0.0064)	(0.0089)	(0.0052)	(0.01211)
π_t^*	0.2885	0.0046	1.1263**	-0.4784	0.2409	-0.3210
	(1.3088)	(0.1467)	(0.5518)	(0.7650)	(0.4516)	(1.0436)
rem_t	-0.0196	0.0602***	0.1514*	0.2477**	0.0163	0.0263
	(0.2123)	(0.0238)	(0.0895)	(0.1241)	(0.0733)	(0.1694)
Observations	36	36	36	36	36	36
R-squared	0.9173	0.9156	0.9319	0.9642	0.9542	0.9380

Note: Asterisks denote significant coefficients, with ***, **, * indicating significance at 1%, 5% and 10% level respectively. Standard deviations reported in parenthesis

Source: Own elaboration.

Next, they are shown the responses of the main variables to a government primary spending shock.

Figure 2: Impulse-Response Functions, Model 2



Source: Own elaboration.

From figure (2), an increase in one percentage point of government primary spending increases in approximately 0.050 percentages points of private consumption and the response is statistically significant in the first two quarters.

Also, an increase in one percentage point of government primary spending increases in approximately 0.015 percentage points of gross capital formation which is lower than in the case of government consumption. Also, the response is statistically significant in the first two quarters. Although, there is not the objective of the present study, it seems that there is no statistical evidence of crowding out in the case of Guatemala.

However, the response of exports from a positive shock of government primary spending is not statistically significant although has the correct direction. The same results are found when this is substituted by openness to trade measure.

Therefore, the study found an empirical evidence that an increase of primary government spending has a positive impact on both private consumption and gross capital formation, although the responses are lower which is consistent with the findings of previous studies in different countries.

In the next subsection, there are some robustness analysis by changing the main explanatory variable of this study.

4.3 Robustness Analysis

In this subsection, the main variable, government primary spending, is changed by government total spending in order to test if the previous results still hold with both models.

4.3.1 VAR-X Alternative Model 1

The VAR-X model 1 is modified by substituting government total spending instead of government primary spending in order to test robustness of the study.

In Appendix $D.1$, table (10) and figure (5), there are shown the results and the impulse response functions respectively.

From Appendix $D.1$, table (10), it can be appreciated that the impact of government total spending in the first and second lag is statistically significant at 1 percent level in the case of the GDP equation in the same way than when we use government primary spending, although the impact is lower.

Also, The R^2 is higher than 0.90 in the case of the equations of GDP, government revenue, government total spending in the same way than the VAR-X Model 1. Therefore, there is not a significant difference between both model 1 and the alternative model 1.

Moreover, the impulse response functions of the alternative model 1 (see $D.1$, figure (6)) shows the same shape than with model 1, and the response of GDP is almost the same than before. In this case, an impact of one percentage point in government total spending generates an increase in around 0.125 percentages points in GDP which is a little higher than in the case of government primary spending.

All in all, the main results are robust when the measure of government spending is changed.

4.3.2 VAR-X Alternative Model 2

The VAR-X model 2 is modified by substituting government total spending instead of government primary spending, in order to test for robustness of the study.

In appendix $D.2$, table (11) and figure (7), there are shown the results and the impulse response functions respectively.

First, from Appendix $D.2$, table (11) it can be appreciated that the impact of government total spending is statistically significant only in the first lag at 1 percent level in the case of the private consumption as in the case in model 2. The coefficient is almost the same. Also, the impact of government total spending is only statistically significant in the first lag at 1 percent level in the case of gross capital formation.

However, in the equation of exports, the effects of government total spending on them is not statistically significant. The same results are obtained when exports is changed by openness to trade.

Also, The R^2 is higher than 0.90 in all of the equations of the system in the same way than model 2.

In addition, the impulse response functions of the alternative model 2 (see $D.2$, figure (7)) shows the same shape than with model 2 and the response is almost the same in the case of private consumption.. An impact of one percentage point in government total spending generates an increase in around 0.055 percentage points in private consumption. However, the response of gross capital formation is statistically significant in the second quarter and after the tenth quarter and approximately about 0.018.

In sum, the main results are robust when the measure of government spending is changed.

5 Final Remarks

This study aimed to test if an increase of government spending generates a positive response of the main macroeconomic variables in the case of Guatemala by using quarterly data.

They are estimated two main VAR-X models with a set of fiscal, macroeconomic and control variables to test the previous hypotheses. In the first model, it is considered GDP, fiscal and control variables. In the second model, there is considered private consumption, gross capital formation, exports and openness to trade instead of exports with both fiscal and control variables. In both models, the main explanatory variable is government primary spending.

The study found empirical empirical evidence that a positive government spending shock generates an increase in GDP, private consumption and gross capital formation. However, there is not empirical evidence that an increase in government spending increase neither exports nor openness to trade. Also, it seems that there is not crowding out effect in the case of Guatemala.

Also, there were estimated two alternative VAR-X models as a robustness test by including government total spending instead of government primary spending. The positive macroeconomic effect of government spending found in the main models with the use of government primary spending held in the estimation of the two alternative models, which gives confidence that the models are well specified.

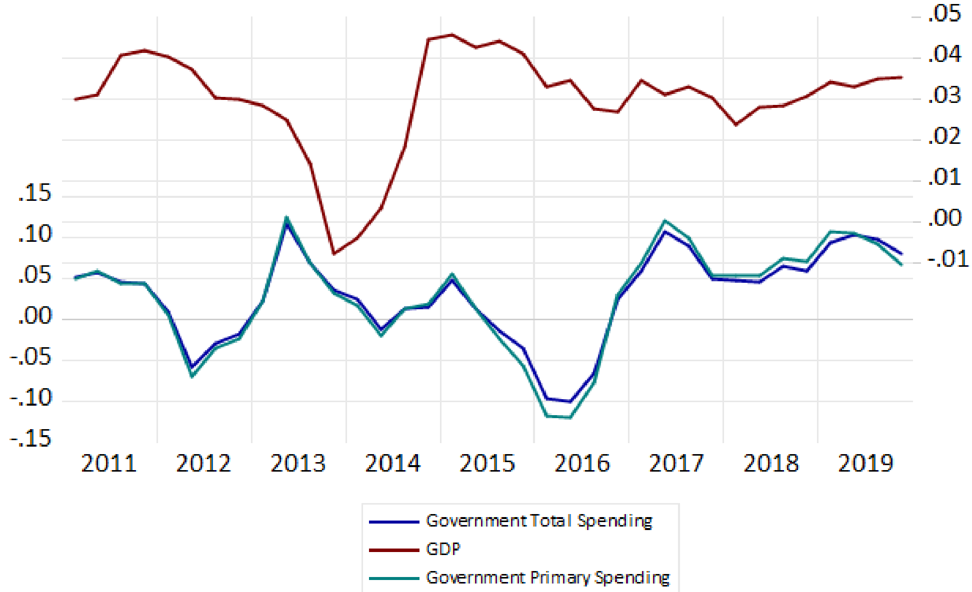
For future research, it may be important to address the crowding out theory in the case of Guatemala since the study found empirical evidence that government spending helps to increase gross capital formation, although it should be testing the previous theory with another specification model.

Also, it may be possible to remake the analysis of the macroeconomic effects of government spending with the inclusion of both years 2020 and 2021 and to test if the contribution of government spending were large over the coronavirus outbreak.

A Graphical Analysis

In this appendix, there are graphic analysis between GDP and both government primary and government total spending.

Figure 3: Annualized Inter-Annual Variations of GDP and Government Spending



Source: Own elaboration.

B Variables Description

Table 3: Variable Description

Variables	Description
y_t	Gross Domestic Product
exp_t	Exports
inv_t	Gross Capital Formation
$openness_t$	Openness to Trade
c_t	Private Consumption
gp_t	Government Primary Spending
it_t	Government Revenue
di_t	Internal Debt
de_t	External Debt
π_t^*	US Consumer Price Index
y_t^*	US Gross Domestic Product
$libor_t$	Libor Rate

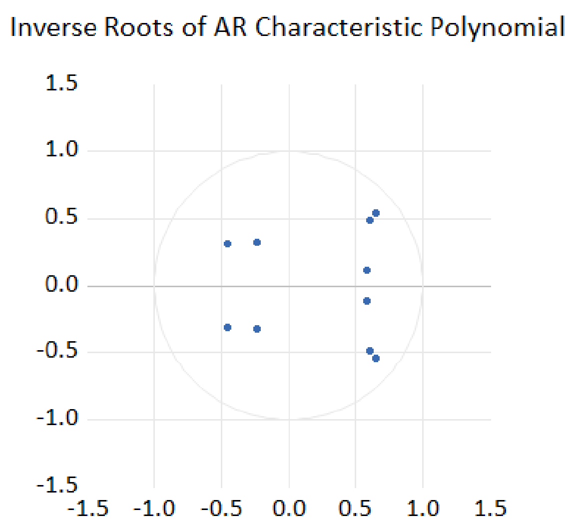
Source: Own elaboration

C Statistical Tests

In this appendix, there are the main statistical tests of the main models estimated in the case of Guatemala. First, they are shown the tables from VAR-X model and second, they are shown the tables from VAR-X model 2.

C.1 VAR-X Model 1

Figure 4: Stability Graph, Model 1



Source: Own elaboration.

Table 4: Multivariate Normality Test, Model 1

Component	Jarque-Bera	P-Values
1	1.1168	0.5721
2	0.2865	0.8665
3	2.3366	0.3109
4	5.6131	0.322
5	0.8890	0.0604
Model	1.4046	0.4954

Source: Own Elaboration

Table 5: Autocorrelation Test, Model 1

Lag	LRE* stat	P-Values	Rao F-stat	P-Values
1	31.0719	0.1867	1.3311	0.6116
2	22.9302	0.5816	0.8923	0.6116
3	15.1074	0.9388	0.5373	0.9455

Source: Own Elaboration

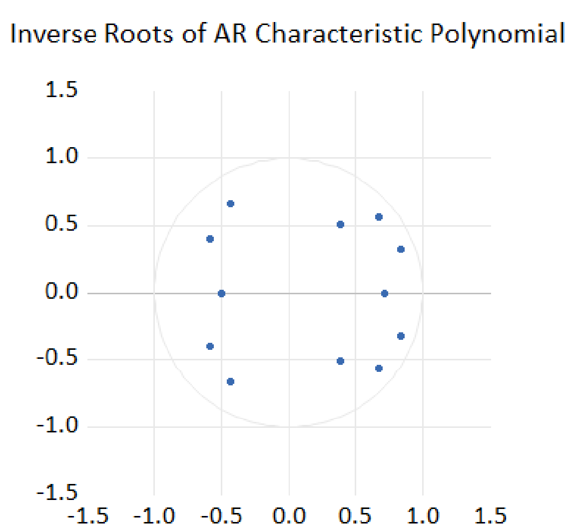
Table 6: Homoscedasticity Test, Model 1

Chi-sq	P-Value
454.5416	0.4313

Source: Own Elaboration

C.2 VAR-X Model 2

Figure 5: Stability Graph, Model 2



Source: Own elaboration.

Table 7: Multivariate Normality Test, Model 2

Component	Jarque-Bera	P-Values
1	2.3303	0.3119
2	1.4360	0.4877
3	1.2300	0.5406
4	5.0980	0.6962
5	0.7241	0.6962
6	0.6551	0.7207
Model	11.4763	0.4888

Source: Own Elaboration

Table 8: Autocorrelation Test, Model 2

Lag	LRE* stat	P-Values	Rao F-stat	P-Values
1	49.1907	0.0703	1.5342	0.1075
2	51.8933	0.0583	1.2841	0.0539
3	35.0617	0.5130	0.9327	0.5824

Source: Own Elaboration

Table 9: Homocedasticity Test, Model 2

Chi-sq	P-Value
716.3896	0.2614

Source: Own Elaboration

D Robustness Tests

D.1 VAR-X Alternative Model 1

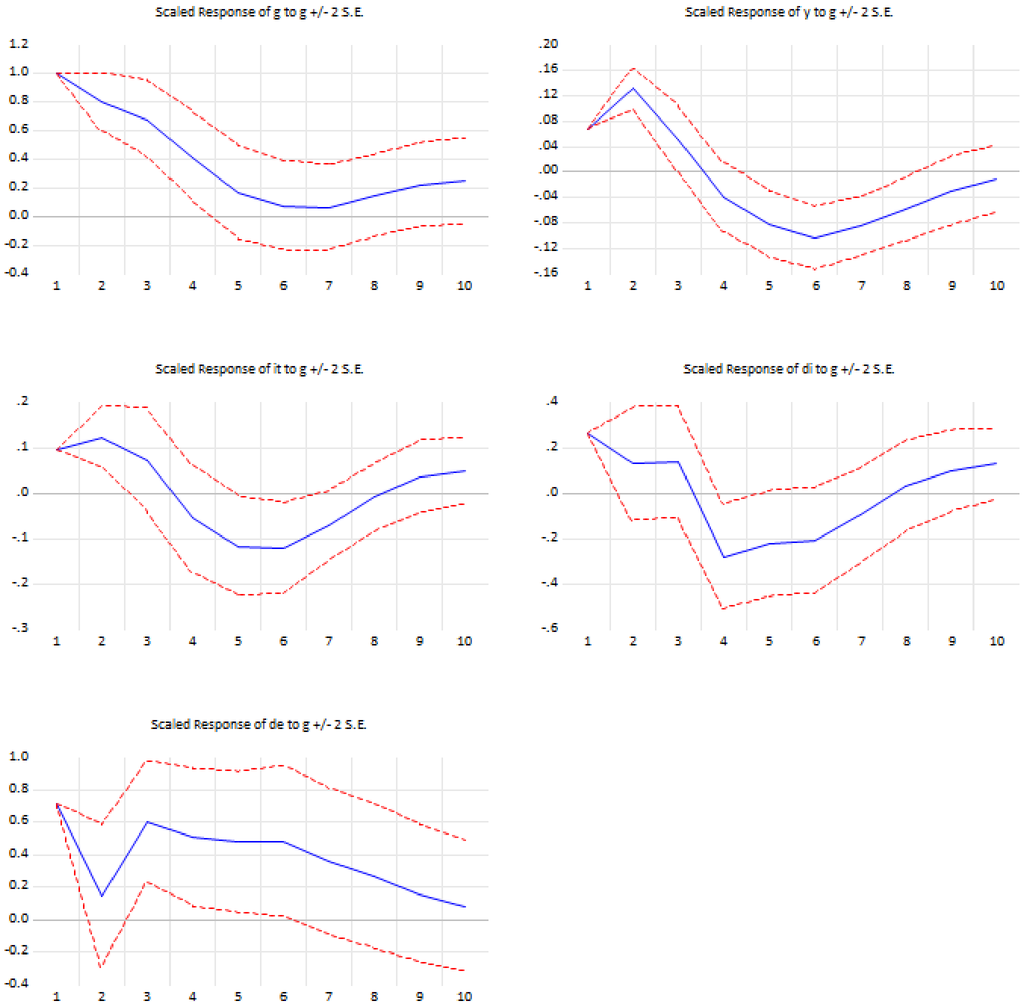
Table 10: VAR-X Alternative Model 1

Variables	g_t	y_t	it_t	di_t	de_t
g_{t-1}	0.3089	0.1175***	0.1554*	0.1818	0.2240
	(0.2778)	(0.0431)	(0.0918)	(0.3384)	(0.5887)
g_{t-2}	-0.0542	-0.09580***	-0.09030	-0.13581	0.4043
	(0.1697)	(0.0263)	(0.0561)	(0.2067)	(0.3596)
y_{t-1}	1.7865*	0.8662***	-0.2800	0.8477	-0.6834**
	(0.9558)	(0.1483)	(0.0.3158)	(1.1642)	(2.0252)
y_{t-2}	-1.4845*	-0.4157***	0.1406	-1.9529*	2.1861
	(0.9254)	(0.1436)	(0.2058)	(1.1274)	(1.9610)
it_{t-1}	0.9850*	-0.1009	0.9020***	0.3245	-0.3452
	(0.5641)	(0.0875)	(0.1864)	(0.6872)	(1.1954)
it_{t-2}	0.2004	-0.0483	-0.6981***	-0.2838	-1.5012
	(0.7350)	(0.1140)	(0.2429)	(0.8954)	(1.5575)
di_{t-1}	0.1165	-0.0532*	-0.0040	0.0734	0.1775
	(0.2100)	(0.0326)	(0.0694)	(0.0.2559)	(0.4451)
di_{t-2}	-0.0324	0.0833***	0.0505	0.3351*	-0.3481
	(0.1544)	(0.0239)	(0.0510)	(0.1881)	(0.3272)
de_{t-1}	0.3473**	-0.0304	-0.1400***	-0.2296	-0.0651
	(0.1673)	(0.0260)	(0.0553)	(0.2038)	(0.3545)
de_{t-2}	0.2187	-0.0367	0.0399	0.0976	0.3160
	(0.1718)	(0.0267)	(0.0568)	(0.2093)	(0.3641)
constant	-0.0903	0.0274**	0.0803***	0.0361	-0.0902
	(0.0853)	(0.0132)	(0.0282)	(0.1039)	(0.1807)
y_t^*	0.8451	-0.2446	-2.0165***	0.9641	-01.8275
	(2.4359)	(0.3779)	(0.8050)	(2.9673)	(5.1617)
π_t^*	-0.6559	0.0216	0.2083	0.3526	0.6437
	(1.2519)	(0.1942)	(0.4137)	(1.5250)	(2.6527)
$libor_t$	0.0283*	-0.0013	-0.0044	-0.0074	-0.0250
	(0.0150)	(0.0023)	(0.0050)	(0.0182)	(0.0317)
Observations	36	36	36	36	36
R-squared	0.9082	0.9555	0.9569	0.7858	0.6881

Note: Asterisks denote significant coefficients, with ***, **, * indicating significance at 1%, 5% and 10% level respectively. Standard deviations reported in parenthesis

Source: Own elaboration.

Figure 6: Impulse-Response Functions, Alternative Model 1



Source: Own elaboration.

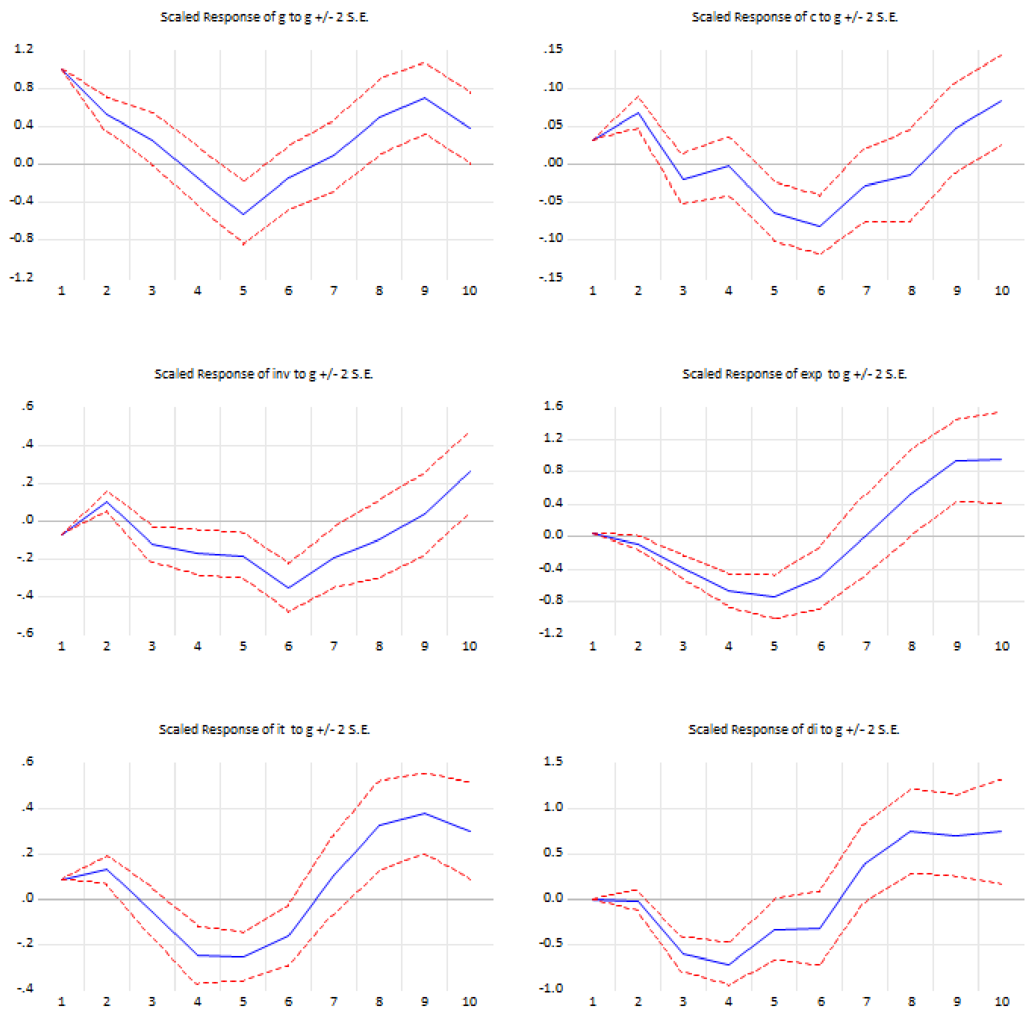
D.2 VAR-X Alternative Model 2

Table 11: VAR-X Alternative Model 2

Variables	g_t	c_t	inv_t	exp_t	it_t	di_t
g_{t-1}	0.6236***	0.0531***	0.1691***	-0.0651	0.0590	-0.0001
	(0.2000)	(0.0232)	(0.0615)	(0.1000)	(0.0732)	(0.1394)
g_{t-2}	-0.1359	-0.0324	-0.1482	-0.2160	-0.1188	-0.2534
	(0.2163)	(0.0251)	(0.0665)	(0.1081)	(0.0792)	(0.1508)
c_{t-1}	-3.7513***	0.0618	-1.2454***	-1.0023	-0.0300	-3.3716***
	(1.7147)	(1.9930)	(0.5272)	(0.8570)	(0.6275)	(1.1953)
c_{t-2}	2.5536*	0.3921**	-1.2505***	-1.4804	-0.6640	-4.2708***
	(1.6577)	(0.1927)	(0.5970)	(0.8285)	(0.6067)	(1.1556)
inv_{t-1}	1.3986***	-0.1058	0.5035***	0.0721	-0.0004	-0.0861
	(0.5654)	(0.0657)	(0.1738)	(0.2826)	(0.2069)	(0.3941)
inv_{t-2}	-0.6103	0.0218	-0.2187	-0.4743	-0.1419	-1.1979***
	(0.5009)	(0.0582)	(0.1540)	(0.2503)	(0.1833)	(0.3492)
exp_{t-1}	0.2999	0.1417***	0.3318***	0.7614***	0.2302	1.2557***
	(0.4318)	(0.0501)	(0.0.1328)	(0.2159)	(0.1584)	(0.3011)
exp_{t-2}	-0.5958	0.0110	0.3637***	-0.5687***	-0.1648	0.2156
	(0.4319)	(0.0502)	(0.1328)	(0.2290)	(0.1677)	(0.3194)
it_{t-1}	1.3764*	-0.0173	-0.0205	-0.1492	0.7357***	0.2110
	(0.7368)	(0.0856)	(0.2266)	(0.3683)	(0.2696)	(0.5136)
it_{t-2}	-0.9670*	-0.0781	-0.0844	0.6888***	-0.3445	-0.3529
	(0.6135)	(0.0713)	(0.1886)	(0.3066)	(0.2245)	(0.4277)
di_{t-1}	-0.0700	-0.0370	-0.2808***	0.3888***	-0.0317	-0.4921***
	(0.2758)	(0.0320)	(0.0848)	(0.0848)	(0.1009)	(0.1922)
di_{t-2}	-0.0137	-0.01189	-0.08062	0.3395***	0.0295	-0.0978
	(0.2323)	(0.0270)	(0.0714)	(0.1161)	(0.0850)	(0.1693)
Constant	-0.0352	0.02452**	0.1187***	0.01806	0.0753**	0.3345***
	(0.1105)	(0.0126)	(0.0340)	(0.0552)	(0.0.0404)	(0.0770)
y_t^*	0.3703	0.6820	0.8041	-1.0675	5.7843***	2.8431
	(2.3251)	(0.2702)	(0.7149)	(1.1621)	(0.8509)	(1.6208)
$libor_t$	-0.0045	-0.0046***	-0.0038	-0.0085	-0.0010	0.0099
	(0.0018)	(0.0048)	(0.0079)	(0.0058)	(0.0110)	(0.01572)
π_t^*	0.0176	0.0498	0.2945	-0.6335	0.2613	-1.3815
	(1.3914)	(0.1617)	(0.4278)	(0.6954)	(0.5092)	(0.9699)
rem_t	0.1131	0.0474*	0.2117***	0.1768*	-0.0112	0.0588
	(0.5134)	(0.0256)	(0.0677)	(0.1100)	(0.0806)	(0.1535)
Observations	36	36	36	36	36	36
R-squared	0.9096	0.9169	0.9678	0.9705	0.9479	0.9309

Source: Own elaboration.

Figure 7: Impulse-Response Functions, Alternative Model 2



Source: Own elaboration.

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