Linkages between the Eurozone and the South-Eastern European Countries: A VECMX* Analysis

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Abstract: In the present paper we assess the impact of the Eurozone's economic policies on specific South-Eastern European countries, namely Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey. Since these countries are connected to the EU or the Eurozone and the economic interdependence among them is evolving, we carried out our analysis using the VECMX* framework. Our results indicate that the transition economies in our sample react in a similar manner to changes in international macroeconomic policies. Cyprus and Greece react also in a similar way, but these responses are very small in magnitude. Finally, Turkey behaves in a different way, probably due to the inflationary pressures in its economy. In general, there is evidence of linkages and interdependence among the EU or Eurozone members of the region.

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1. Introduction

The integration procedure of the South-Eastern European economies to the European Union (EU) is continuously evolving during the last decades. Some of the South-Eastern European countries are either already members of the EU or the Eurozone, or associated with the EU; while others are set to become EU members. This integration procedure implies that the EU affects the above countries in a more systematic way. It has also led to the expansion of economic transactions in the whole region. Consequently, there is a need of systematic and detailed research about the economic policies of the countries in this region, especially in our days when the current financial and debt crisis in the Eurozone is at stake. For instance, Greece, which is a Eurozone member since 2001, is in deep recession with high sovereign debt, and having signed the Memoranda I and II with the ECB-EU-IMF, is in fiscal contraction and faces high unemployment. Also, the emerging economies of the South-Eastern Europe have relatively high current account deficits and are more vulnerable to the deterioration of the international economy, since they have been negatively affected by the reduction of external demand and the increase in the cost of borrowing from abroad.

In this study we attempt to investigate the monetary transmission mechanism of the Eurozone's monetary policy for seven countries of South-Eastern Europe, namely Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey. Also, we explore the way that foreign macroeconomic variables affect their domestic counterparts, for each of the above countries. Especially for the transition economies (Bulgaria, Croatia, Romania and Slovenia) this analysis will allow us (a) to understand how fast, and to what extent, a change in the central bank's instruments modifies domestic variables, such as inflation, and (b) to evaluate whether monetary transmission operates differently in the transition economies. In general, the monetary policy transmission mechanism in Central and Eastern Europe has been analysed by Coricelli, Égert and MacDonald (2006). These authors studied this mechanism through four channels: (i) interest rate channel, (ii) exchange rate channel, (iii) asset price channel, and (iv) broad lending channel.

The literature about monetary policy transmission mechanism is quite large and extending. In general, the interest rate pass-through is usually investigated using an error correction model (ECM) framework. Regarding the transition countries of the Central and Eastern Europe, several researchers have studied the asymmetry of the adjustment process, in relation to the Eurozone countries, with mixed results (Opiela, 1999; Crespo-Cuaresma, Égert and Reininger, 2004; Horváth, Krekó and Naszódi, 2004; Sander and Kleimeier, 2004; Égert, Crespo-Cuaresma and Reininger, 2006). Additionally, a number of researchers have studied the long-run pass through. Their results indicate that both the contemporaneous and long-run pass-through increase over time, while the mean adjustment lag to full pass-through decreases, as more recent data have been used (Crespo-Cuaresma, Égert and Reininger, 2004; Horváth, Krekó and Naszódi, 2004; Sander and Kleimeier, 2004). Also, there is a number of studies that investigate the exchange-rate pass-through in the transition economies, using mainly vector autoregressive (VAR) and vector error-correction (VECM) models (see, for instance, Darvas, 2001; Mihaljek and Klau, 2001; Coricelli, Jazbec and Masten, 2003; Gueorguiev, 2003; Kara et al., 2005; Korhonen and Wachtel, 2005).

Since the economies of South-Eastern Europe are quite interdependent and influenced, as well, by the the EU and the Eurozone, models that have been used for studying the domestic economies are not well-suited, since they do not take into account the way economies react to economic and financial interdependencies. In the last decades, the use of VARs and the subsequent cointegration analysis have resulted in long-run relations between various variables in the same economy, as suggested by economic theory. However, many long-run relations in one country may be influenced and affected by variables from other regions. One of the problems with the VAR methodology is that it works with a limited number of variables. But in order to incorporate a reasonable number of variables to account for global effects, large dimensionally system are required. A very important step in this direction is the development of Global VAR (GVAR) modelling developed by Pesaran, Schuermann and Weiner (2004, henceforth PSW), which facilitated the study of international linkages. This methodology has been used to examine the interdependencies of economies worldwide. More specifically, it was used to investigate the changing degree of the dominance of the USA economy and its effect on other regions (Dées and Sain-Guilhem, 2009), the analysis of the Swiss economy (Assenmacher-Wesche and Pesaran, 2009), the role of China and its increased influence around the world (Feldkircher and Korhonen, 2012), the linkages in the euro area (Dées, di Mauro, Pesaran and Smith, 2005), world trade flows (Bussiére, Chudik and Sestieri, 2012), and regional financial effects (Galesi and Sgherri, 2009).

In the present paper we investigate the impact of the Eurozone's economic policies on specific economies of South-Eastern Europe, namely Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey. Today, these economies are interdependent, since they are with one way or another connected to the European Union (EU) and the Eurozone.[1] Thus, there is a need of detailed investigation of the economic policies of the above countries, as well as the effects of the Eurozone policies. To carry out this task, we followed the methodology developed firstly by Pesaran, Shin and Smith (2000) and further extended by PSW (2004) in the GVAR framework. This methodology allows us to estimate country-specific VECMX* models and to evaluate econometric long-run relationships, including non-stationary foreign variables in each of them. Note here that we did not construct a full structural model with many equations in order to capture relationships proposed by economic theory. Data limitation is one reason. The other reason is that our sample countries are extremely heterogeneous. More specifically, some of them have been transformed from centrally-planned to free market economies and probably they have not yet settled to a long-run pattern. Also, for most of the sample countries there is an acute problem of structural uncertainty of their economies yet. Thus, our model is a reduced-form one.

In brief, our dynamic analysis indicates similar and expected impulse responses for Bulgaria, Croatia, Romania and Slovenia. The same conclusion can be drawn for Cyprus and Greece, but in these two cases the impulse response functions are very small in magnitude. Finally for Turkey, even though the effects from the impulse response functions are expected, most of them do not converge to a stable level in the time horizon that we have used. A possible explanation could be the strong inflationary tendencies in the Turkish economy.

The structure of the paper is organised as follows. Section 2 illustrates the framework of the VECMX* modelling, while section 3 reports the data and the model specification. Section 4 analyses the empirical results, section 5 presents the dynamic analysis, while section 6 draws some concluding remarks.

2. Country-specific Models

The model developed by PSW (2004) begins with country-specific models and assumes that there exist $N+1$ countries in the global economy. These countries are indexed by $i = 0,1,2,...,N,$ adopting country 0 as the reference country. For each country, the country-specific variables are related to the global variables. The latter are measured as country-specific weighted averages of foreign variables. The weights will be analysed in the following

[1] Bulgaria and Romania joined the EU in 2007; Croatia will join the EU in 2013; Cyprus is a Eurozone member since 2008; Greece is a Eurozone member since 2001; Slovenia is a Eurozone member since 2007 and Turkey has settled a customs union with the EU in 1996 and is under negotiations for EU membership in the future. The latter country also had a stand-by agreement with the International Monetary Fund (IMF) for a number of years.

section. In general, deterministic variables and global (weakly) exogenous variables (such as oil prices) are also included in each country specific model.

In brief, for a first-order dynamic specification that relates the $k_i \times 1$ vector of country specific variables (denoted by $\mathbf{x}_{it}$) to a $k_i^* \times 1$ vector of foreign variables specific to country i (denoted by $\mathbf{x}_{it}^*$), the VARX*(1,1) model is the following:

$$\mathbf{x}_{it} = \boldsymbol{\alpha}_{i0} + \boldsymbol{\alpha}_{i1} t + \boldsymbol{\Phi}_i \mathbf{x}_{i,t-1} + \boldsymbol{\Lambda}_{i0} \mathbf{x}_{it}^* + \boldsymbol{\Lambda}_{i1} \mathbf{x}_{i,t-1}^* + \boldsymbol{\varepsilon}_{it}, \ t = 1, 2, ..., T, \ N = 0, 1, 2, ..., N, \quad (1)$$

where $\boldsymbol{\Phi}_i$ is a $k_i \times k_i$ matrix of lagged coefficients, $\boldsymbol{\Lambda}_{i0}$ and $\boldsymbol{\Lambda}_{i1}$ are $k_i \times k_i^*$ matrices of coefficients related to foreign variables, and $\boldsymbol{\varepsilon}_{it}$ is a $k_i \times 1$ vector of idiosyncratic country-specific shocks. In the special case where $\boldsymbol{\Lambda}_{i0} = \boldsymbol{\Lambda}_{i1} = \mathbf{0}$, the model reduces to a standard VAR(1) process. We also assume that the idiosyncratic shocks are serially uncorrelated with zero mean and a non-singular covariance matrix, or $\boldsymbol{\varepsilon}_{it} \sim iid\left(\mathbf{0}, \boldsymbol{\Sigma}_{ii}\right)$.[2]

The error-correction representation of equation (1) is given by

$$\Delta\mathbf{x}_{it} = \boldsymbol{\alpha}_{i0} + \boldsymbol{\alpha}_{i1} t - \left(\mathbf{I}_{k_i} - \boldsymbol{\Phi}_i\right)\mathbf{x}_{i,t-1} + \left(\boldsymbol{\Lambda}_{i0} + \boldsymbol{\Lambda}_{i1}\right)\mathbf{x}_{i,t-1}^* + \boldsymbol{\Lambda}_{i0}\Delta\mathbf{x}_{it}^* + \boldsymbol{\varepsilon}_{it}. \quad (2)$$

Using $\mathbf{z}_{it} = \begin{bmatrix} \mathbf{x}_{it} \\ \mathbf{x}_{it}^* \end{bmatrix}$, equation (2) can be transformed to

$$\Delta\mathbf{x}_{it} = \boldsymbol{\alpha}_{i0} + \boldsymbol{\alpha}_{i1} t - \left(\mathbf{A}_i - \mathbf{B}_i\right)\mathbf{z}_{i,t-1} + \boldsymbol{\Lambda}_{i0}\Delta\mathbf{x}_{it}^* + \boldsymbol{\varepsilon}_{it}. \quad (3)$$

For country i we set the $k_i \times \left(k_i + k_i^*\right)$ matrix $\boldsymbol{\Pi}_i = \mathbf{A}_i - \mathbf{B}_i$, where its rank $\left(r_i\right)$ specifies the number of 'long-run' (cointegrating) relationships among the domestic and the country-specific foreign variables ($\mathbf{x}_{it}$ and $\mathbf{x}_{it}^*$, respectively). Thus, we have

$$\mathbf{A}_i - \mathbf{B}_i = \mathbf{a}_i \boldsymbol{\beta}_i', \quad (4)$$

where $\mathbf{a}_i$ is the $k_i \times r_i$ matrix of adjustment coefficients and $\boldsymbol{\beta}_i$ is the $\left(k_i + k_i^*\right) \times r_i$ matrix of cointegrating vectors. Note that both matrices are of full column rank.

3. Data and Model Specification

Our sample consists of monthly data for the period 2000:01-2011:12. We included Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey, along with EMU12 as the base country. We obtained data for real effective exchange rates based on consumer price index

[2] PSW (2004) indicate that for the idiosyncratic shocks there is allowance of limited correlation across countries, while the assumption regarding time invariance of the country-specific covariance matrices can be relaxed.

(RER), harmonised consumer price index (HCPI), index of industrial production (IP) and interest rates (IR). We used money market rates for all countries, except for Greece and Cyprus, for which these data were not available. For that reason, we used Treasury bill rates (TB) for Greece and government bond yields (GB) for Cyprus. We also obtained data for the nominal exchange rate of the euro against the US dollar (number of euros per US dollar - NER) and for the oil price (OIL). Almost all data were obtained from the International Financial Statistics of the IMF. The real effective exchange rate for Slovenia and Turkey, the harmonised consumer price index for all countries, and the index of industrial production for the EMU (which excludes construction) were derived from the Eurostat. All data, except interest rates, were transformed into natural logarithms.

In our model, we used seven countries, namely Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey. For each of these countries we set the vector of domestic variable $\mathbf{x}_{it} = (RER_{it}, HCPI_{it}, IR_{it}, IP_{it})'$, with $k_i = 4$. EMU12 has been used as the reference country, in which we have also used NER and OIL as (weakly) exogenous variables. The vector $\mathbf{x}_{it}^*$ of the foreign ('starred') variables has been constructed from the domestic variables, using the following relations that are based on PSW (2004), equation 4:

$$\begin{aligned} &\mathbf{x}_{it}^* = (RER_{it}^*, HCPI_{it}^*, IR_{it}^*, IP_{it}^*)' \;, \\ &RER_{it}^* = \sum\nolimits_{j=0}^{N} w_{ij}^{RER} RER_{jt}, \\ &HCPI_{it}^* = \sum\nolimits_{j=0}^{N} w_{ij}^{HCPI} HCPI_{jt}, \\ &IR_{it}^* = \sum\nolimits_{j=0}^{N} w_{ij}^{MMR} IR_{jt}, \\ &IP_{it}^* = \sum\nolimits_{j=0}^{N} w_{ij}^{IP} IP_{jt}, \end{aligned} \tag{5}$$

For weights we based on trade weights. Trade data were obtained from the Comtrade database of the United Nations. Note that if we allow trade weights to vary over time could introduce an undesirable degree of randomness in the analysis. For this reason and based on the PSW (2004) analysis, we used fixed trade weights. These fixed trade weights were computed as averages of trade flows for the 2001-2006 period, and are presented in Table 1. The trade shares for each country are presented in columns and show the degree to which one country depends on the remaining ones.

In our analysis, we estimate vector error-correction models (VECMX*s) for each sample country, where the domestic macroeconomic variables (real effective exchange rate, harmonised consumer price index, interest rate and industrial production) are related to corresponding foreign ('starred') variables constructed to match the international trade pattern of the country under consideration. The latter variables are treated as weakly exogenous for all sample countries. For Turkey we excluded domestic and foreign interest rates from the analysis. The reason is that the Turkish interest rate shows anomalies and extreme values for a long period of time, after the economic crisis of 2001 and the involvement of the IMF. For the VECMX* of the Eurozone, we used only the nominal exchange rate of the euro against the US dollar and for oil price as (weakly) exogenous variables.

4. Country-specific Cointegration Models

Before estimating each country-specific VECMX*, we tested each domestic, foreign and global variable for a unit root using Augmented Dickey-Fuller (ADF) and the KPSS (Kwiatkowski, Phillips, Schmidt and Shinn, 1992) unit root tests. In order to select the lag length in each regression of the ADF test, we started from 12 lags and employed the Akaike Information Criterion (AIC). The results are presented in tables 2 and 3 and indicate that all of the variables under consideration have a unit root.[3]

Given the fact that almost all of the variables have a unit root, we individually estimate each country-specific cointegration model (VECMX*). Since we are dealing with a small number of time series observations relative to the number of unknown parameters in each model, we started for a VECMX*(3,3) model for each country and chose the lag specification for endogenous and exogenous variables based on the AIC. The cointegration results are presented in table 4, while the selected (normalised on the real effective exchange rate) VECMX* for each country is presented in column 1 of this table.[4] The cointegration results imply that for each of Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey there exist one cointegrating vector at the 5 per cent level of significance. These results also show evidence of two cointegrating vectors for EMU12 at the 5 per cent level of significance. Tables 5 and 6 report the solved cointegrating vectors normalised on the real effective exchange rate, while tables 7 and 8 present the adjustment coefficients for the error-correction models.[5,6]

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[3] We also tested all variables for a second unit root. This hypothesis was rejected in all cases. For saving space, these results are not presented here but are available upon request.

[4] All estimations of the present paper were performed using the econometric package Microfit 5.

[5] Note that it is commonly acceptable that the coefficients of the (Johansen) cointegrating vector are not easily interpretable in many times, without imposing (overidentified) restrictions from economic theory. PSW (2004) use their estimates to generate forecasts without insisting on economic interpretations.

[6] The variables of the countries included in the model have probably experienced a number of structural shifts in their intercept or trend during the sample period, due to specific events that have taken place (e.g. the long transition period from centrally-planned to free markets economies for Bulgaria, Croatia, Romania and Slovenia, the involvement of the IMF in the Turkish Economy, and, of course, the current financial and debt crisis that

Also, we also tested our model for serial correlation in the residuals of the error-correction regressions. Based on the VECMX*s specification, we used lag order 3 for EMU12, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey, and lag order 2 for Bulgaria. The *F*-statistics for the serial correlations test are reported in table 9. As indicated in this table, 23 of the 31 regressions pass the serial correlation test, since for these cases the null hypothesis of no serial correlation cannot be rejected at the 5 per cent level of significance. Finally, before proceeding with the dynamic analysis and the estimation of generalised impulse response functions, we estimated the persistence profiles for each cointegrating vector. Persistence profiles refer to the time profiles of the effects of system or variable-specific shocks on the cointegrating relations (Pesaran and Shin, 1996). They have a value of unity on impact, while they should tend to zero as the horizon $n \to \infty$, if the vector under consideration is a valid cointegrating vector. The persistence profiles also provide information on the speed with which the cointegrating relationships return to their equilibrium states. The estimated persistence profiles for each cointegrating vector of our model are presented in Figure 1. As shown, they all converge very fast to zero (except for the second cointegrating vector of the EMU12 and the cointegrating vector of Turkey) implying that our cointegrating vectors are valid.

5. Generalised Impulse Response Functions

In this section we proceed with the dynamic analysis of our model using Generalised Impulse Response Functions (GIRFs), as they proposed by Koop, Pesaran and Potter (1996) for non-linear models and further developed in Pesaran and Shin (1998) for vector error-correcting models. The methodology of GIRFs differs from that of Orthogonalised Impulse Responses (OIRs) developed by Sims (1980) in the following two ways. Firstly, it does not require any a priori economic-based restrictions and its outcome is invariant to the ordering of the variables in the model, since it does not orthogonalise the residuals of the system. This methodology takes into account the historical correlations among the variables, summarised by the estimated variance-covariance matrix. Secondly, it cannot provide information about the causal relationships among the variables because the shocks are not identified. However, the GIRFs methodology is preferable in VAR analysis, since in most cases there is no reasonable way to order the variables in the model. It is important to note here that our dynamic analysis

affected all countries). Due to small sample and technical difficulties regarding the estimation of our model, we did not account for these potential structural breaks in the current analysis.

is carried out on the levels of the variables, implying that the effects of a given shock are typically permanent.

In the present analysis, we estimated GIRFs of one standard error (s.e) shock of each of the foreign (‘starred’) variables to each domestic variable. More specifically, for the EMU12 we investigated the propagation of a s.e. shock to the nominal exchange rate of the euro against the US dollar and to the oil price on the domestic variables. For each of Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey we explored the effects from one s.e. shock to each of the four ‘starred’ variables on each of the domestic variables. The GIRFs are presented in figures 2-9.

As shown in these figures, we obtain almost similar impulse responses for Bulgaria, Croatia, Romania and Slovenia. ‘Starred’ real effective exchange rate seems to have expected responses on the domestic variables of Bulgaria, Croatia and Slovenia, while for Romania there are some peculiarities. Also, ‘starred’ harmonised consumer price index and industrial production have expected results on the domestic variables of all these four countries. ‘Starred’ interest rate has a more complicated picture, reflecting probably the differences on economic policy implementation in these countries, due to different stages of integration with the EU. For Cyprus and Greece, we obtain similar, but very small in magnitude, impulse response functions. Again, ‘starred’ real effective exchange rate, harmonised consumer price index and industrial production seem to have expected responses on the domestic variables of the model. ‘Starred’ interest rate, which is money market rate, behaves differently, because for these two countries the corresponding interest rates are government bond yields (for Cyprus) and treasury bill rates (for Greece). Note also that all GIRFs for the above six countries are moving quickly to equilibrium (less than twelve months for most of them) and thus, our model seems stable.

Finally for Turkey, foreign real effective exchange rate, harmonised consumer price index and industrial production have positive effects on domestic real effective exchange rate, and harmonised consumer price index, and negative effects, as expected, on the domestic industrial production. For the domestic real effective exchange rate and harmonised consumer price index, most of the impulse response functions do not converge to a stable level in the time horizon that we have used. A possible explanation could be the strong inflationary tendencies in the Turkish economy.

6. Concluding Remarks

In this paper we assessed the impact of the Eurozone's economic policies on specific South-Eastern European countries, namely Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia and Turkey. To carry out our analysis, we used VECMX*s models, which allow the inclusion of non-stationary foreign variables that are treated as (weakly) exogenous. This approach seems quite appropriate, since it allows for the interdependencies that exist between national and international factors in a consistent manner.

In general, our results indicate that for the transition economies of South-Eastern Europe, namely Bulgaria, Croatia, Romania and Slovenia, changes in international (i.e. Eurozone's) macroeconomic policies have expected effects on their domestic variables. Similar and expected results are obtained for Cyprus and Greece, but for these two countries these results are very small in magnitude. Also for Turkey, changes in Eurozone's macroeconomic policies have expected results on the country's industrial production, but in the cases of domestic real effective exchange rate and harmonised consumer price index the generalised impulse response functions do not converge to a stable level in the time horizon that we have used. This anomaly could possibly be attributed to the strong inflationary tendencies in the Turkish economy.

Overall, the above results indicate that there are linkages (a) among the economies of the South-Eastern Europe, and (b) between each of these economies and the Eurozone. Our evidence also implies that the international (i.e. Eurozone's) economic policies affect the EU or Eurozone members of this region in the same way. On the other hand, the Turkish economy seems to behave relatively differently to Eurozone's macroeconomic policies.

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Table 1. Trade weights

Country	EMU12 (ex. Greece)	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
EMU12 (ex. Greece)	0.0000	0.6738	0.8272	0.6906	0.8402	0.8539	0.8667	0.8884
Bulgaria	0.0575	0.0000	0.0080	0.0121	0.0446	0.0229	0.0062	0.0280
Croatia	0.0688	0.0073	0.0000	0.0027	0.0030	0.0047	0.0946	0.0023
Cyprus	0.0178	0.0049	0.0040	0.0000	0.0295	0.0018	0.0003	0.0082
Greece	0.2036	0.1256	0.0079	0.2766	0.0000	0.0305	0.0063	0.0260
Romania	0.1759	0.0538	0.0124	0.0117	0.0293	0.0000	0.0125	0.0420
Slovenia	0.1183	0.0091	0.1269	0.0037	0.0037	0.0078	0.0000	0.0052
Turkey	0.3580	0.1256	0.0137	0.0027	0.0497	0.0785	0.0133	0.0000

Trade weights are computed as shares of imports and exports, shown in columns by country, such that a column sums to unity.

Table 2. ADF Unit Root Test Results

				Intercept and Trend				
Variable	EMU12	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
RER	-1.40	-2.35	-0.20	-1.98	-1.33	-1.58	-2.11	-2.55
HCPI	-3.35	-1.40	-2.36	-2.56	-2.49	-1.93	-2.83	-3.03
IR	-1.94	-1.47	-3.12	-0.86	-2.22	-1.65	-2.84	NA
IP	-3.03	-2.21	-0.50	-1.74	-0.20	-2.02	-1.89	-3.08
RER*	-2.68	-1.16	-1.28	-1.36	-0.94	-1.01	-1.18	-1.32
HCPI*	-2.33	-3.09	-2.89	-2.89	-2.89	-2.96	-2.85	-2.83
IR*	-2.98	-2.37	-1.77	-2.30	-2.69	-2.99	-1.75	NA
IP*	-2.29	-2.63	-1.05	-2.55	-1.04	-1.07	-1.01	-1.00
NER	-1.74							
OIL	-2.21							
				Intercept				
Variable	EMU12	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
RER	-1.73	-1.00	-2.15	-1.62	-1.32	-1.43	-2.03	-2.50
HCPI	-3.71*	-1.73	-0.63	-0.50	-1.16	-0.81	-2.14	-1.81
IR	-1.46	-1.21	-2.42	-2.07	-2.06	-2.00	-1.30	NA
IP	-1.98	-1.91	-2.33	-1.47	-0.67	-1.22	-1.94	-1.20
RER*	-2.32	-2.20	-1.77	-1.67	-1.99	-2.46	-1.77	-1.69
HCPI*	-1.83	-3.85*	-3.69*	-4.57*	-3.69*	-3.73*	-3.76*	-3.68*
IR*	-2.36	-2.09	-0.78	-1.77	-1.37	-2.06	-0.97	NA
IP*	-1.78	-2.36	-1.09	-2.01	-1.03	-1.03	-1.11	-1.05
NER	-1.37							
OIL	-0.38							

The value in each cell is the ADF unit root test statistic. The 95% critical value for this test is -3.44 for regressions with intercept and trend, and -2.88 for regressions with intercept. * denotes rejection of the unit root hypothesis at the 5% level of significance. NA stands for non-available.

Table 3. KPSS Unit Root Test Results

				Intercept and Trend				
Variable	EMU12	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
RER	0.29*	0.18*	0.18*	0.20*	0.25*	0.20*	0.20*	0.31*
HCPI	0.28*	0.29*	0.23*	0.17*	0.17*	0.19*	0.31*	0.34*
IR	0.25*	0.30*	0.49*	0.25*	0.28*	0.33*	0.25*	NA
IP	0.34*	0.32*	0.36*	0.36*	0.34*	0.26*	0.21*	0.21*
RER*	0.32*	0.31*	0.30*	0.29*	0.32*	0.30*	0.30*	0.30*
HCPI*	0.34*	0.28*	0.28*	0.28*	0.28*	0.28*	0.28*	0.28*
IR*	0.19*	0.22*	0.21*	0.26*	0.21*	0.20*	0.25*	NA
IP*	0.27*	0.19*	0.28*	0.23*	0.31*	0.29*	0.31*	0.30*
NER	0.26*							
OIL	0.23*							
				Intercept				
Variable	EMU12	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
RER	0.79*	1.37*	1.26*	1.09*	1.28*	1.06*	0.59*	0.89*
HCPI	1.25*	0.79*	1.41*	1.41*	1.41*	1.41*	1.36*	1.32*
IR	0.65*	0.50*	0.61*	0.75*	0.49*	1.25*	1.19*	NA
IP	0.54*	1.06*	1.13*	0.76*	0.72*	1.43*	0.93*	1.37*
RER*	0.99*	0.96*	0.84*	0.96*	0.93*	0.91*	0.88*	0.88*
HCPI*	1.36*	1.27*	1.26*	1.27*	1.25*	1.26*	1.26*	1.25*
IR*	1.08*	1.07*	0.91*	0.71*	1.05*	1.00*	0.81*	NA
IP*	1.23*	0.59*	0.73*	0.64*	0.99*	0.84*	0.77*	0.66*
NER	1.15*							
OIL	1.26*							

The value in each cell is the KPSS unit root test statistic. The 95% critical value for this test is 0.146 for regressions with intercept and trend, and 0.463 for regressions with intercept. * denotes rejection of the stationarity hypothesis at the 5% level of significance. NA stands for non-available.

Table 4. Cointegration Tests Results

Model		EMU12 (excluding Greece)				CV[a] Trace		CV maxλ	
VARX*(3,3)	p-r	Trace	Maxλ			95%	90%	95%	90%
restricted	4	186.44**	113.51**			94.60	88.33	43.37	40.78
trend,	3	72.93**	47.84**			63.70	59.75	35.05	32.58
unrestricted	2	25.09	16.89			38.53	35.57	28.38	24.75
intercept	1	8.20	8.20			20.06	17.31	20.06	17.31
Model		Bulgaria				CV Trace		CV maxλ	
	p-r	Trace	maxλ			95%	90%	95%	90%
VARX*(2,2)	4	137.83**	72.11**			101.62	97.05	47.74	43.68
restricted	3	65.72	35.26			72.05	66.57	38.99	35.98
trend,	2	30.46	22.13			44.78	40.81	30.59	28.08
no intercept	1	8.33	8.33			22.31	19.75	22.31	19.75
Model		Croatia				CV Trace		CV maxλ	
	p-r	Trace	maxλ			95%	90%	95%	90%
VARX*(3,1)	4	149.02**	89.78**			99.48	95.86	45.38	42.54
restricted	3	59.24	27.38			69.39	65.08	37.88	35.76
intercept,	2	31.86	17.86			43.03	39.58	30.57	27.54
no trend	1	14.01	14.01			22.14	19.71	22.14	19.71
Model		Cyprus				CV Trace		CV maxλ	
	p-r	Trace	maxλ			95%	90%	95%	90%
VARX*(3,3)	4	108.23*	53.55**			109.93	104.70	50.78	47.05
restricted	3	54.67	36.76			76.34	71.30	41.86	38.60
trend,	2	17.91	11.07			46.74	42.73	32.28	29.28
no intercept	1	6.84	6.84			23.56	20.62	23.56	20.62
Model		Greece		Slovenia		CV Trace		CV maxλ	
VARX*(3,1)	p-r	Trace	maxλ	Trace	maxλ	95%	90%	95%	90%
restricted	4	120.77**	50.86**	154.25**	84.25**	110.02	105.07	48.10	45.29
trend,	3	69.91	32.13	70.00	34.24	79.28	72.63	41.56	38.52
unrestricted	2	37.78	23.13	35.76	22.80	48.80	45.37	33.72	30.40
intercept	1	14.65	14.65	12.96	12.96	24.44	22.04	24.44	22.04
Model		Romania				CV Trace		CV maxλ	
	p-r	Trace	maxλ			95%	90%	95%	90%
VARX*(3,3)	4	110.32**	57.46**			108.88	103.71	50.23	45.99
restricted	3	52.86	26.73			74.66	69.92	40.73	38.08
intercept,	2	26.13	18.34			46.26	42.57	32.73	29.65
no trend	1	7.79	7.79			23.66	20.83	23.66	20.83
Model		Turkey				CV Trace		CV maxλ	
VARX*(3,2)	p-r	Trace	maxλ			95%	90%	95%	90%
unrestricted	3	92.83**	62.78**			59.27	54.92	35.18	31.70
intercept, no	2	30.05	25.03*			36.39	33.15	26.47	24.40
trend	1	5.02	5.02			19.08	16.71	19.08	16.71

[a] CV is for critical values. The 95% and 90% critical values are computed by stochastic simulations using 1000 replications. ** and * denote rejection of the null hypothesis at the 5% and the 10% level of significance, respectively.

Table 5. Estimated Coefficients of the Normalised Cointegrating Vectors

Parameter estimates	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
β_{RER}	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
β_{HCPI}	0.7766	0.1612	0.8885	0.7270	-3.7554	2.7287	-3.6776
β_{IR}	0.0165	-0.0020	-0.0019	-0.0049	-0.0090	0.0006	NA
β_{IP}	-0.6984	0.7068	0.2170	-0.1890	8.9426	-2.2333	-0.8282
β_{RER*}	0.0796	-0.0616	0.4194	0.4309	0.6293	0.1677	-0.3454
β_{HCPI*}	-0.0119	-0.0853	0.0354	-0.0596	-1.4906	-0.2500	3.1525
β_{IR*}	0.0018	-0.0066	0.0093	-0.0013	-0.0257	0.0227	NA
β_{IP*}	0.7777	-0.4826	-0.5429	0.1794	-3.3158	2.1138	1.4591
Intercept	NA	3.5353	NA	NA	-0.1386	NA	NA
Trend	0.0045	NA	0.0090	-0.0010	NA	-0.0028	NA

β's are the parameters of the solved cointegrating vectors, normalised on the real effective exchange rate. * indicates foreign variables. NA stands for non-available.

Table 6. Estimated Coefficients of the Normalised Cointegrating Vectors

Parameter estimates	EMU12 (excluding Greece)	
β_{RER}	1.0000	1.0000
β_{HCPI}	0.2127	0.0282
β_{IR}	0.0338	-0.0015
β_{IP}	-1.2642	-0.1262
β_{NER}	-0.7214	-0.5110
β_{OIL}	-0.0083	0.0496
Trend	-0.0021	-0.0021

β's are the parameters of the solved cointegrating vectors, normalised on the real effective exchange rate. * indicates foreign variables.

Table 7. Adjustment Coefficients

Parameter estimates	Bulgaria	Croatia	Cyprus	Greece	Romania	Slovenia	Turkey
α_{RER}	0.0009	-0.0116	-0.0470*	-0.0123*	-0.0094	-0.0165*	-0.0803
	(0.0076)	(2.0257)	(13.1155)	(15.8466)	(0.3135)	(12.4010)	(3.1310)
	[0.930]	[0.155]	[0.000]	[0.000]	[0.576]	[0.000]	[0.077]
α_{HCPI}	-0.0044	0.0061	0.0074	0.0034	-0.0186*	-0.0130*	-0.0330*
	(0.4348)	(0.7017)	(0.8864)	(0.7440)	(4.9046)	(7.1491)	(38.1675)
	[0.510]	[0.402]	[0.346]	[0.388]	[0.027]	[0.008]	[0.000]
α_{IR}	0.3315	0.5981	-0.2173	-0.0555	1.9402	-0.0166	NA
	(0.1581)	(0.1105)	(0.8561)	(0.1555)	(2.0764)	(0.0018)	
	[0.691]	[0.740]	[0.355]	[0.693]	[0.150]	[0.966]	
α_{IP}	-0.4504*	-0.4660*	0.2775*	-0.2051*	-0.2980*	-0.3690*	-0.1948*
	(78.9491)	(108.1310)	(27.3710)	(26.9618)	(52.6919)	(99.0004)	(8.1949)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.004]

α's are the adjustment coefficients. Numbers in parentheses are Wald test statistics for $H_0 : \alpha_i = 0$ and numbers in brackets are the respective p-values. * denotes rejection of the null hypothesis at the 5% level of significance. NA stands for non-available.

Table 8. Adjustment Coefficients

Parameter estimates	EMU12 (excluding Greece)	
α_{RER}	0.0026	-0.0354*
	(0.1035)	(19.6598)
	[0.748]	[0.000]
α_{HCPI}	-0.0322*	-0.0516*
	(8.1951)	(21.0767)
	[0.004]	[0.000]
α_{IR}	0.2578*	-0.1144
	(5.5604)	(1.0938)
	[0.018]	[0.296]
α_{IP}	-0.7821*	-0.0508
	(121.8808)	(0.5148)
	[0.000]	[0.473]

α's are the adjustment coefficients. Numbers in parentheses are Wald test statistics for $H_0 : \alpha_i = 0$ and numbers in brackets are the respective p-values. * denotes rejection of the null hypothesis at the 5% level of significance.

Table 9. Serial Correlation Tests of the VECMX* Residuals

Country	Δ(RER)	Δ(HCPI)	Δ(IR)	Δ(IP)
EMU12	5.0291*	2.4896	5.1776*	4.4748*
(excluding Greece)	(0.003)	(0.064)	(0.002)	(0.005)
Bulgaria	0.4780	1.9464	1.1492	2.4375
	(0.621)	(0.147)	(0.320)	(0.091)
Croatia	0.7408	1.8655	0.2777	0.9020
	(0.530)	(0.139)	(0.841)	(0.442)
Cyprus	1.0129	2.6043	2.5879	1.1303
	(0.390)	(0.055)	(0.056)	(0.340)
Greece	2.8459*	1.4902	2.4953	4.4555*
	(0.040)	(0.220)	(0.063)	(0.005)
Romania	0.3116	6.3188*	5.0579*	1.0469
	(0.817)	(0.001)	(0.002)	(0.375)
Slovenia	0.2213	0.4782	1.2518	2.8930*
	(0.881)	(0.698)	(0.294)	(0.038)
Turkey	1.9182	2.2266	NA	1.2499
	(0.130)	(0.088)		(0.295)

The value in each cell is *F*-statistic for the null hypothesis of no serial correlation. Numbers in parentheses are the respective p-values. * denotes rejection of no serial correlation at the 5% level of significance.

Figure 1. Persistence Profiles of the Cointegrating Relations to System-Wide Shocks

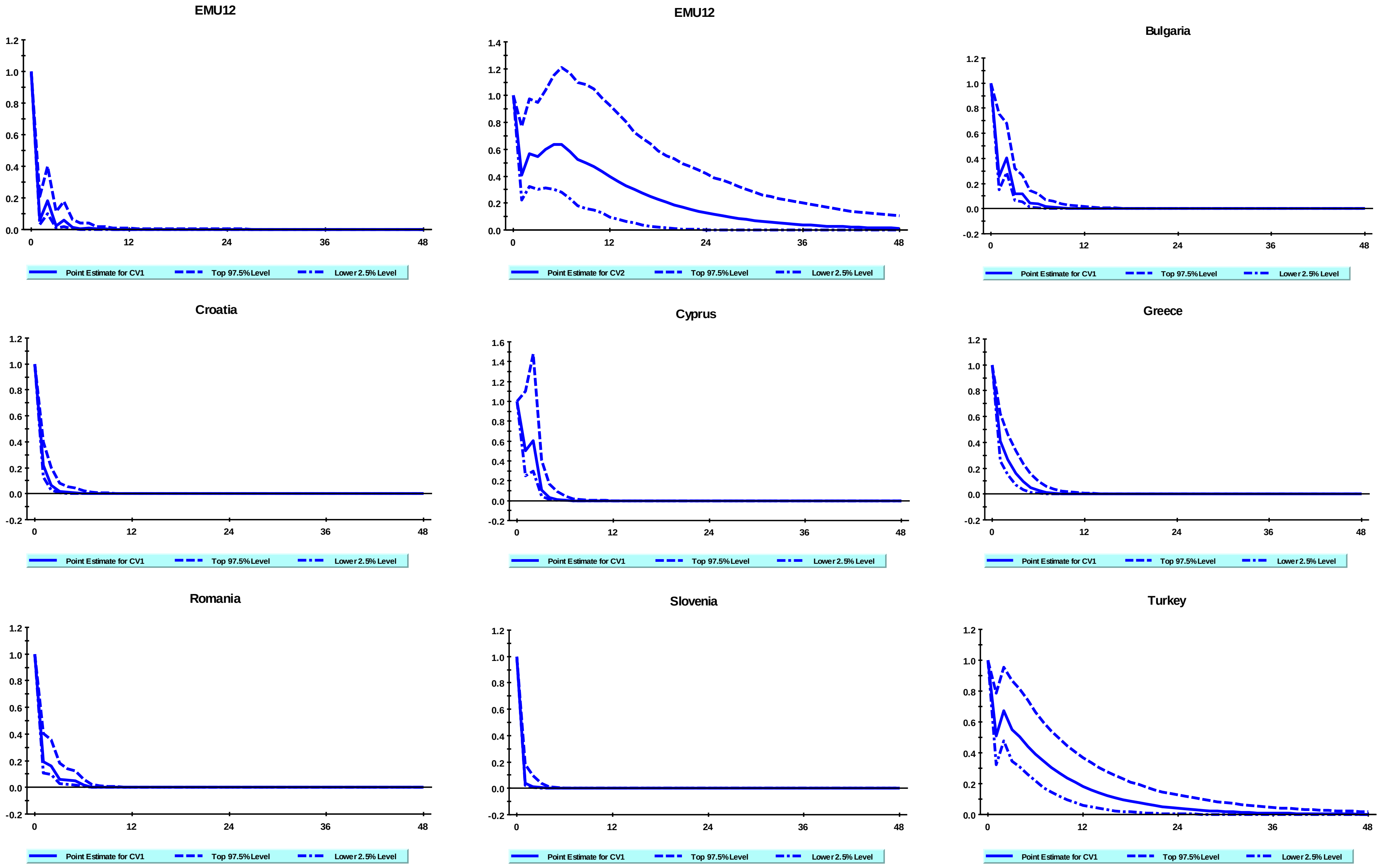


Figure 2: EMU12

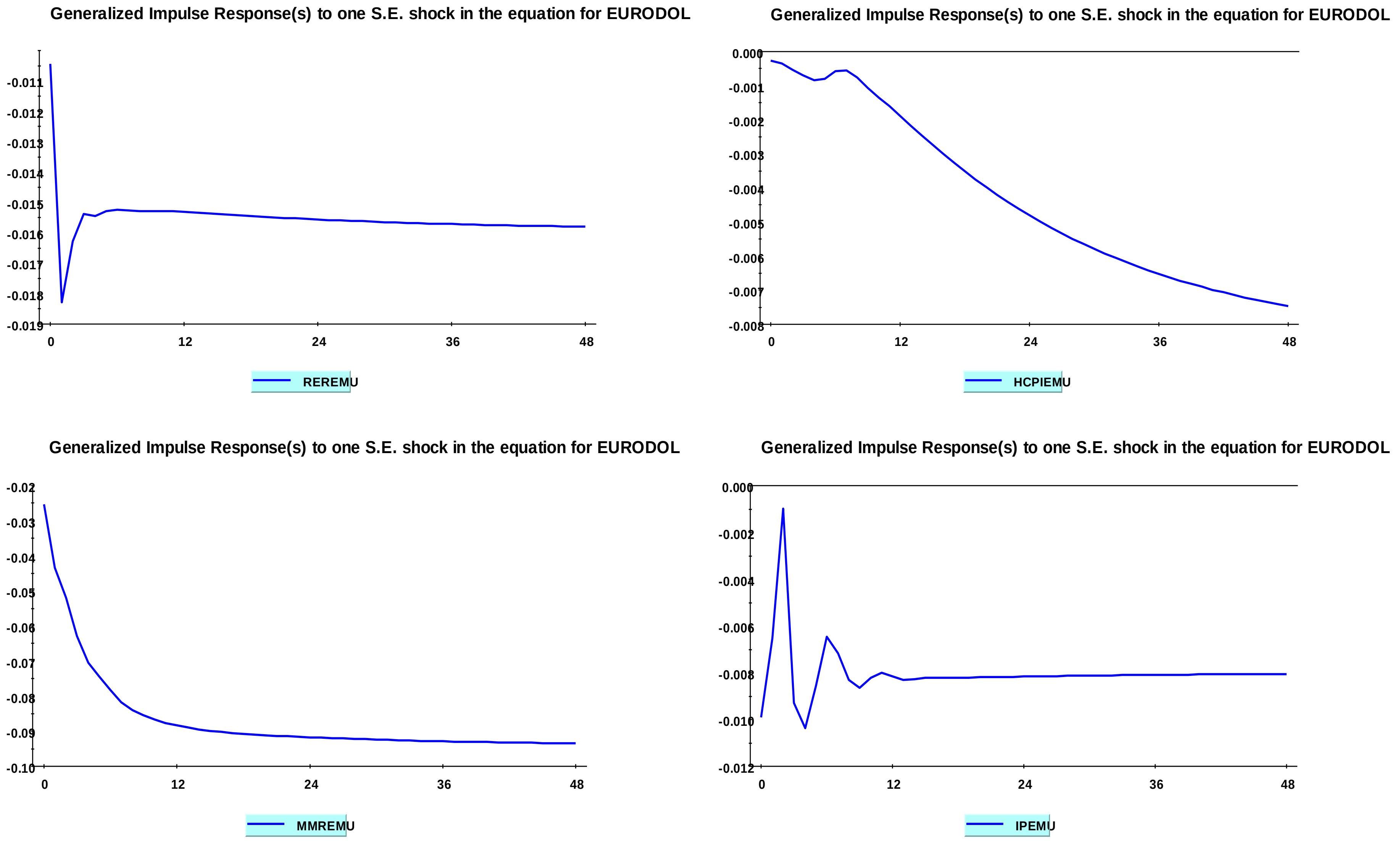


Figure 2 ***(continued)***

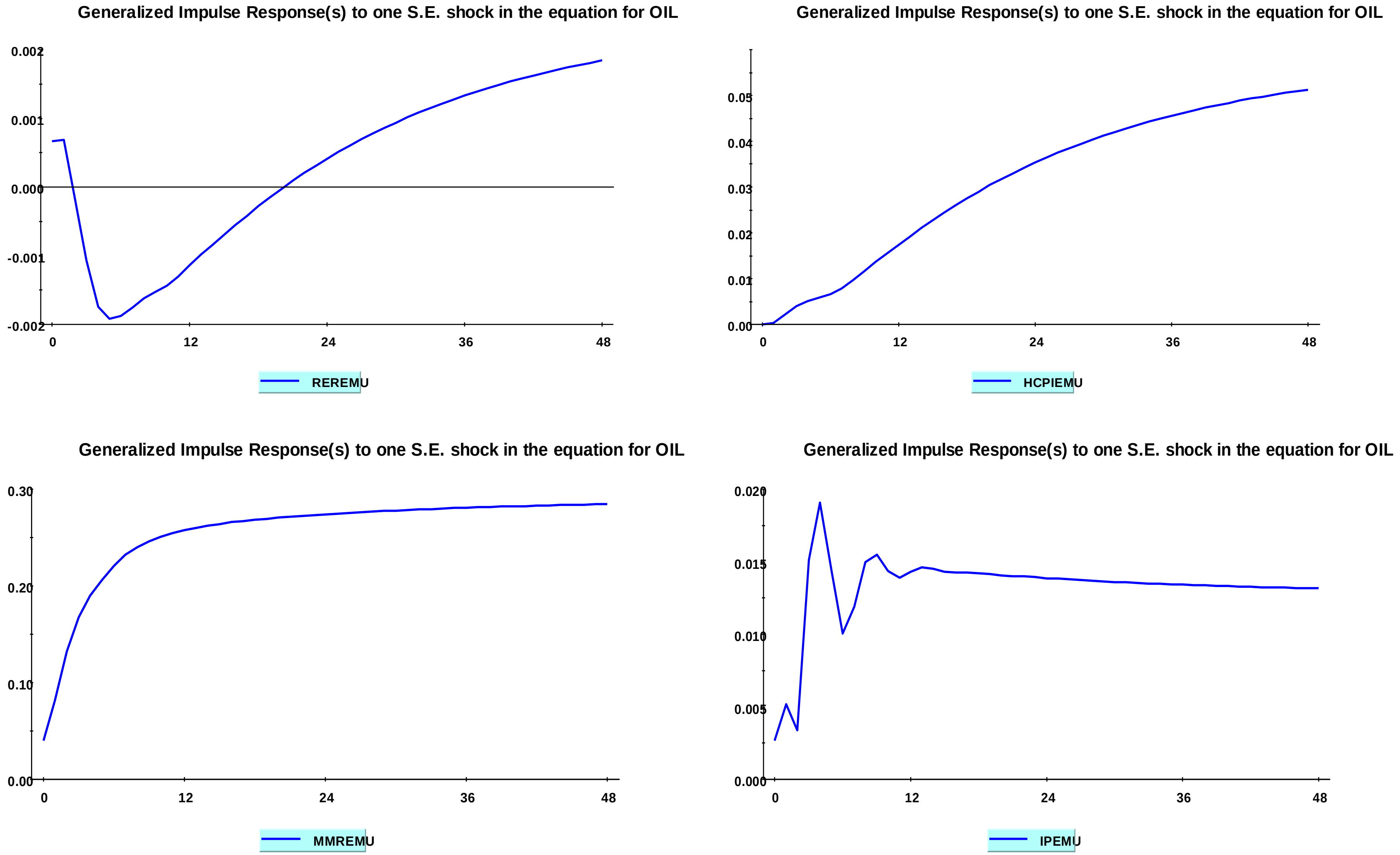


Figure 3: Bulgaria (SBUL in each variable denotes 'starred' variable)

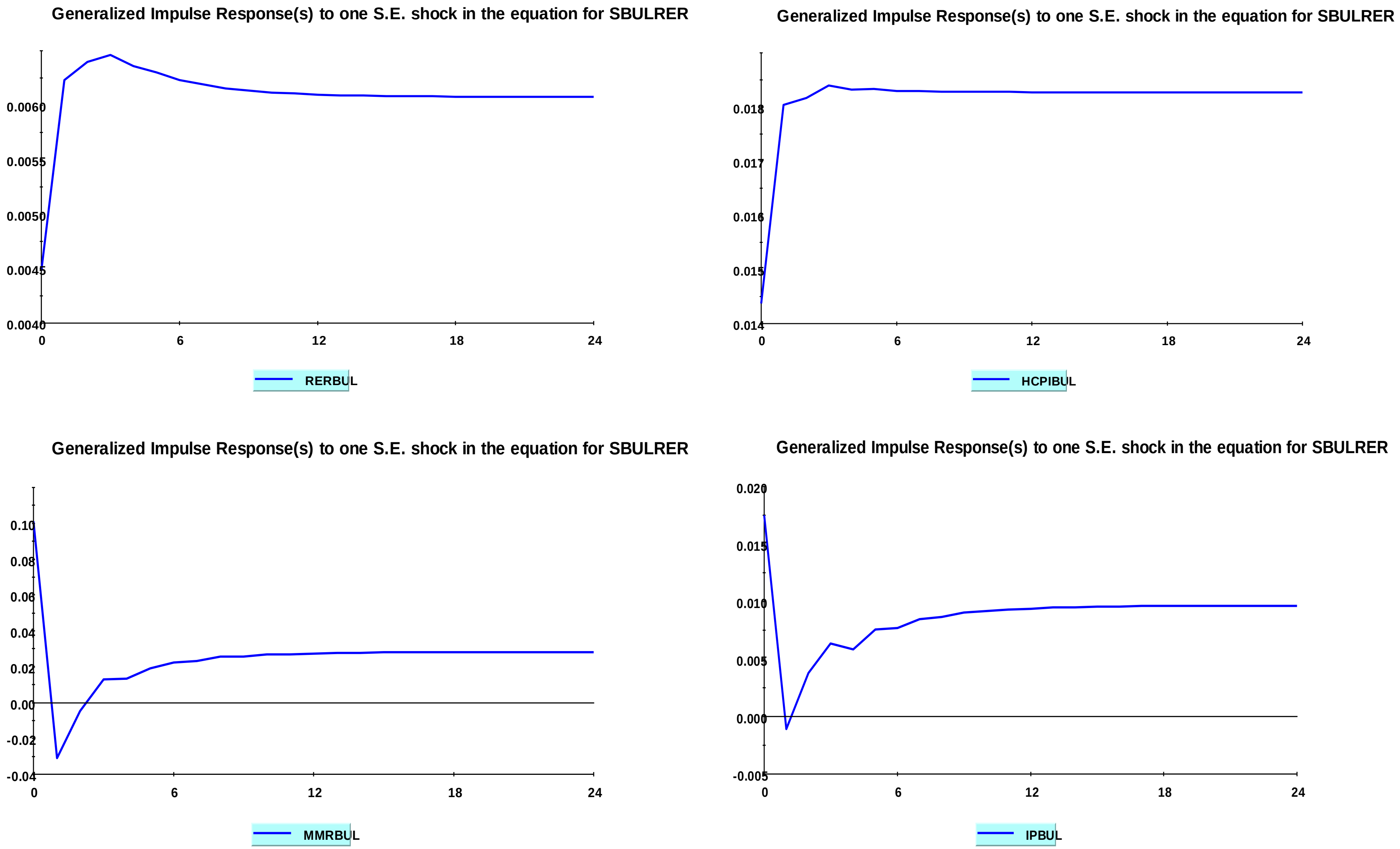
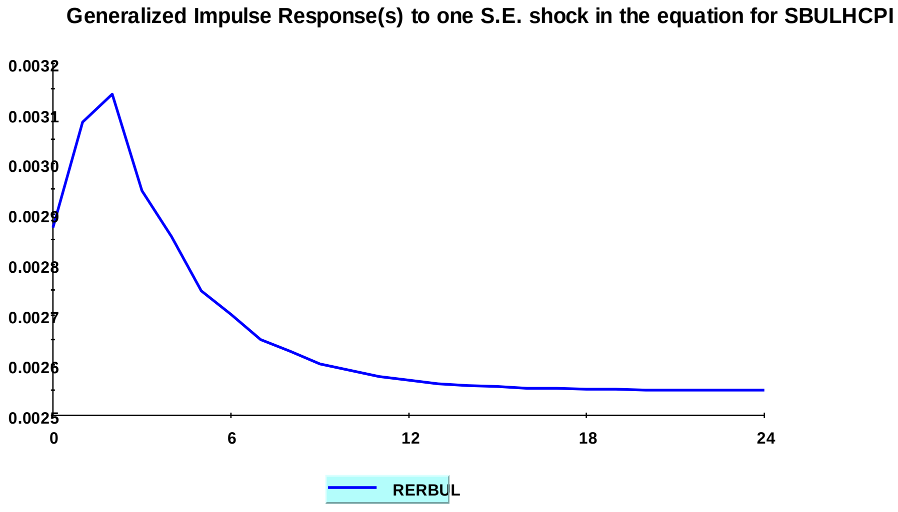
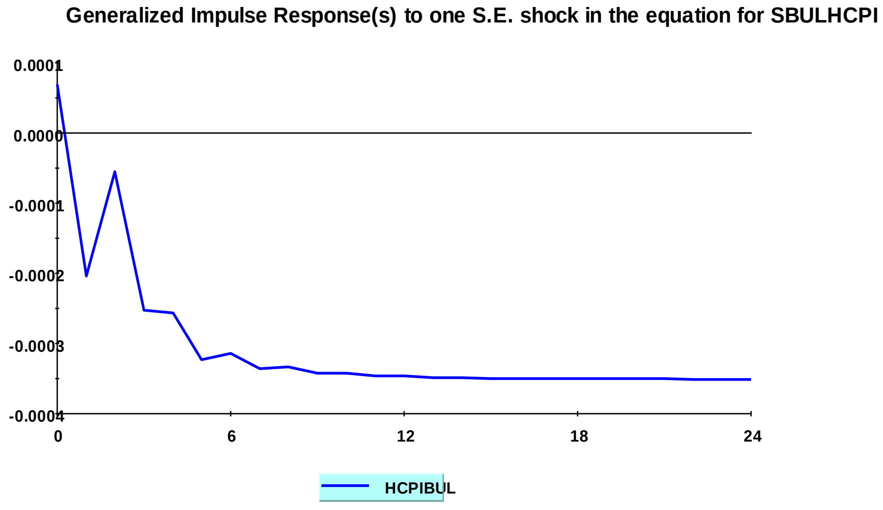
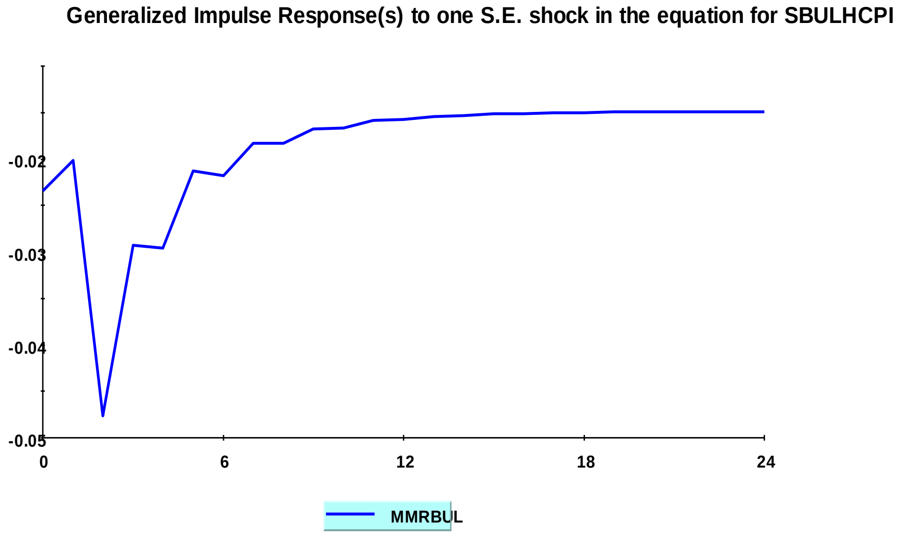


Figure 3 ***(continued)***







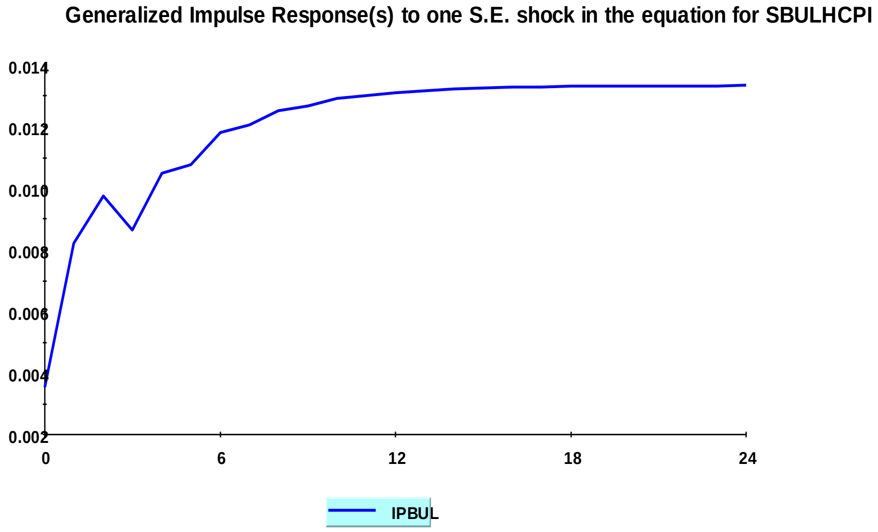
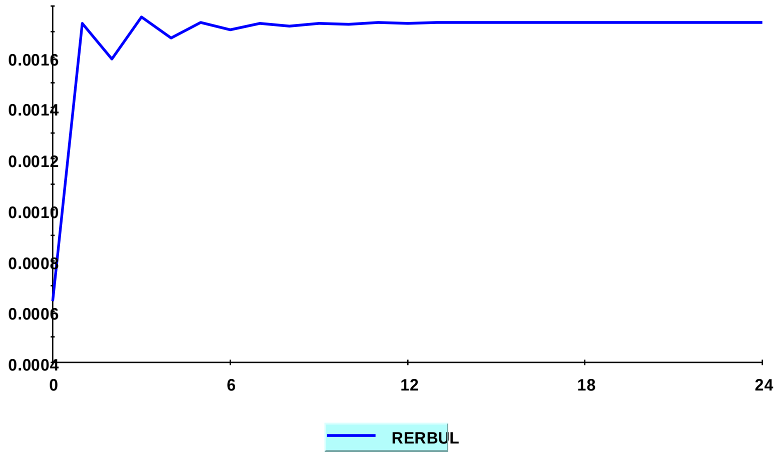
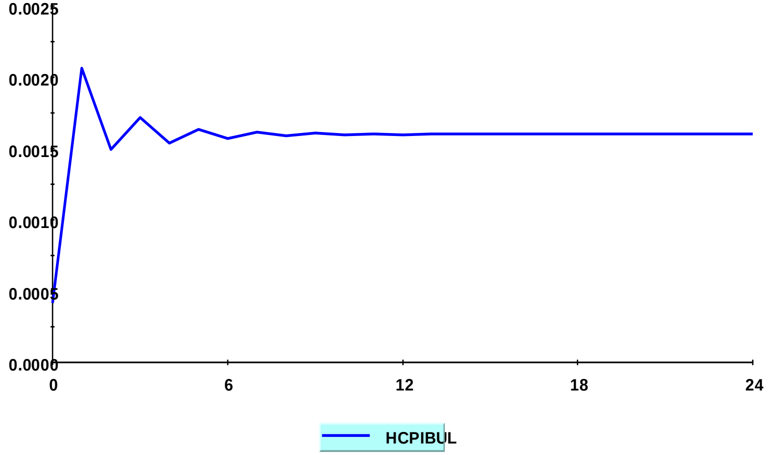


Figure 3 ***(continued)***

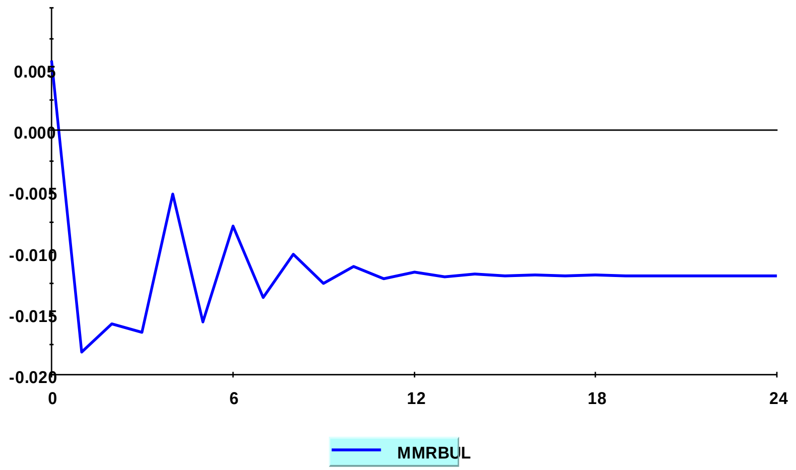
Generalized Impulse Response(s) to one S.E. shock in the equation for SBULMMR



Generalized Impulse Response(s) to one S.E. shock in the equation for SBULMMR



Generalized Impulse Response(s) to one S.E. shock in the equation for SBULMMR



Generalized Impulse Response(s) to one S.E. shock in the equation for SBULMMR

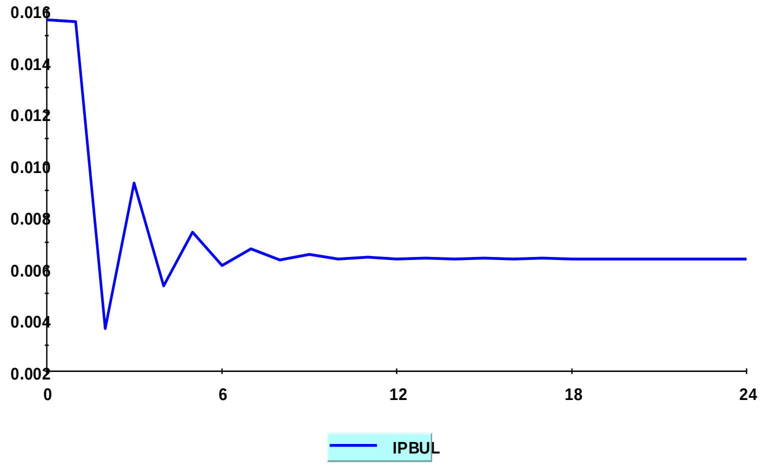
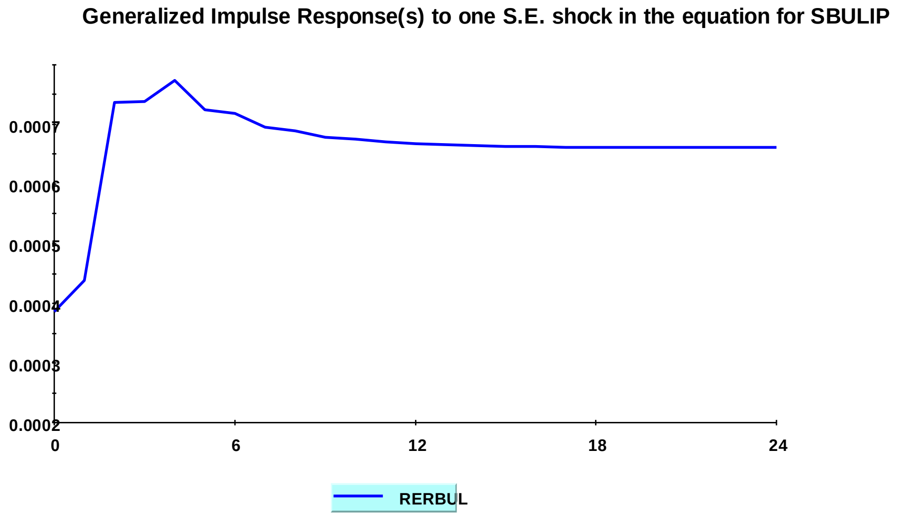
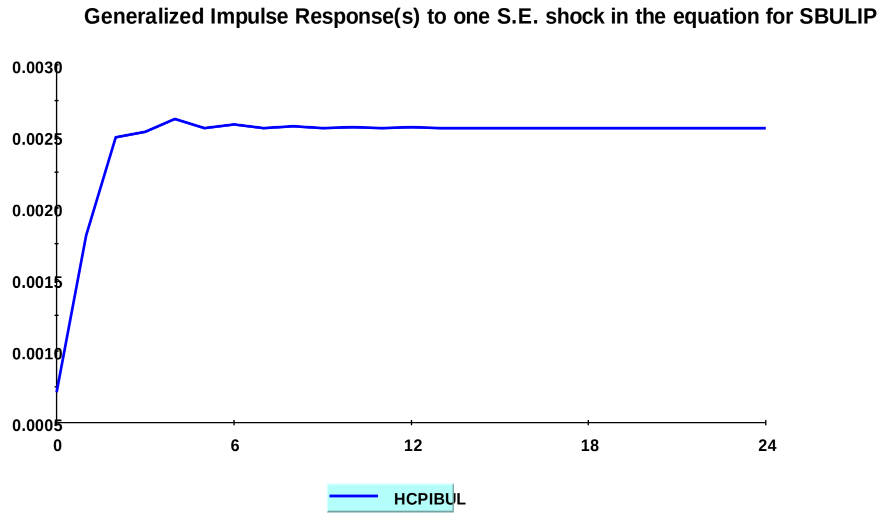
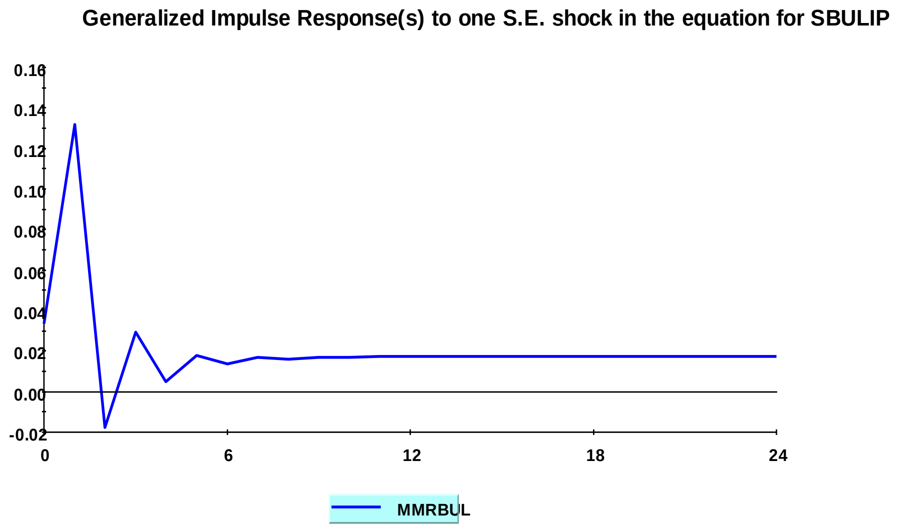


Figure 3 ***(continued)***







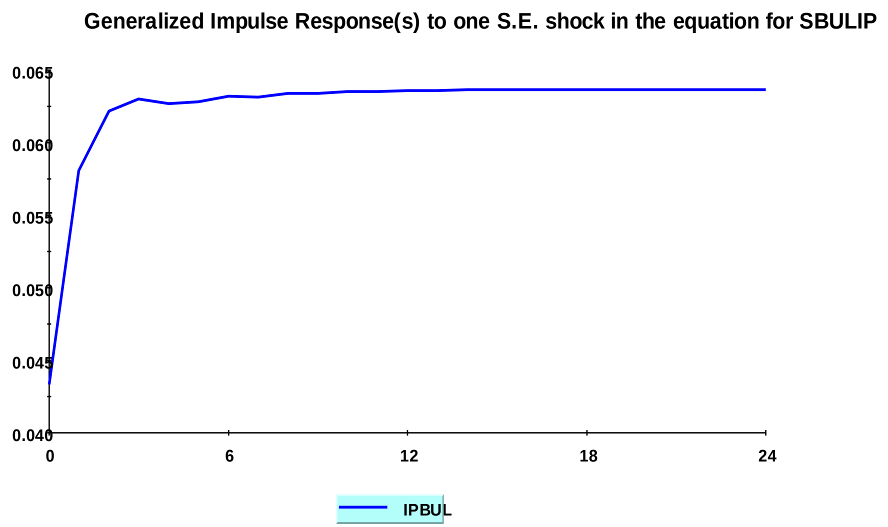


Figure 4: Croatia (SCRO in each variable denotes 'starred' variable)

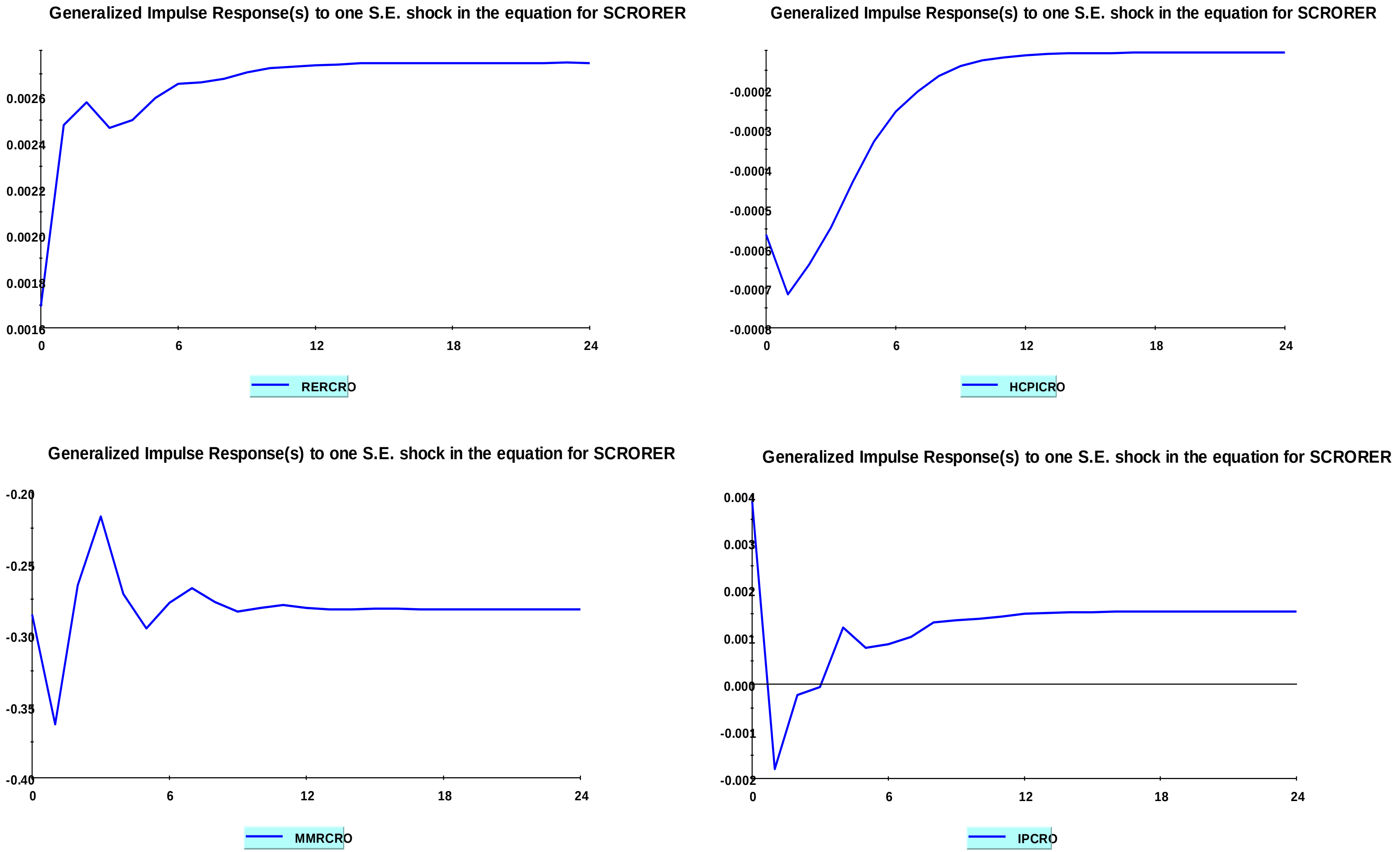
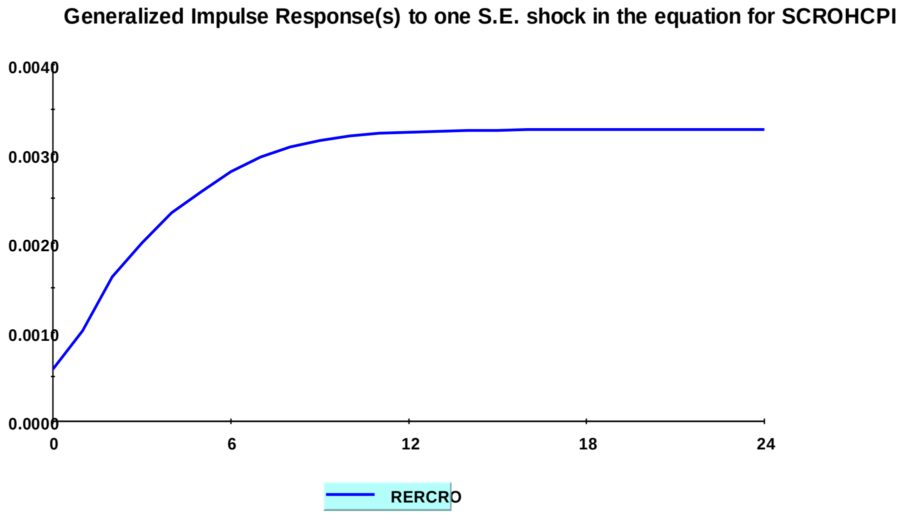
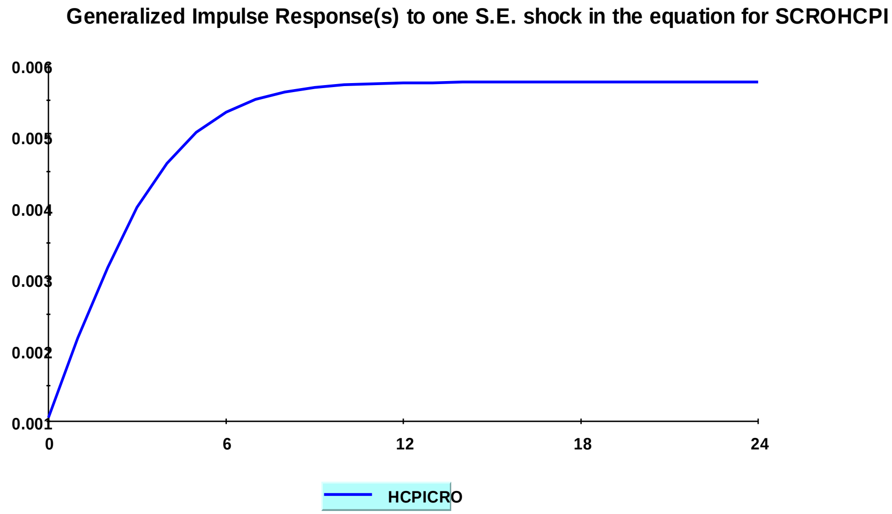
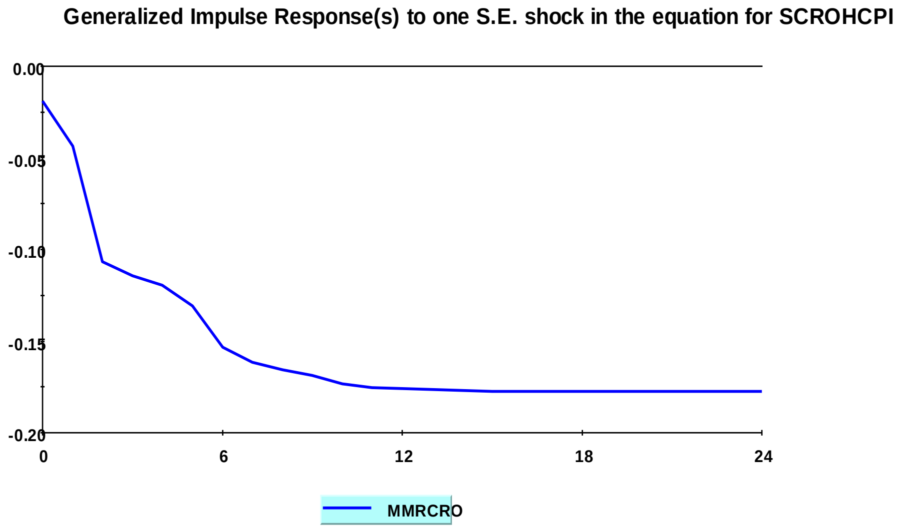


Figure 4 *(continued)*







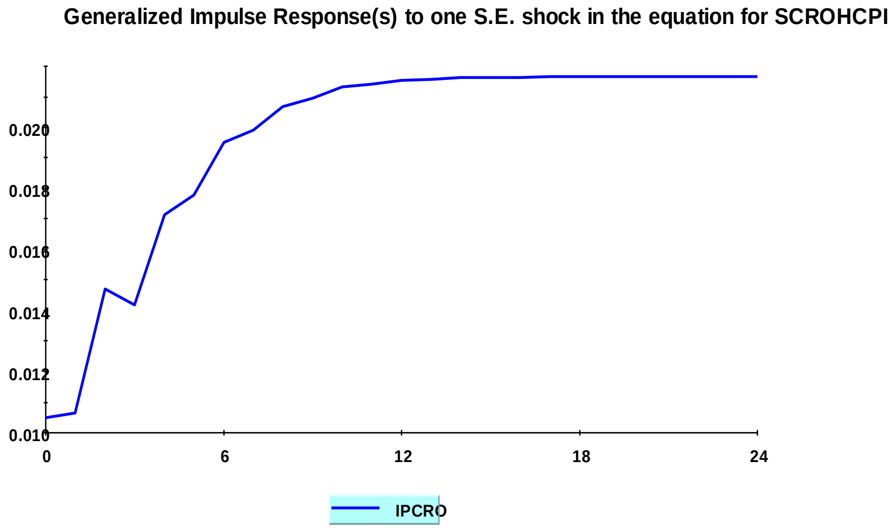
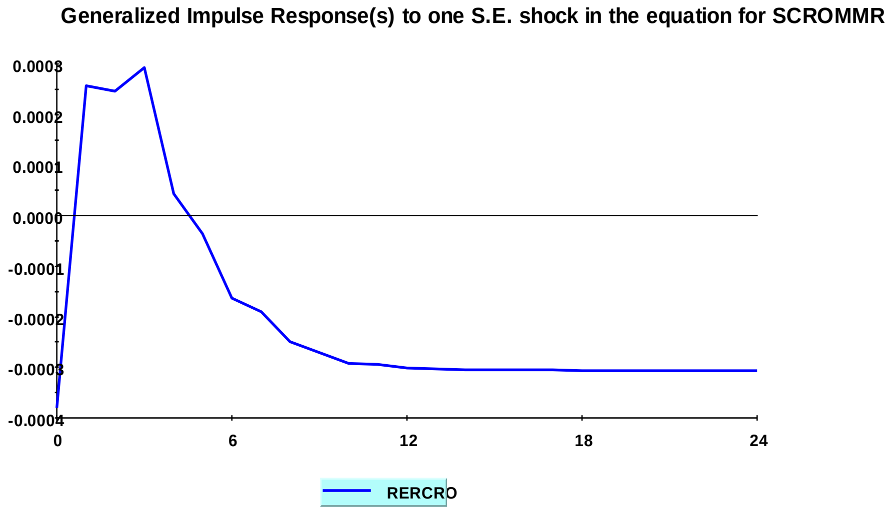
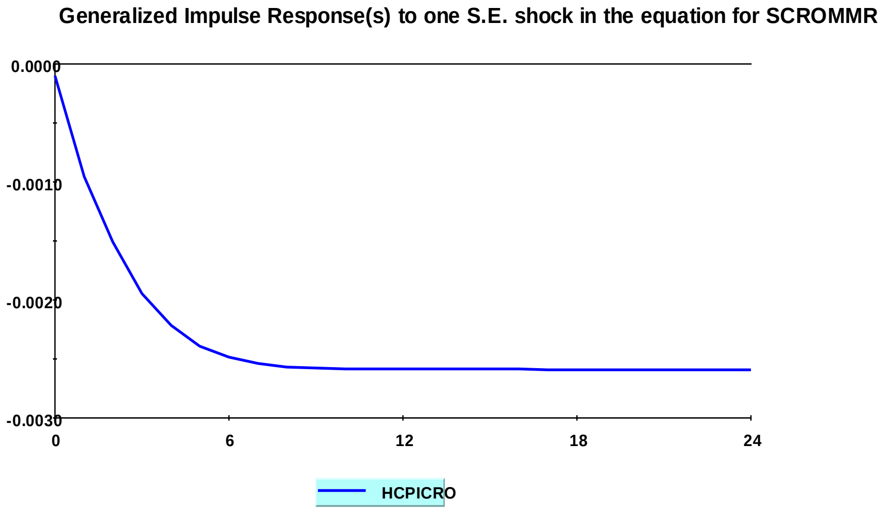
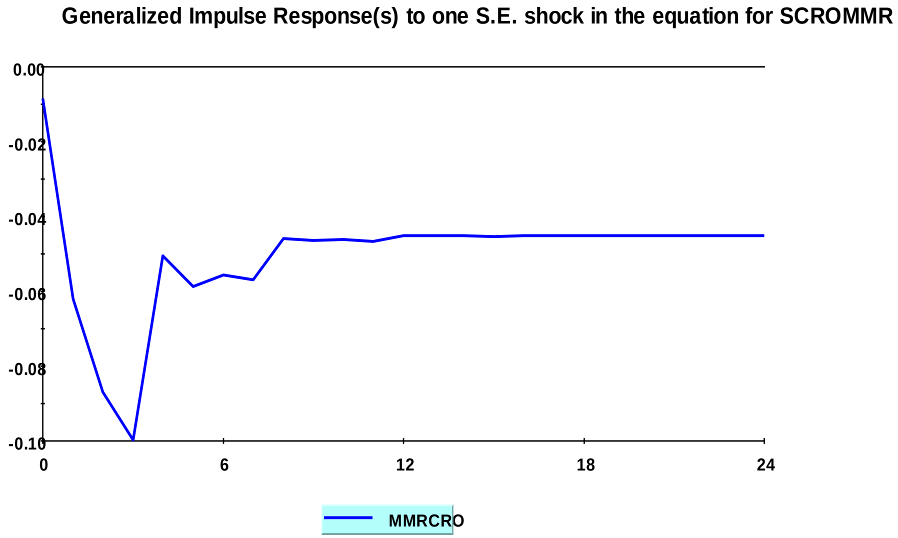


Figure 4 ***(continued)***







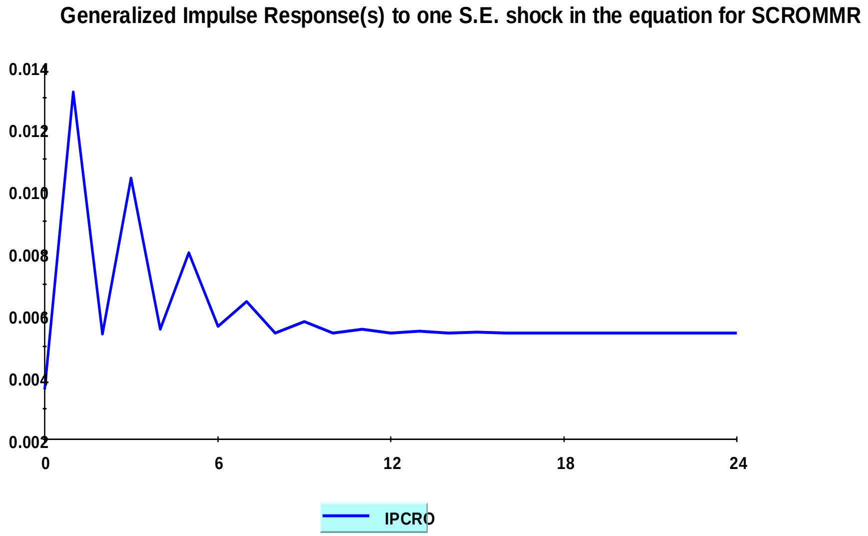


Figure 4 *(continued)*

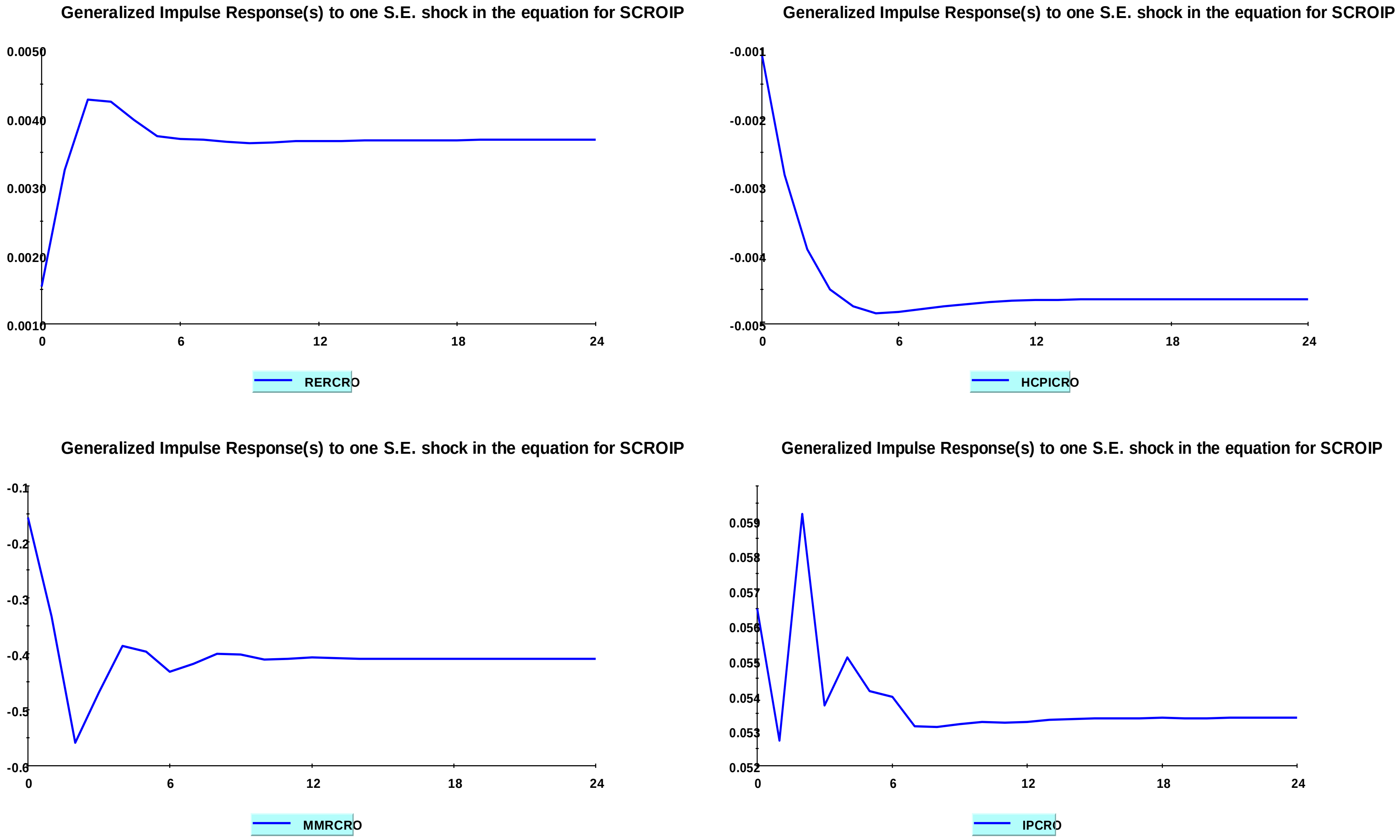
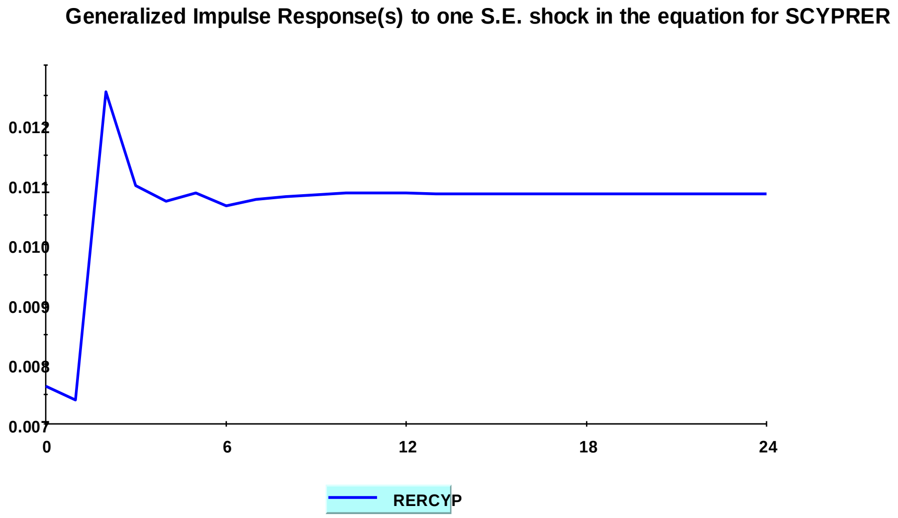
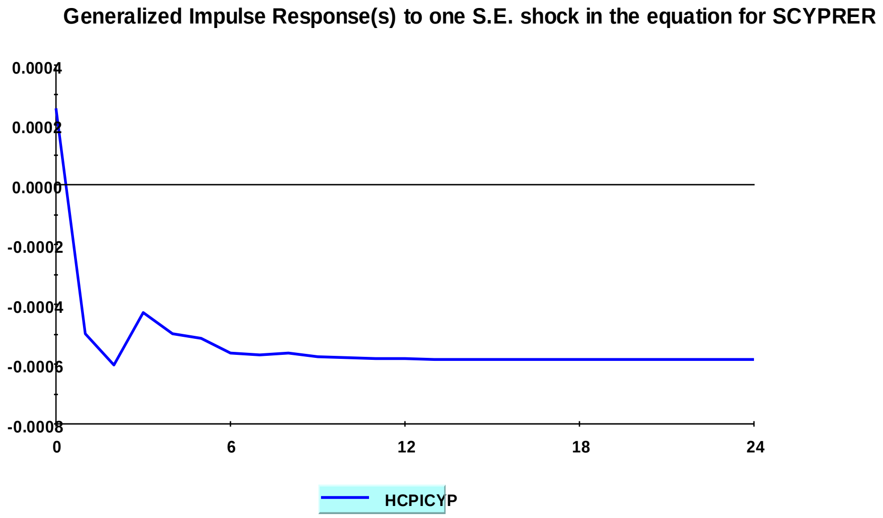
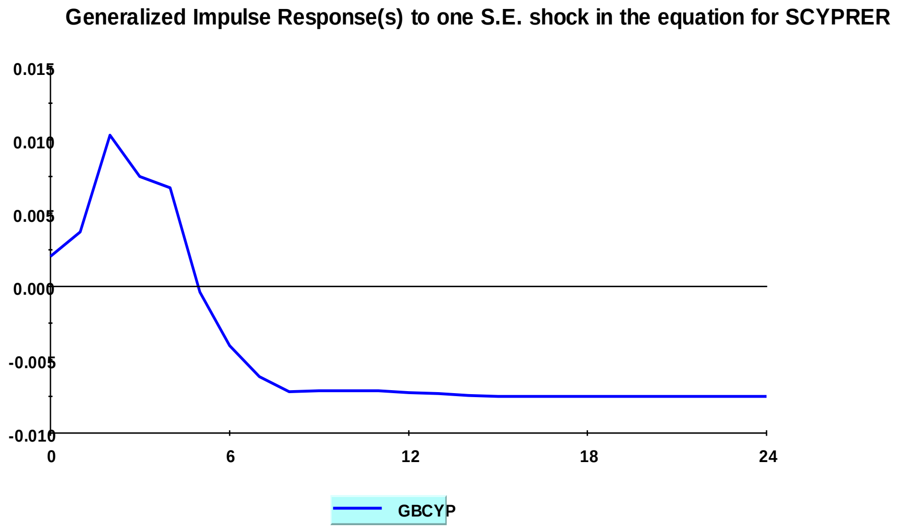


Figure 5: Cyprus (SCYP in each variable denotes 'starred' variable)







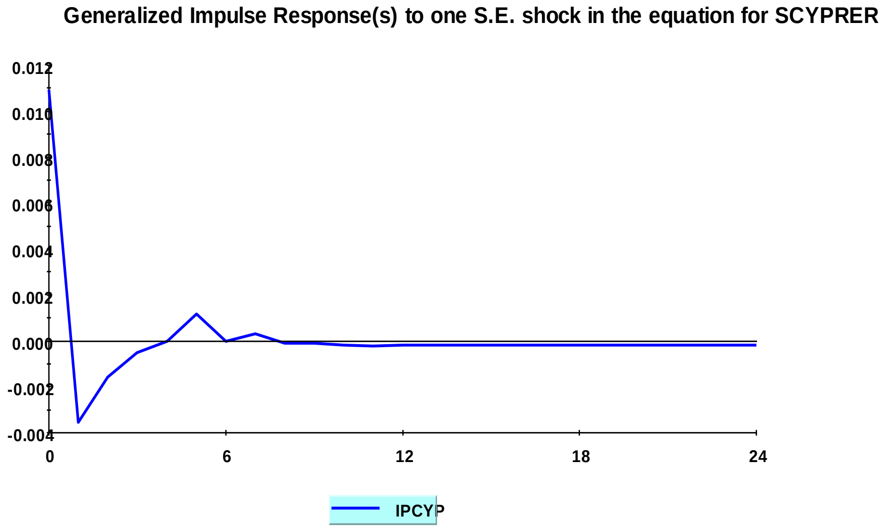
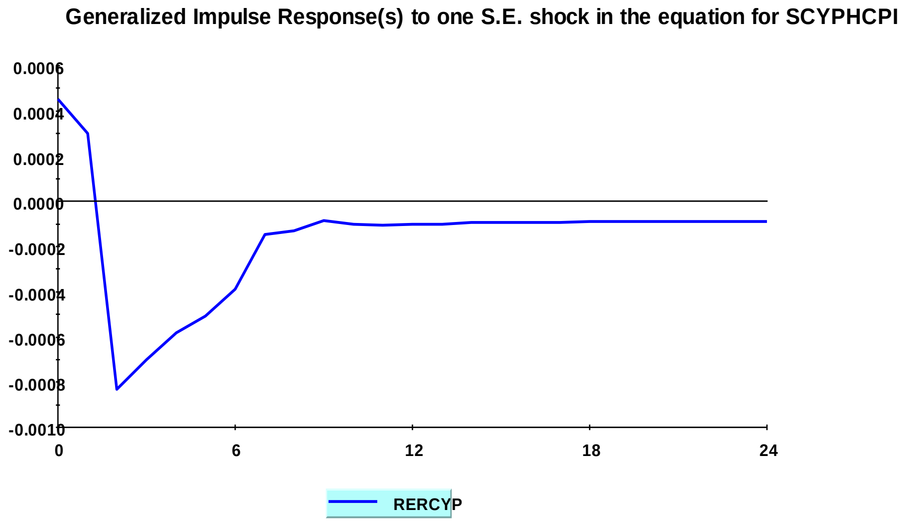
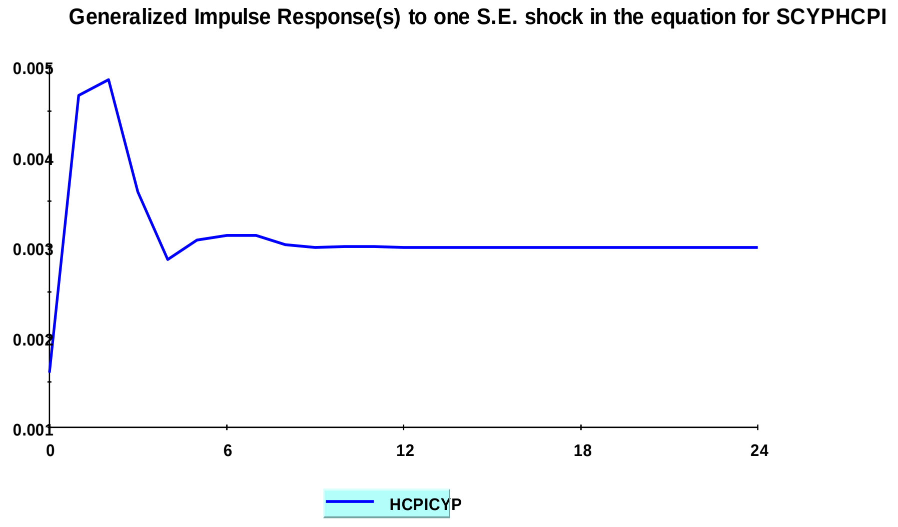
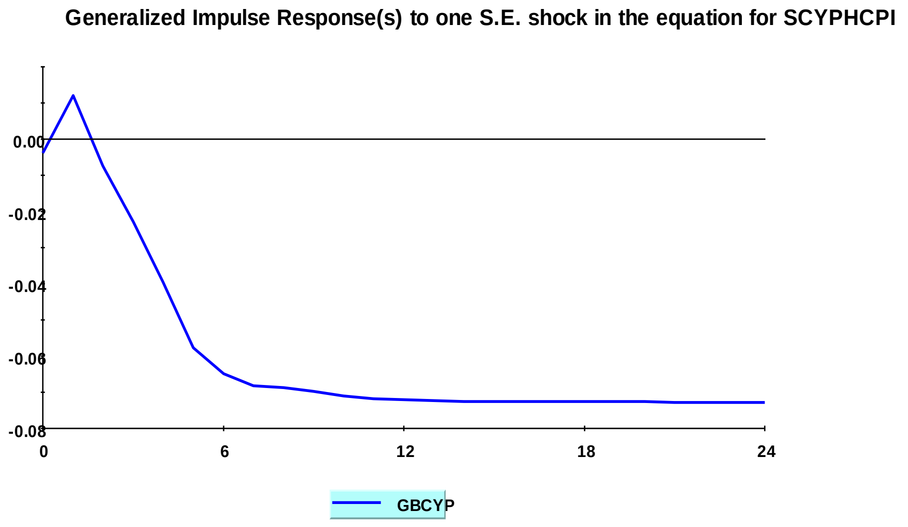


Figure 5 ***(continued)***







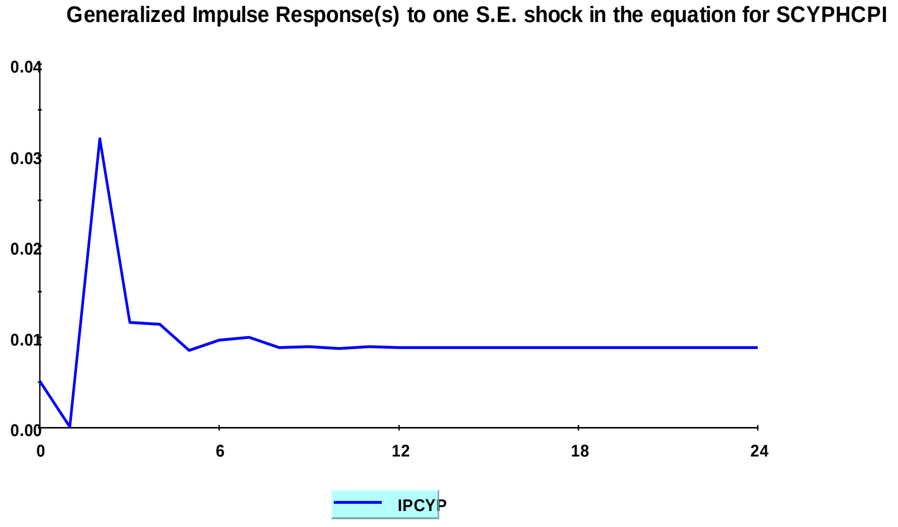
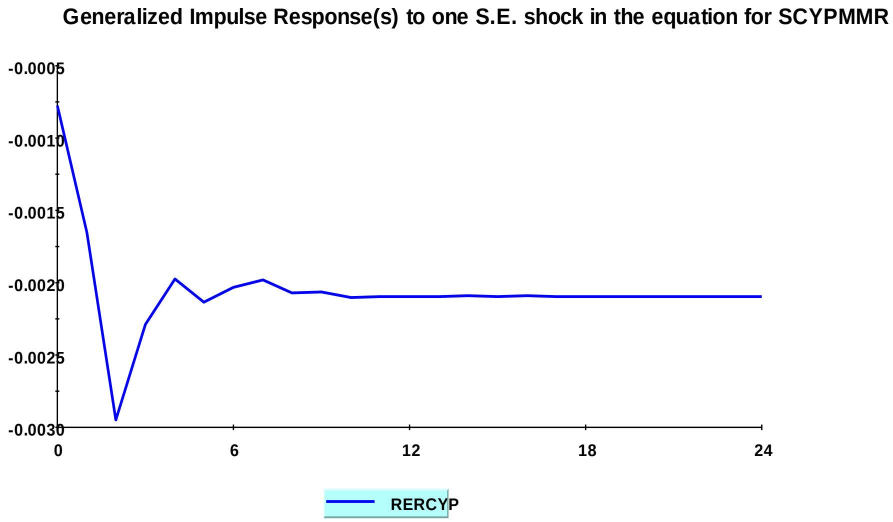
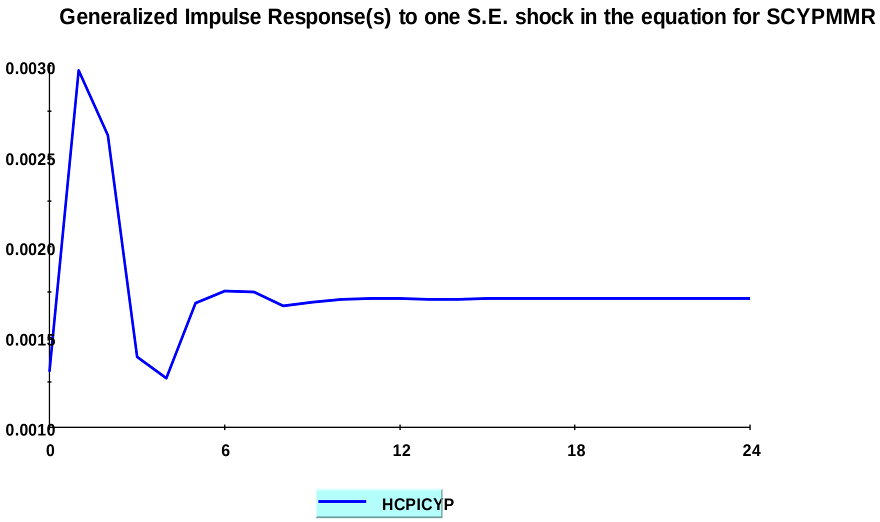
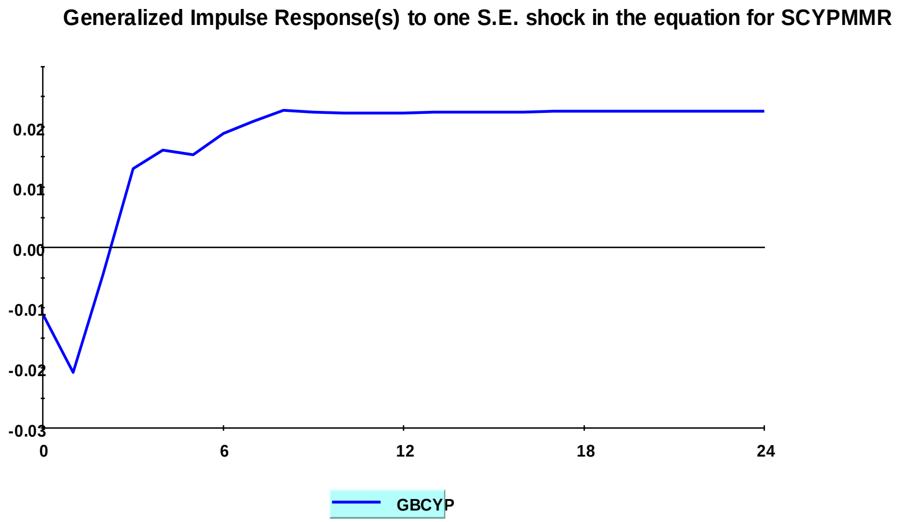


Figure 5 ***(continued)***







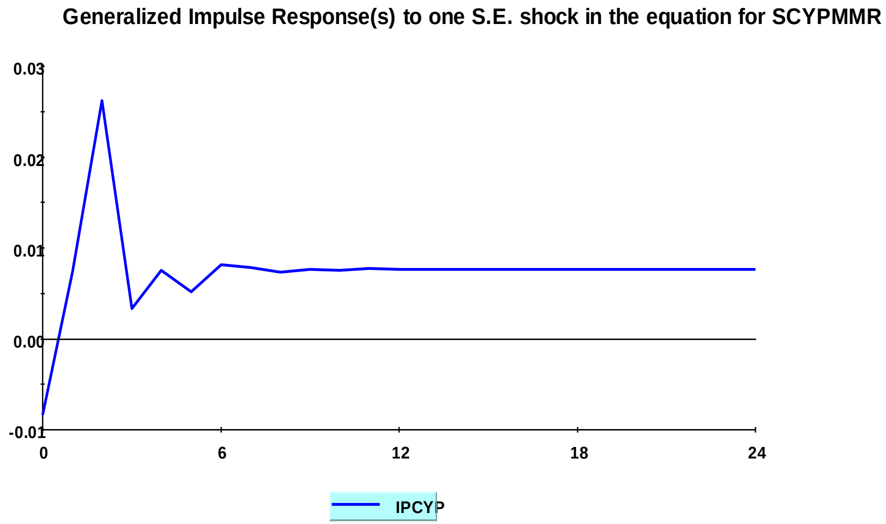
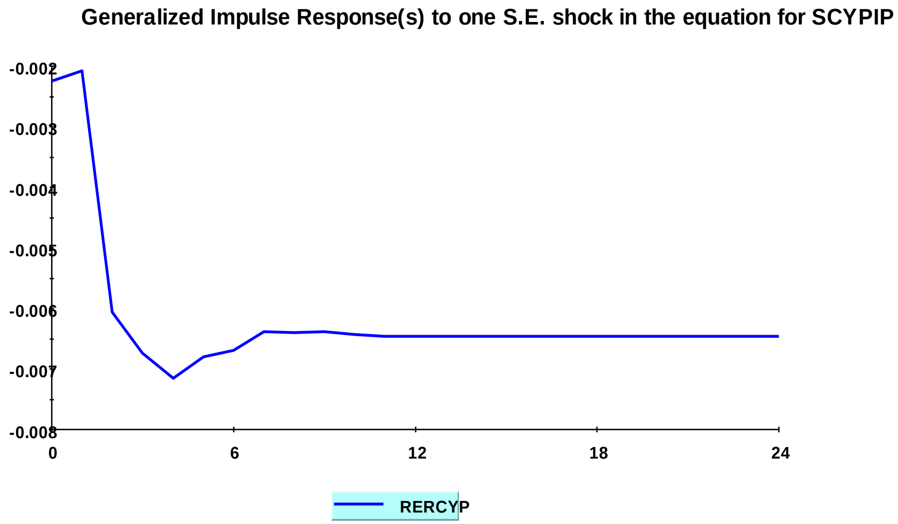
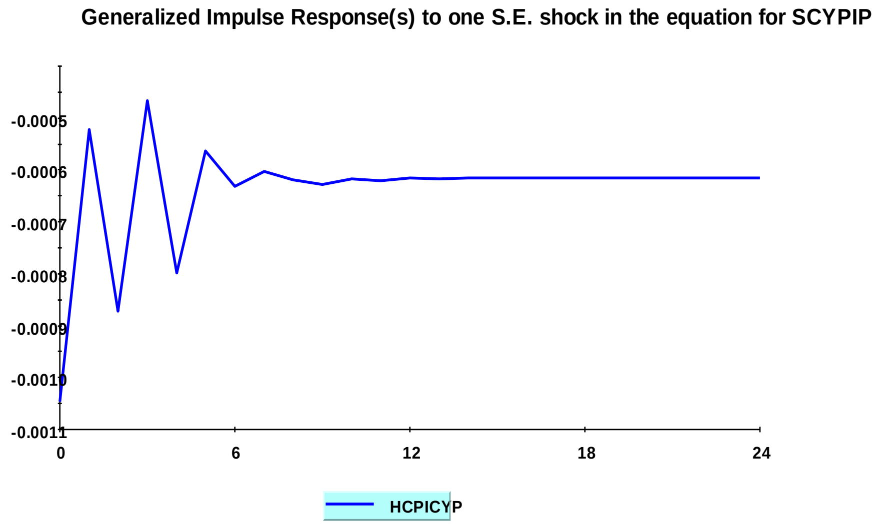
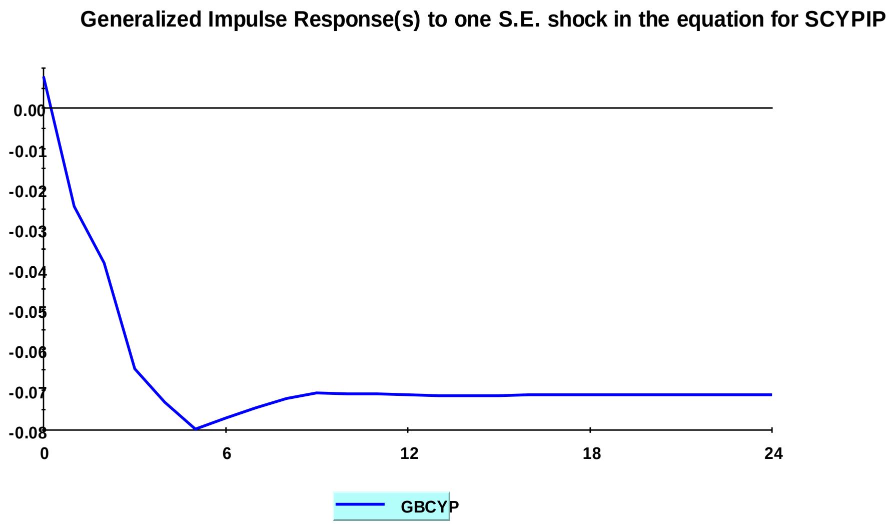


Figure 5 ***(continued)***







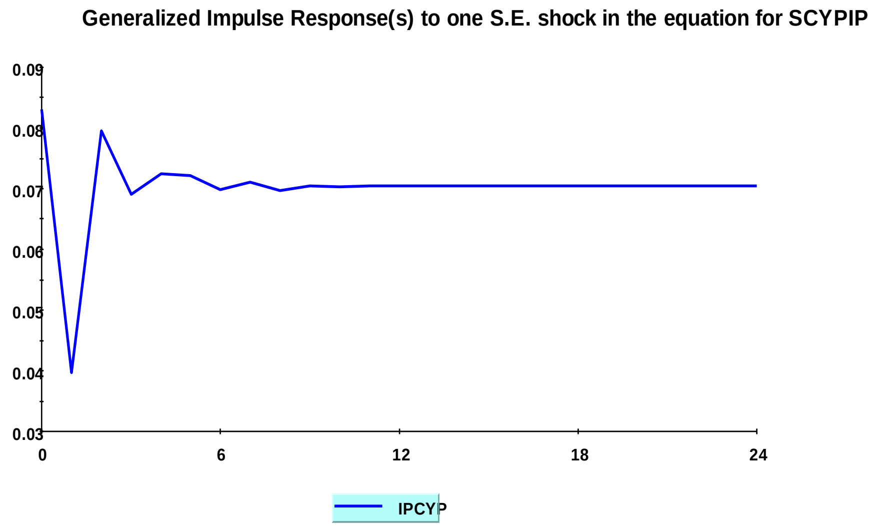
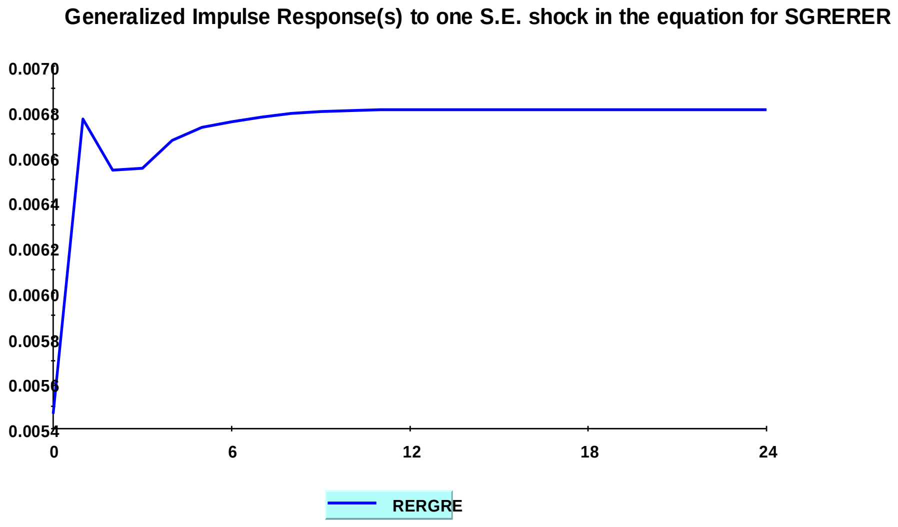
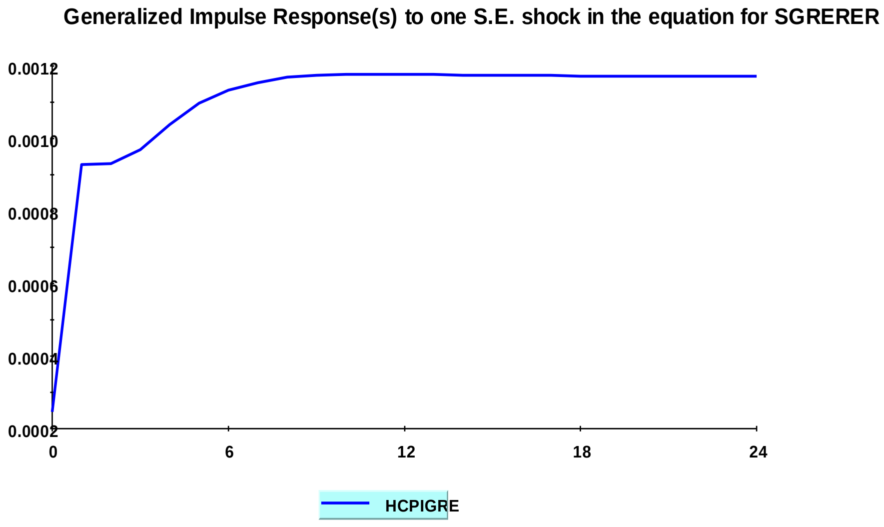
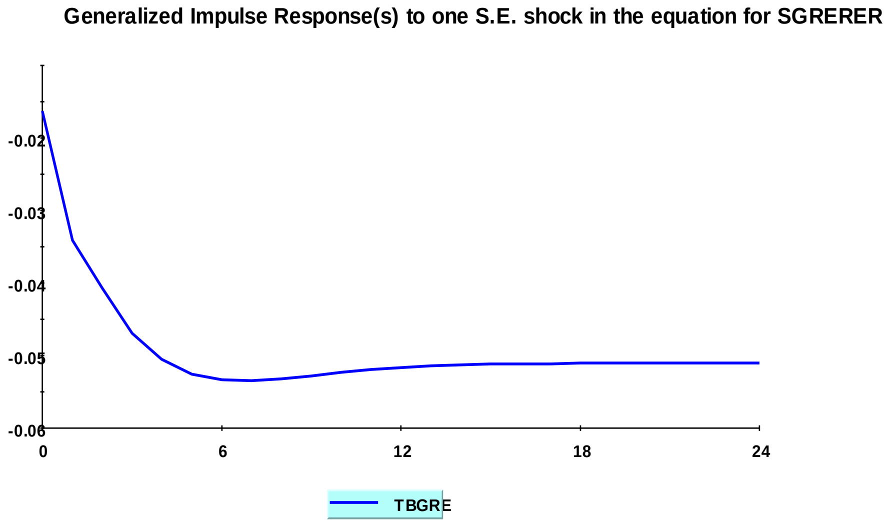


Figure 6: GREECE (SGRE in each variable denotes 'starred' variable)







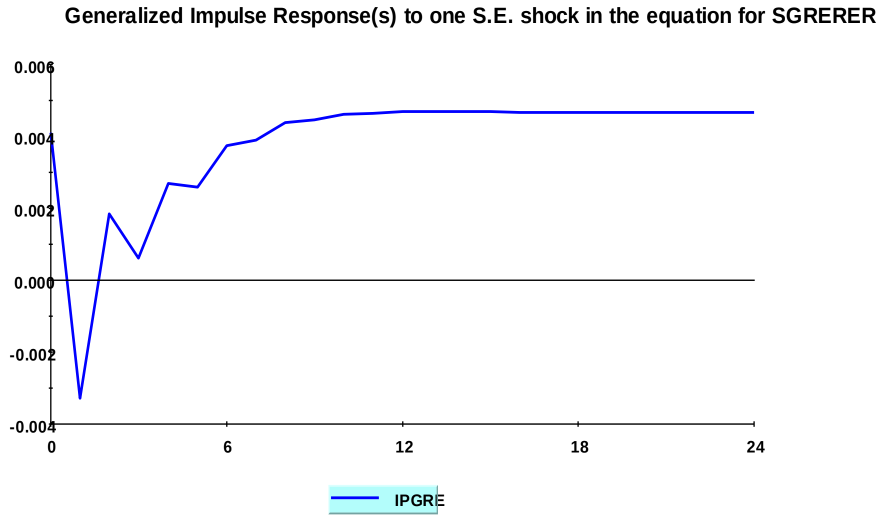
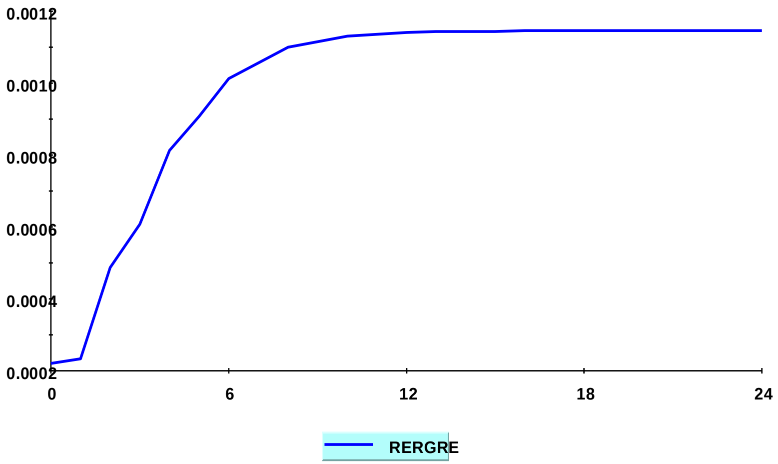
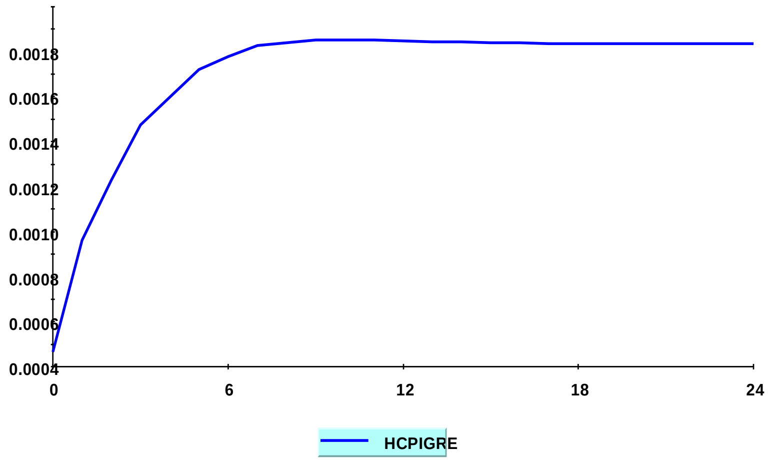


Figure 6 ***(continued)***

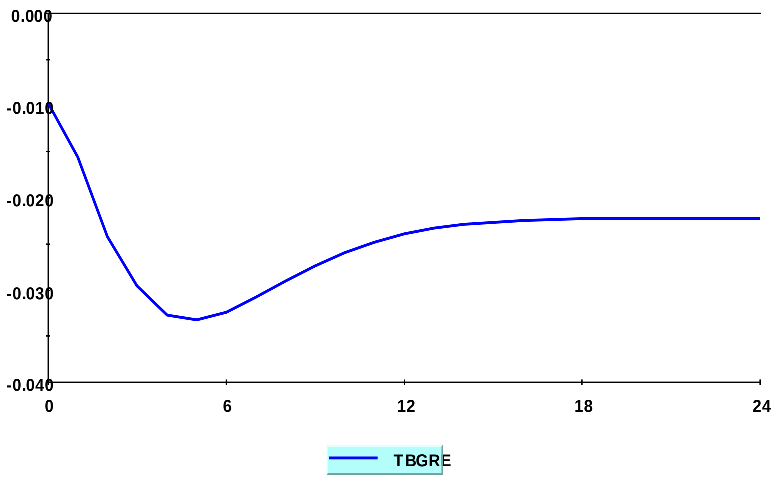
Generalized Impulse Response(s) to one S.E. shock in the equation for SGREHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREHCPI

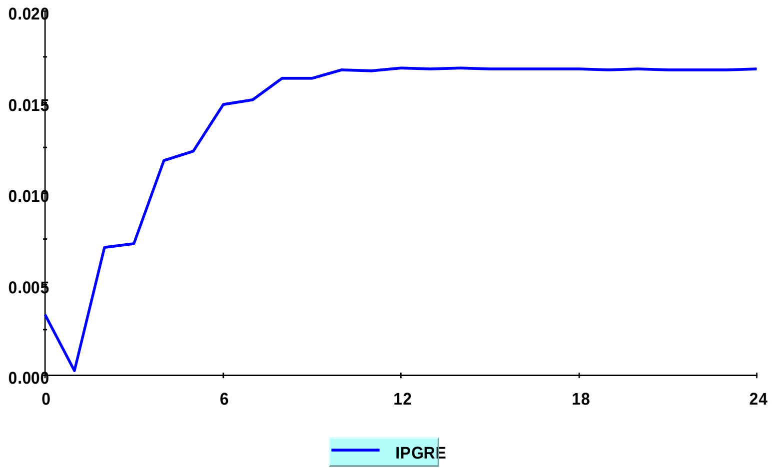
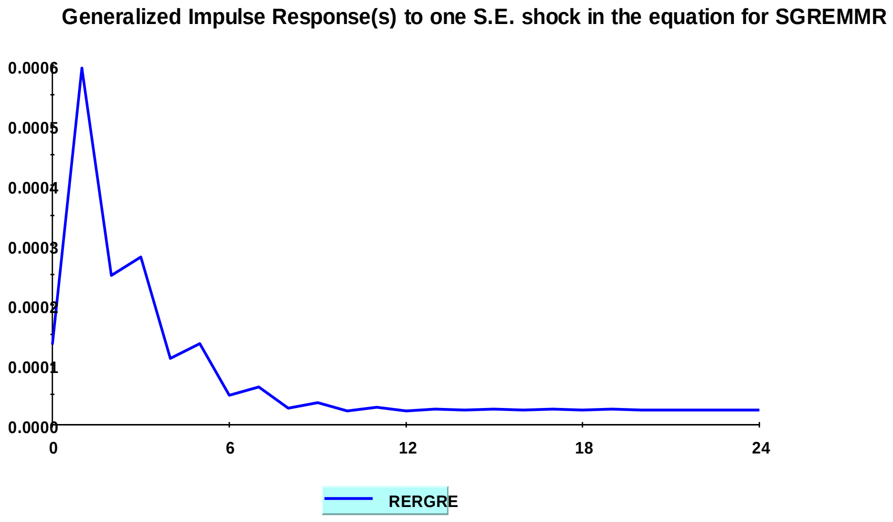
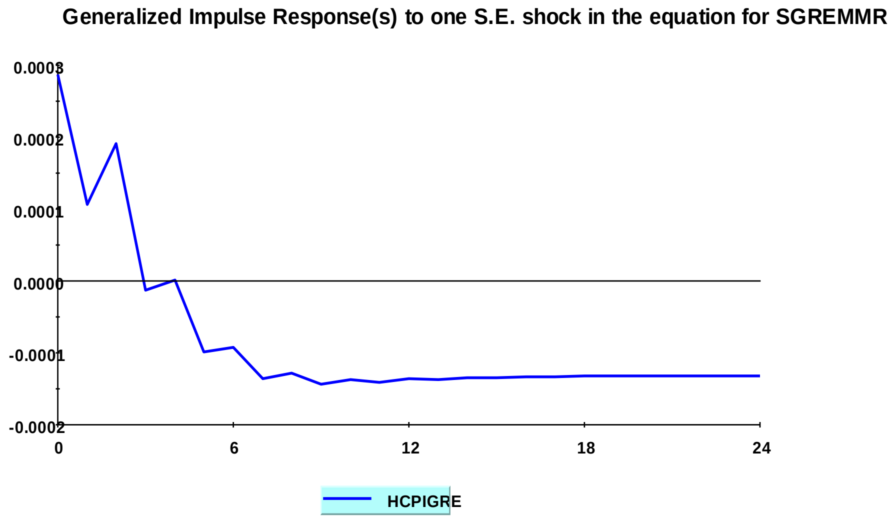
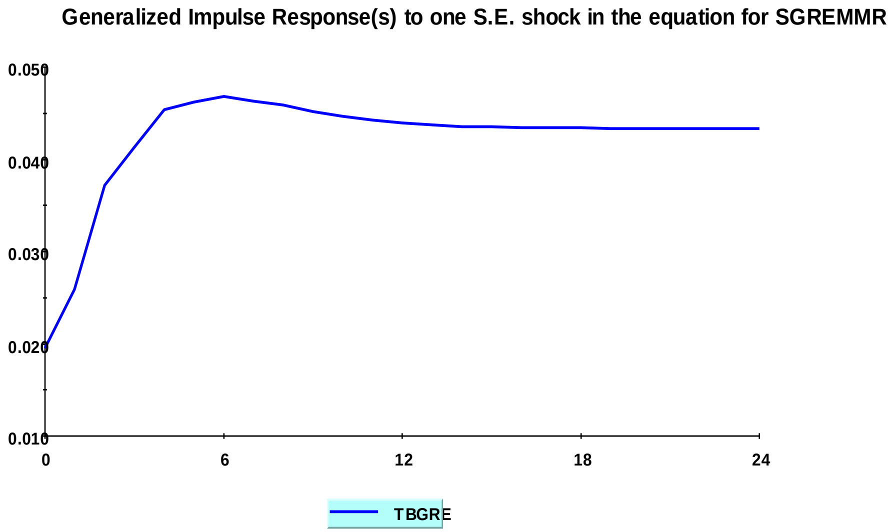


Figure 6 ***(continued)***







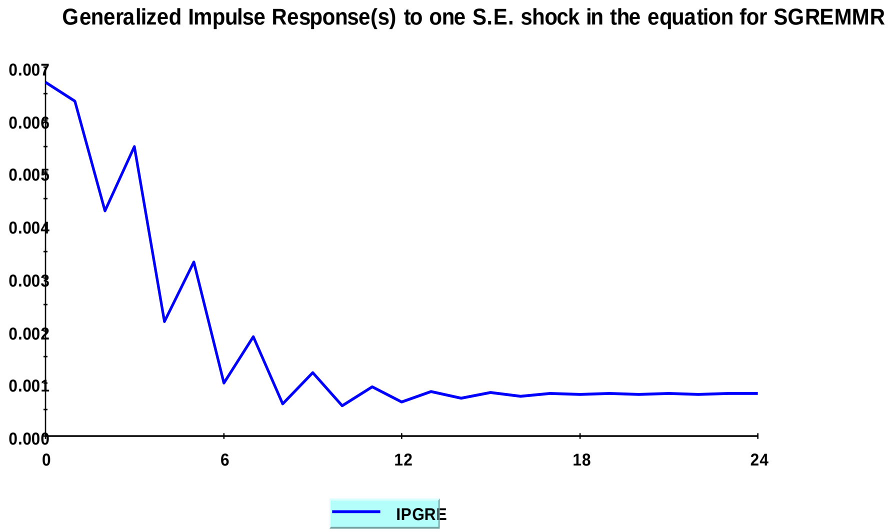
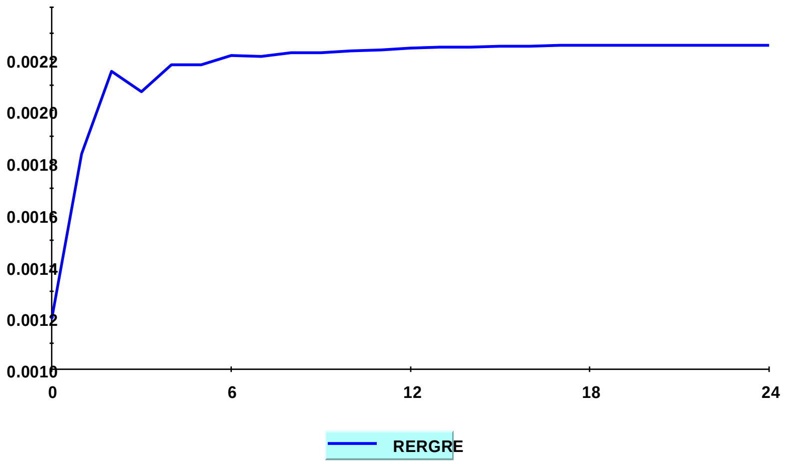
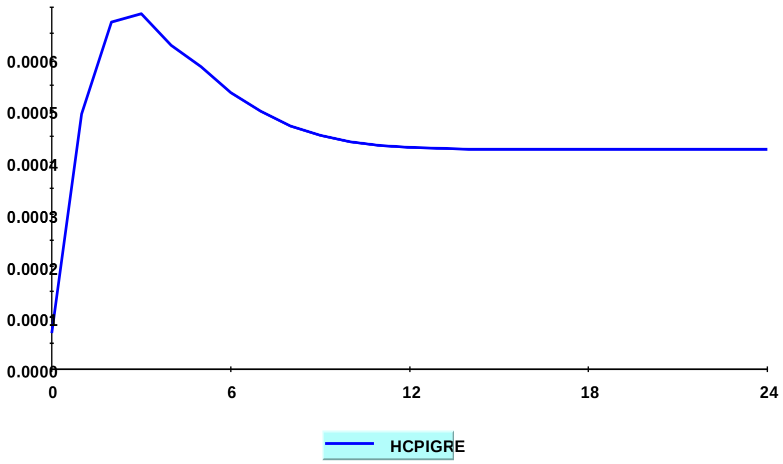


Figure 6 ***(continued)***

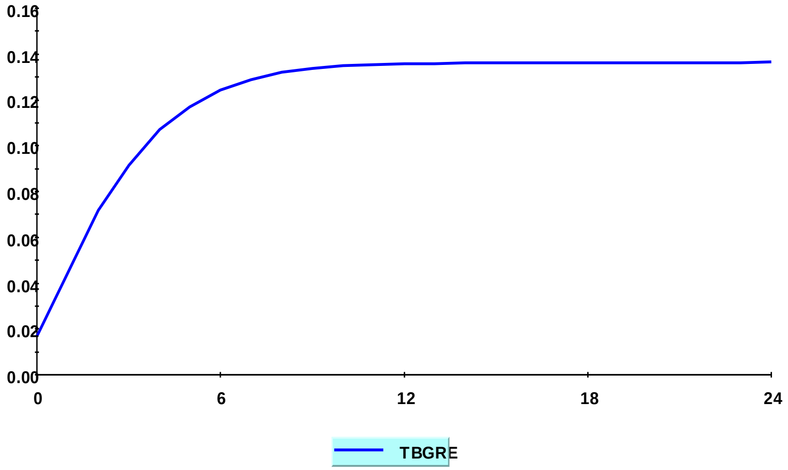
Generalized Impulse Response(s) to one S.E. shock in the equation for SGREIP



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREIP



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREIP



Generalized Impulse Response(s) to one S.E. shock in the equation for SGREIP

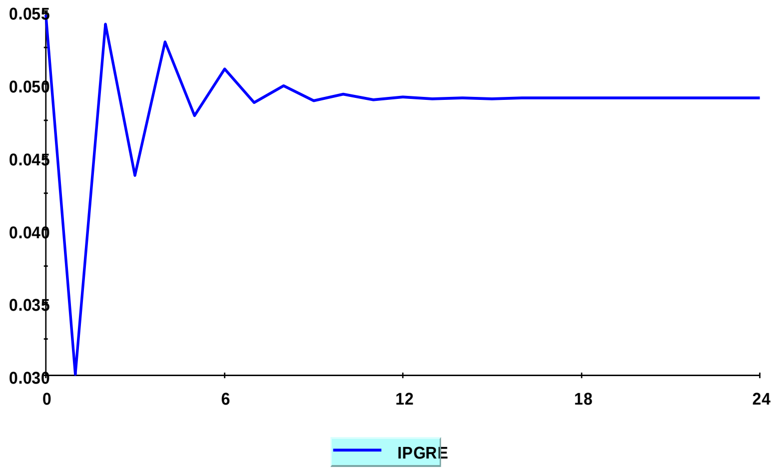


Figure 7: Romania (SROM in each variable denotes 'starred' variable)

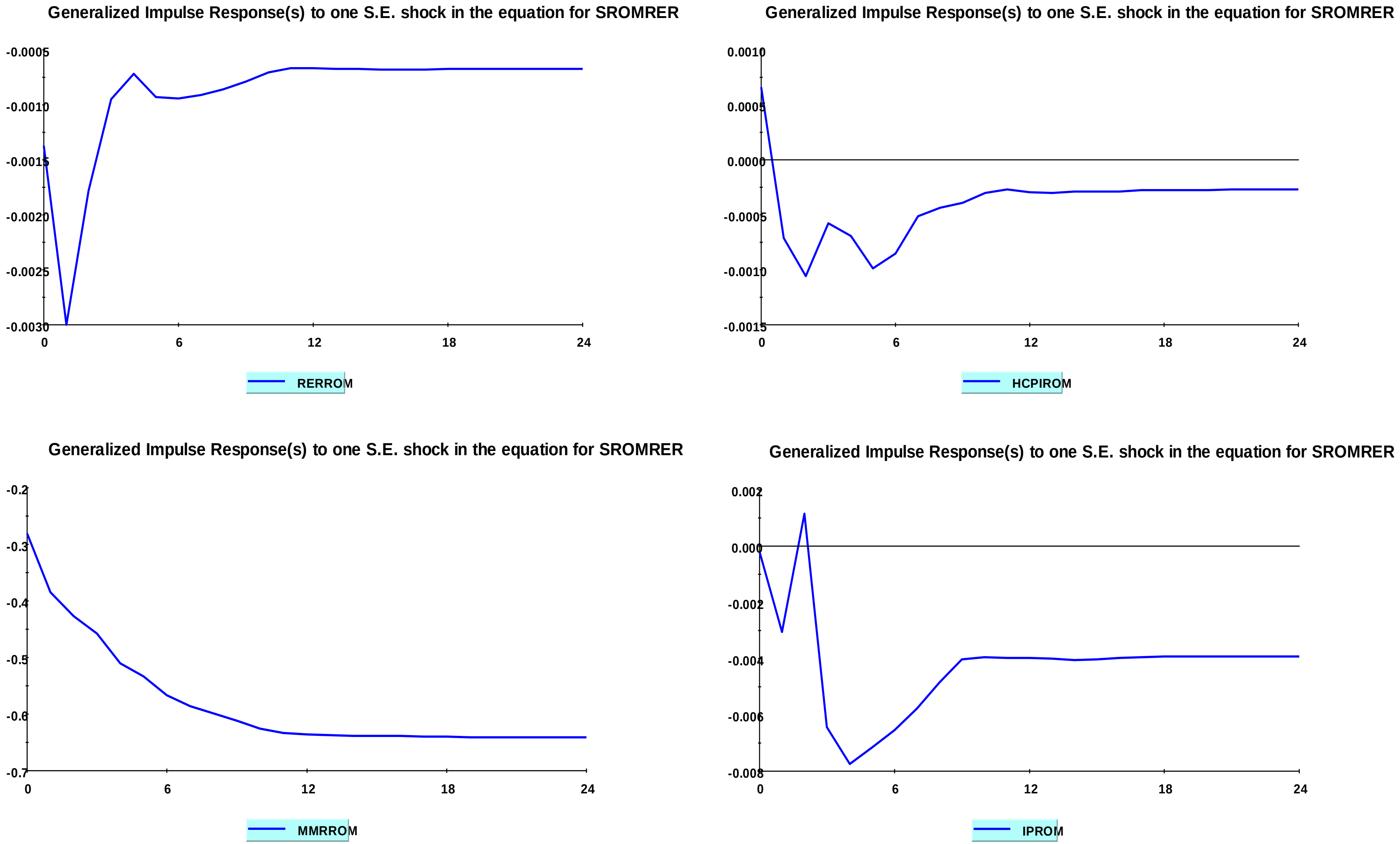


Figure 7 ***(continued)***

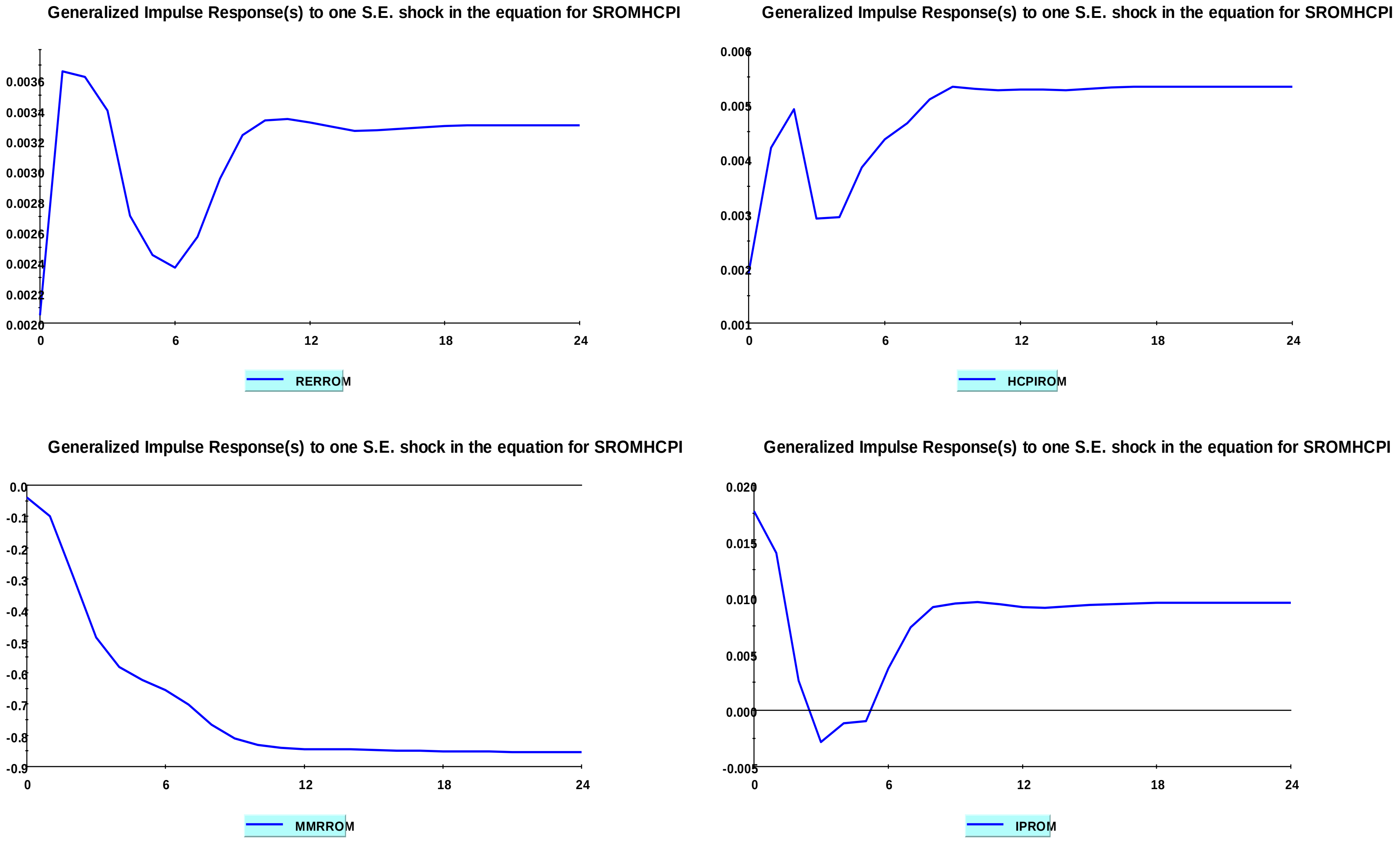
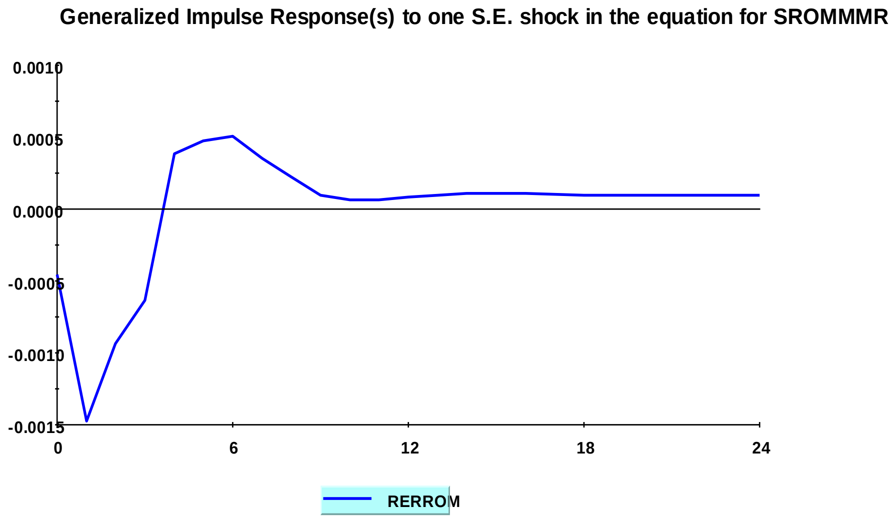
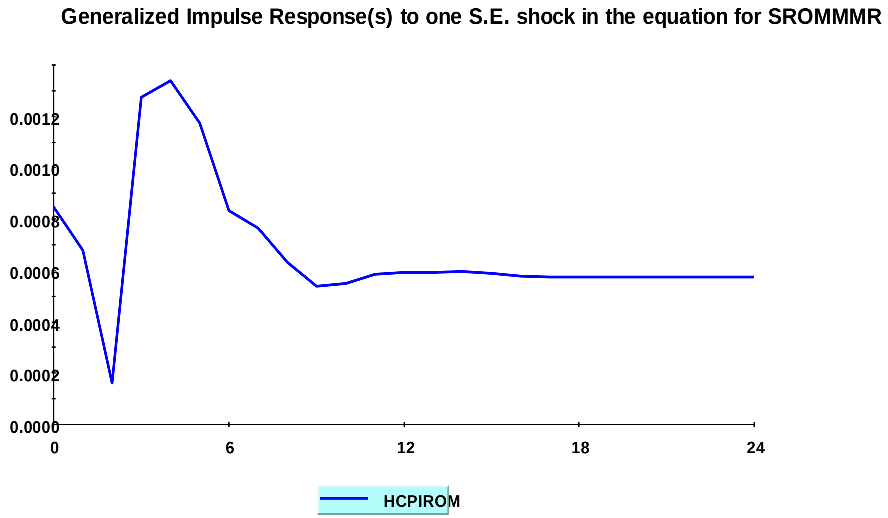
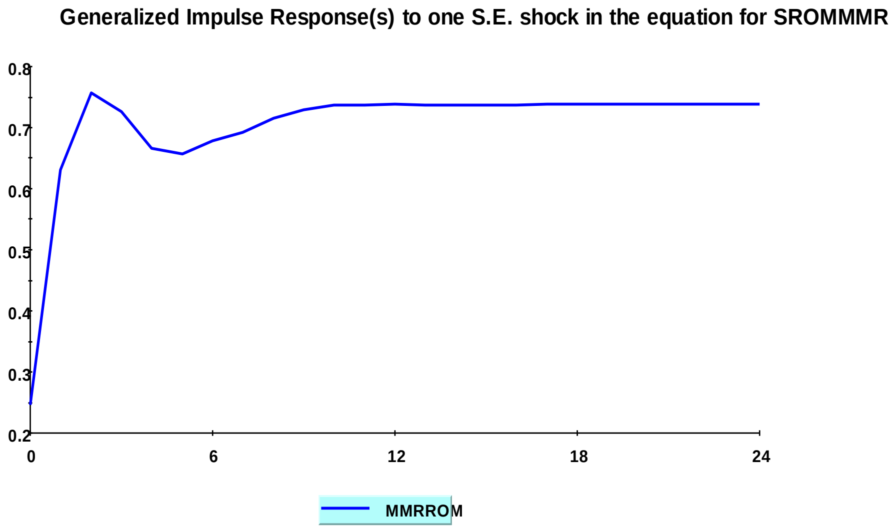


Figure 7 ***(continued)***







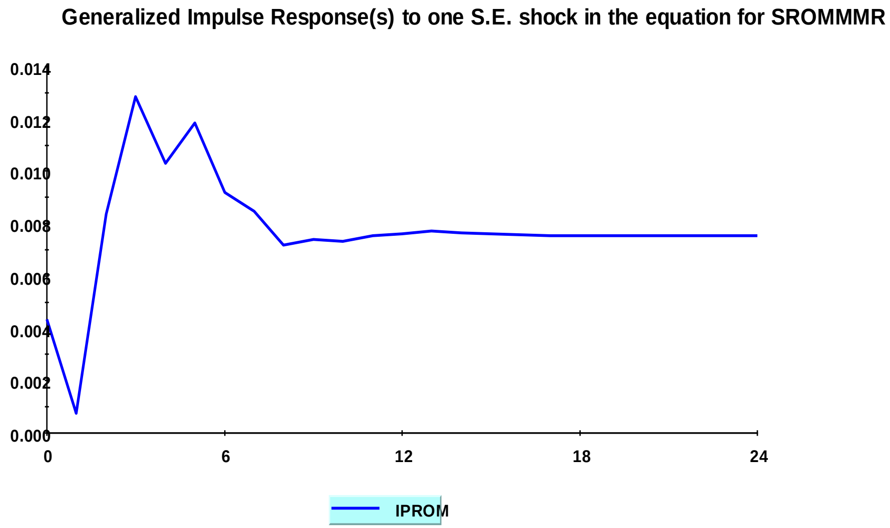
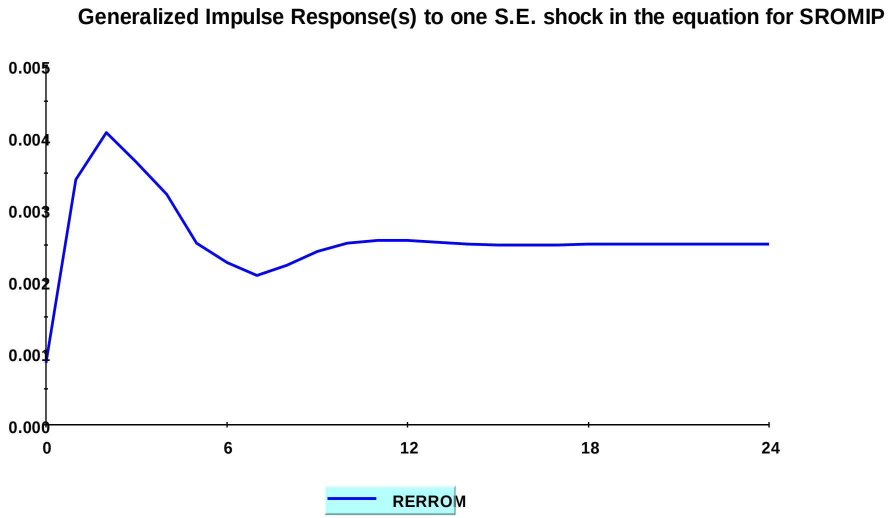
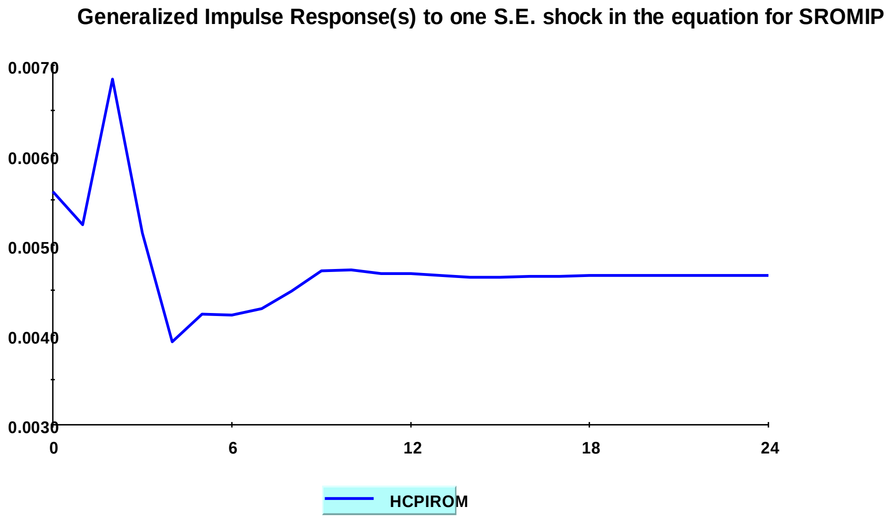
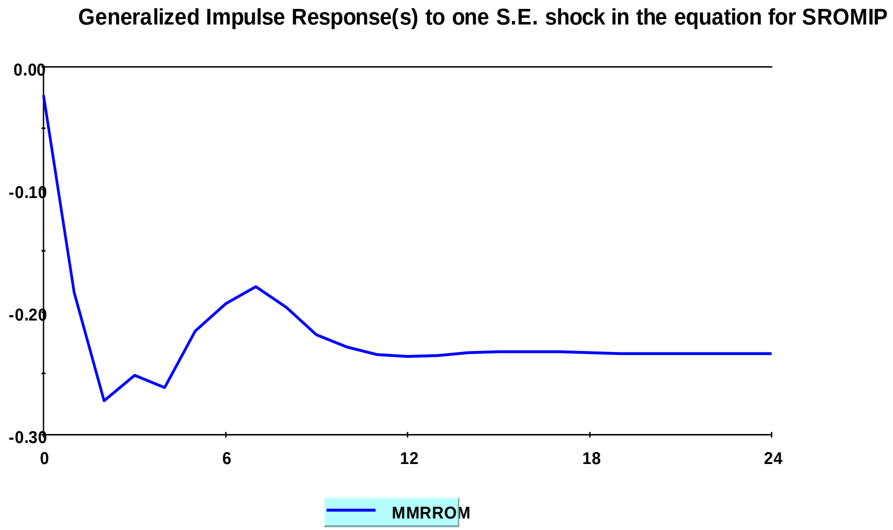


Figure 7 ***(continued)***







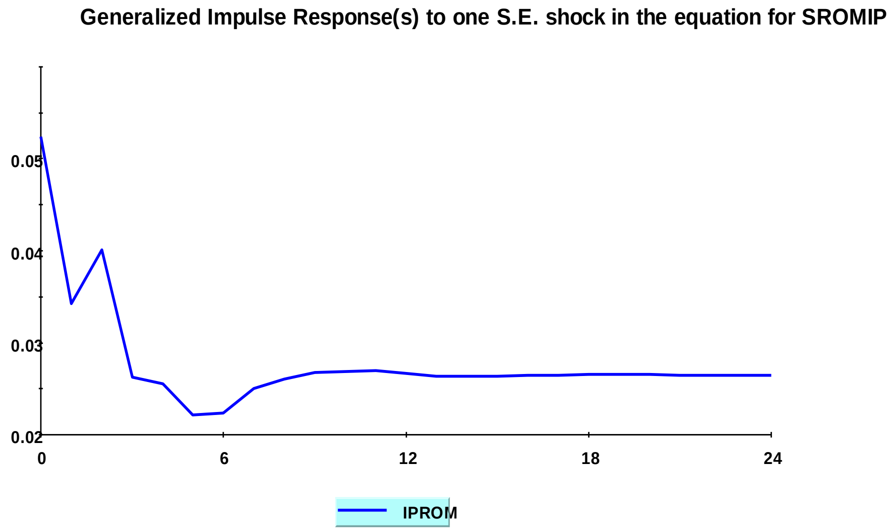
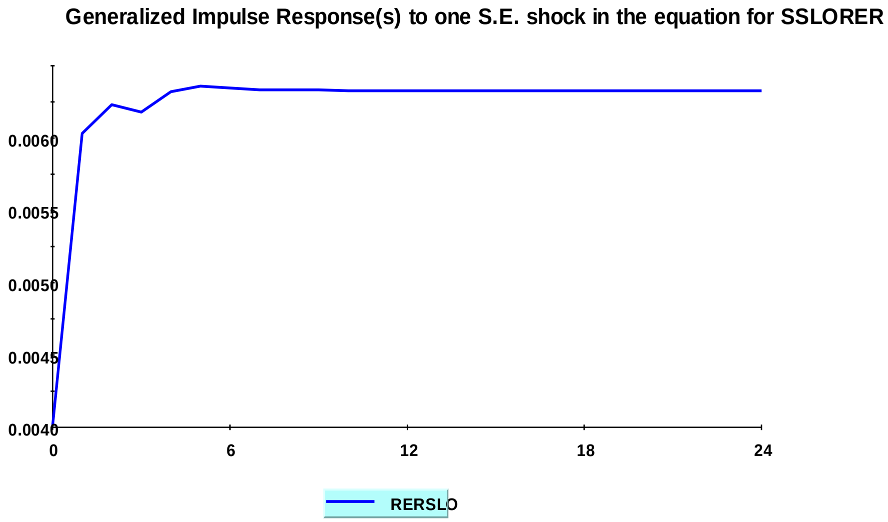
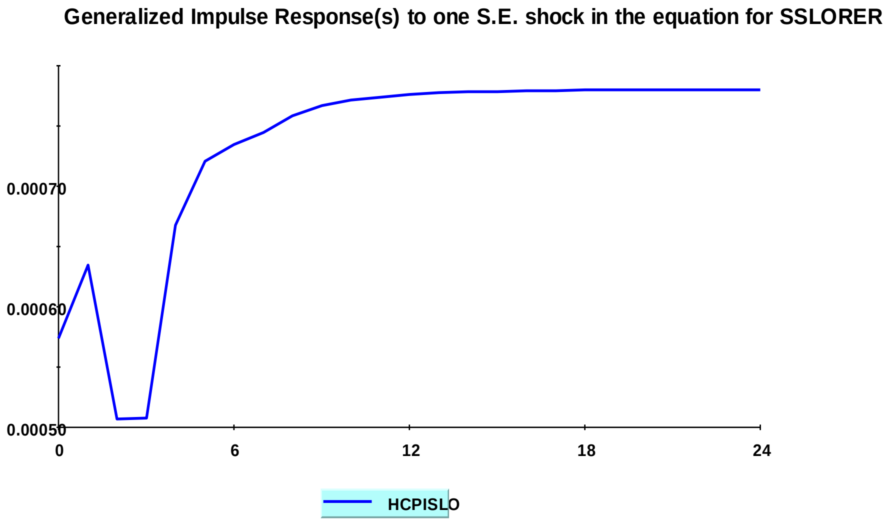
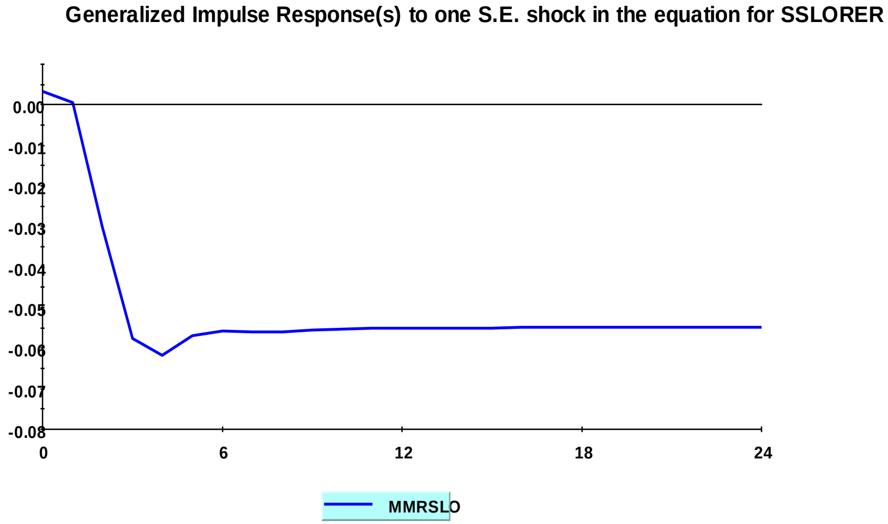


Figure 8: Slovenia (SSLO in each variable denotes ‘starred’ variable)







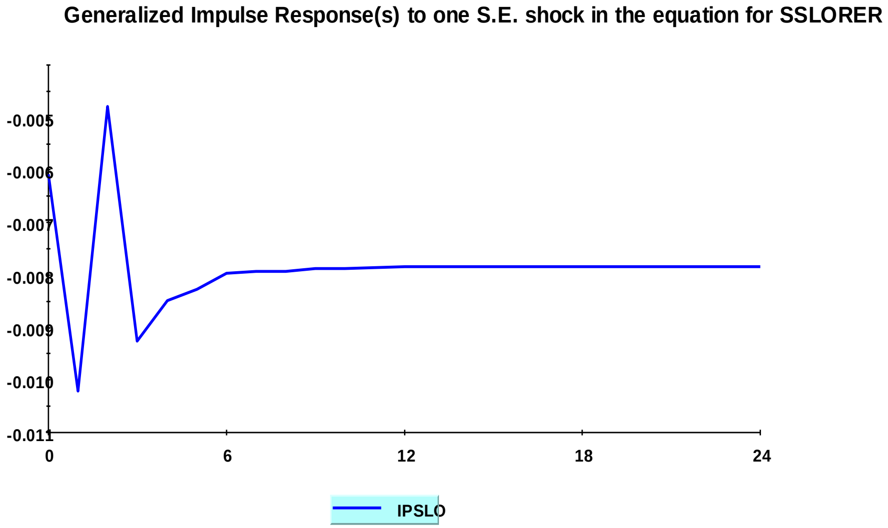
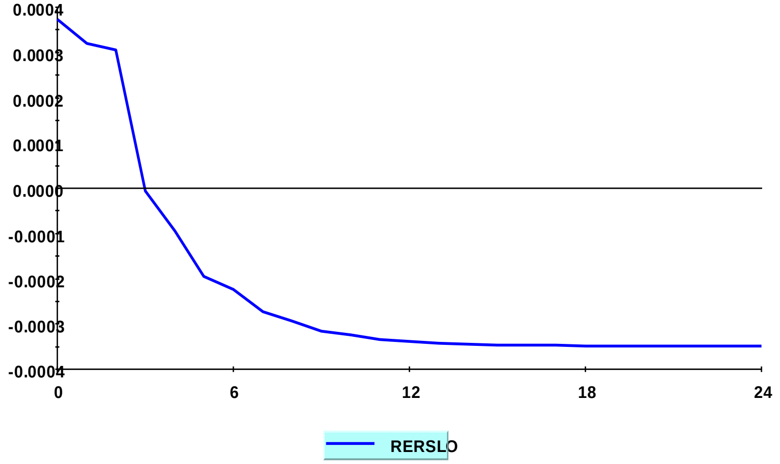
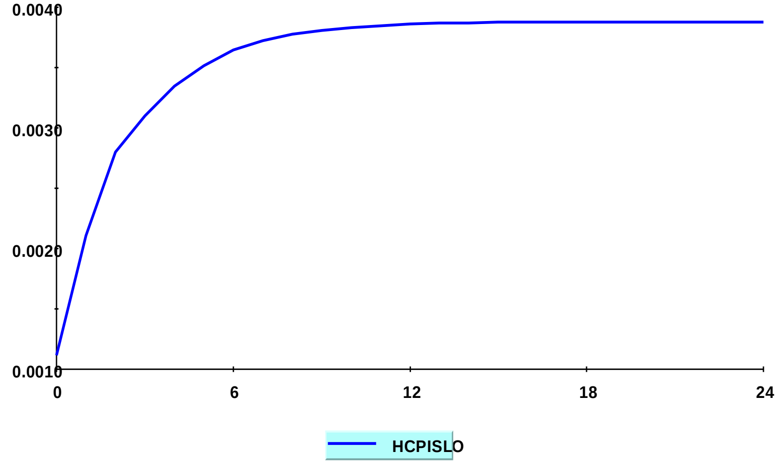


Figure 8 ***(continued)***

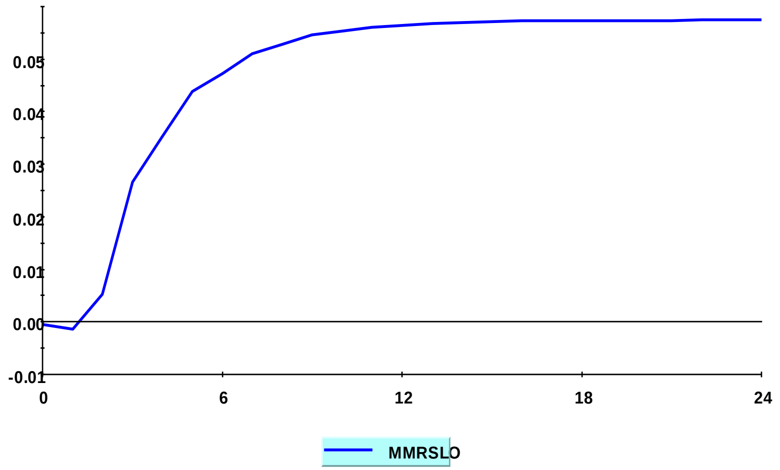
Generalized Impulse Response(s) to one S.E. shock in the equation for SSLOHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SSLOHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SSLOHCPI



Generalized Impulse Response(s) to one S.E. shock in the equation for SSLOHCPI

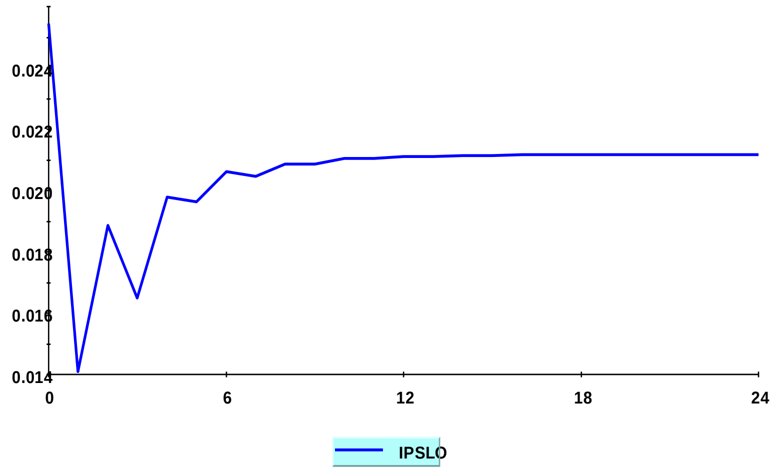


Figure 8 ***(continued)***

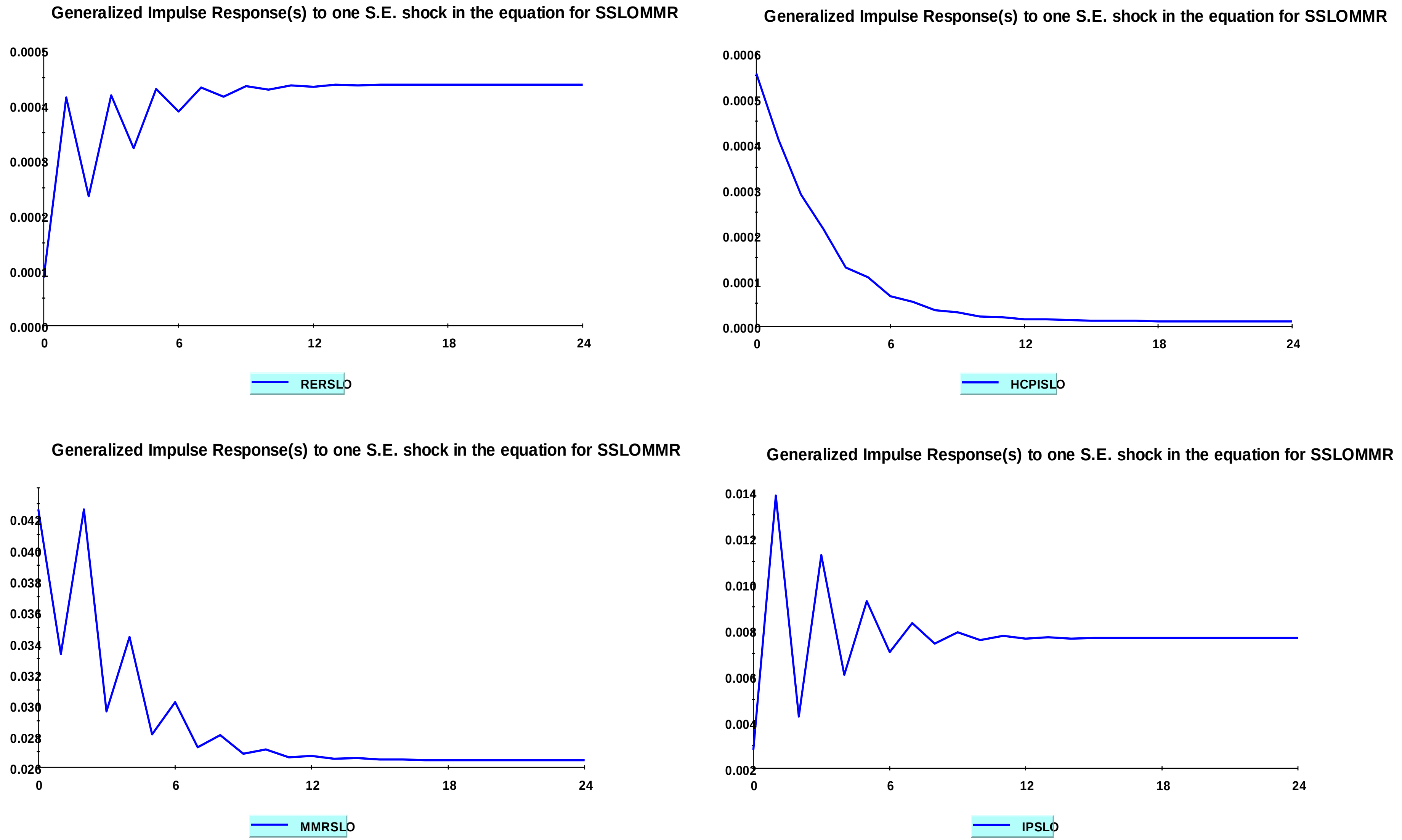
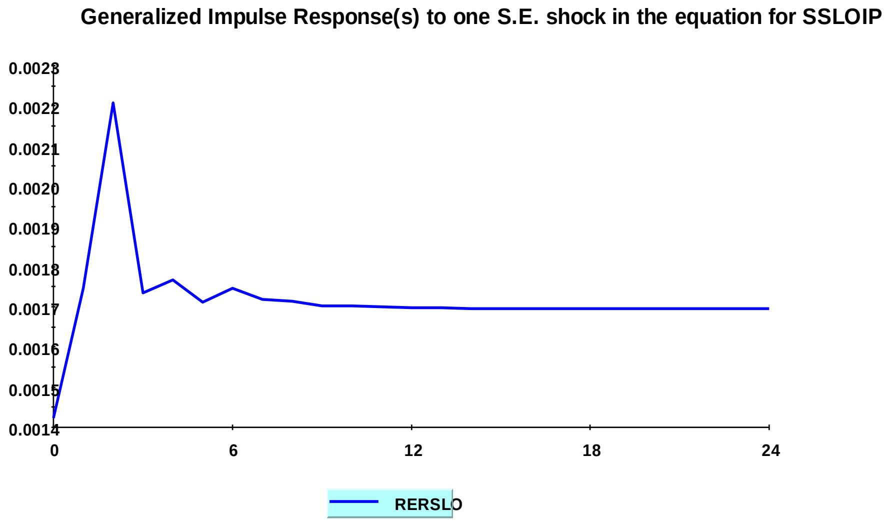
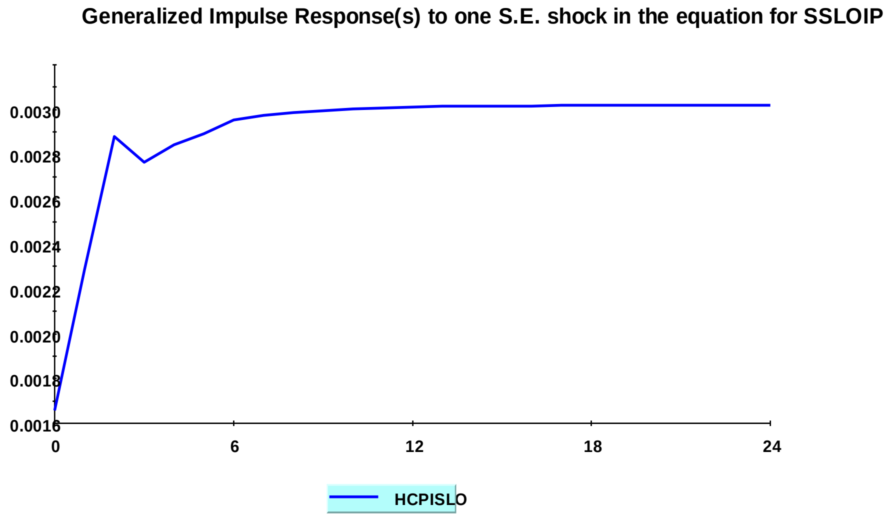
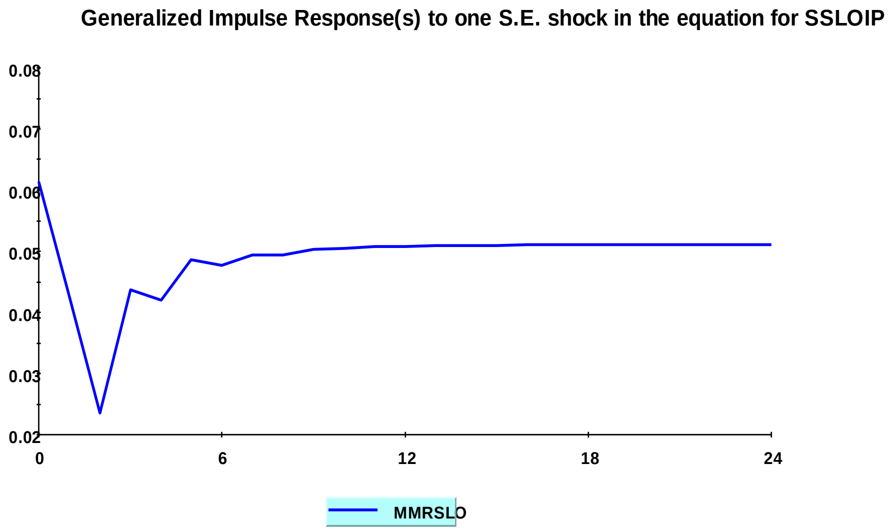


Figure 8 ***(continued)***







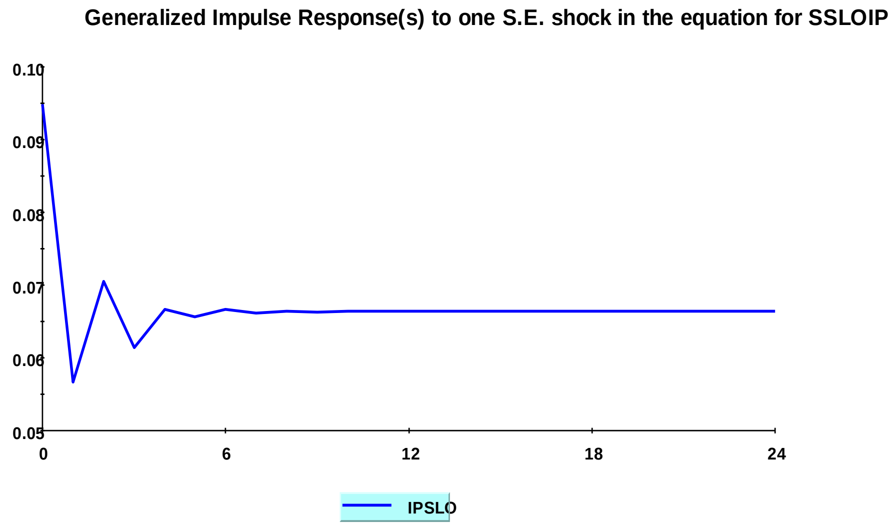
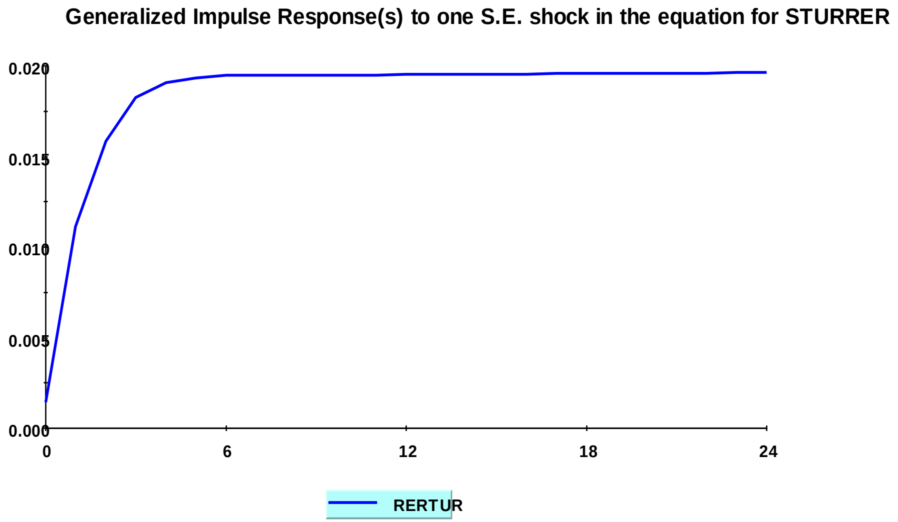
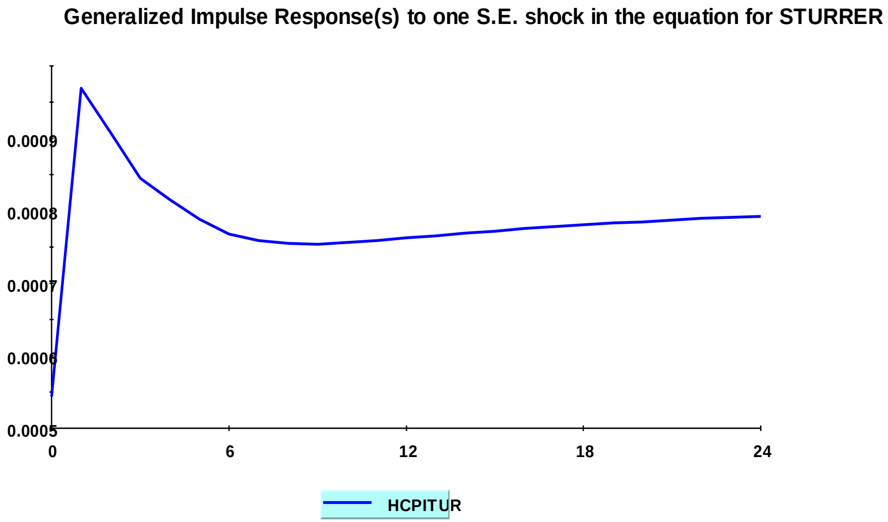


Figure 9: Turkey (STUR in each variable denotes 'starred' variable)





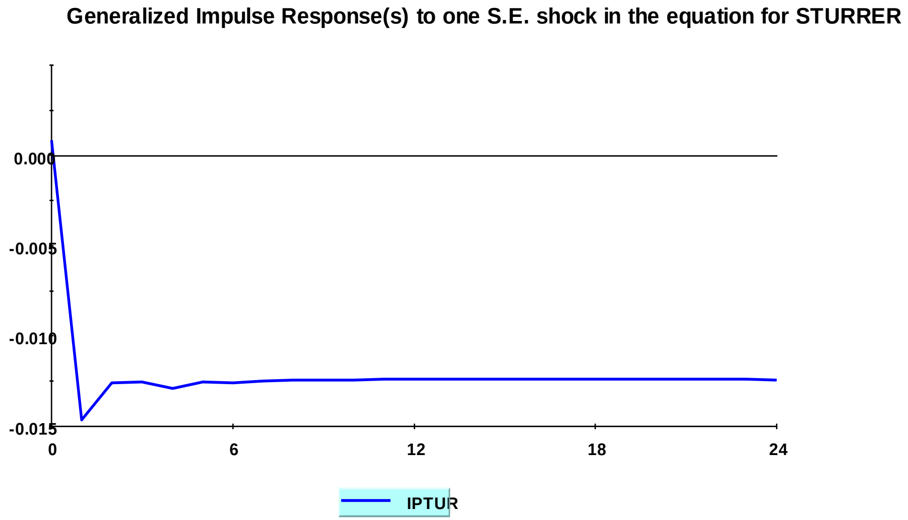
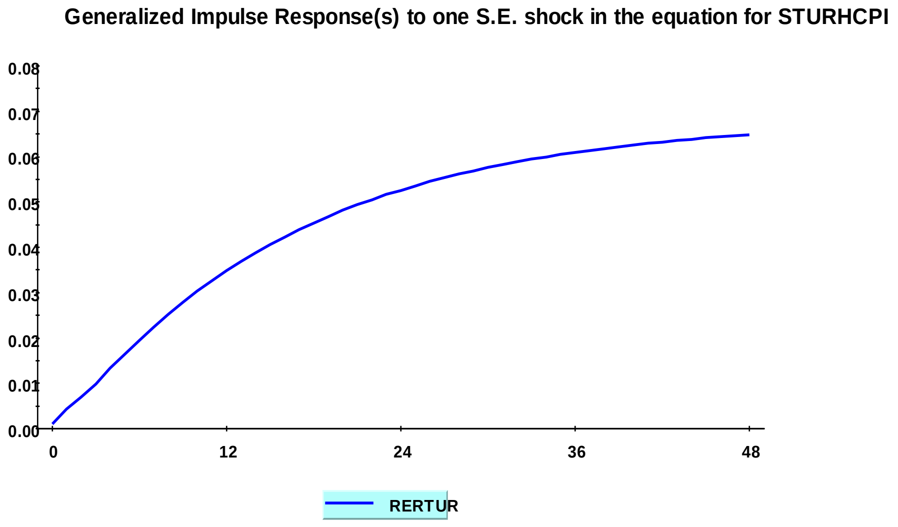
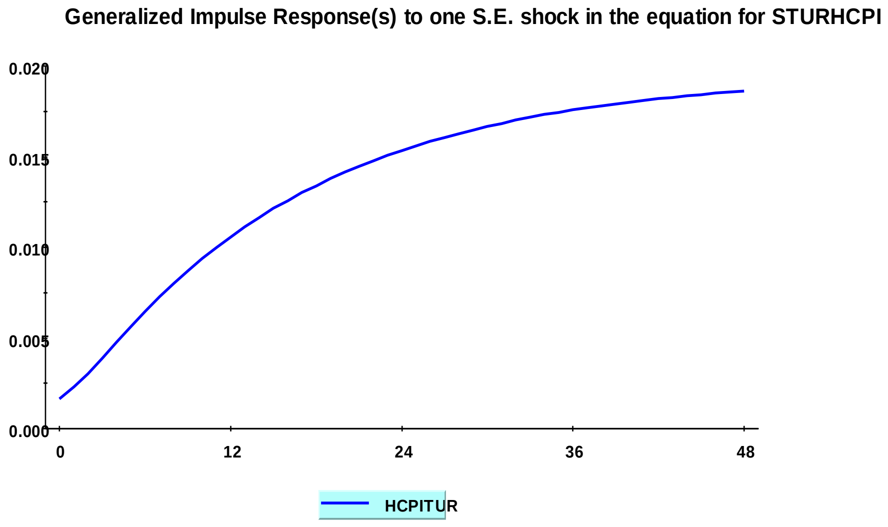


Figure 9 *(continued)*





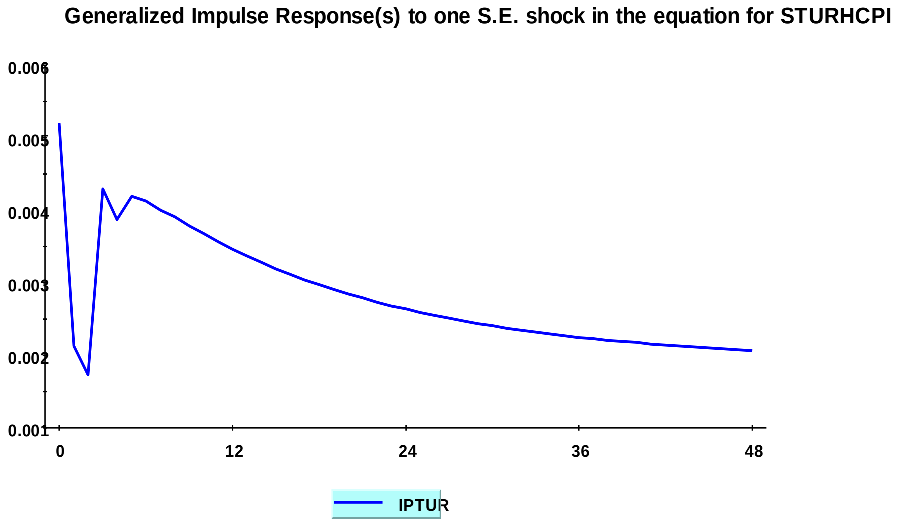


Figure 9 *(continued)*