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Greek fiscal multipliers revisited

Government spending cuts vs. tax hikes and the role of public investment expenditure

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1. Non technical summary

The present empirical study estimates *regime-dependent* fiscal multipliers for a range of key government revenue and expenditure categories in Greece and constitutes an important extension of an earlier paper we published last October.[1]

In our earlier study we utilized the classic SVAR approach developed in Blanchard and Perotti (2002) and extended further in Perotti (2004) for estimating output responses to discretionary fiscal shocks. In addition, we applied a variant of the Smooth Transition Vector Autoregression (STVAR) model presented in Auerbach and Gorodnichenko (2011) to investigate the *time-* and *regime-dependent* properties of Greece's fiscal multipliers.

In the present paper we employ a different econometric methodology *i.e.,* a Multivariate Threshold Autoregressive Model (TVAR) that has a number of unique features that make it particularly suitable for our empirical analysis. The primary aim of our new exercise is to: **(**i) check the robustness of our earlier empirical results; and (ii) take a closer look at certain important government expenditure categories *e.g.* public investment outlays that could potentially play a key role in facilitating a return to positive economic growth.

Threshold vector autoregressions are piecewise linear models with different autoregressive matrices in each regime. The regimes are determined by a transition (i.e., threshold) variable, which can be either an exogenous variable or one of the endogenous TVAR variables (as is the case in the present paper).

The TVAR model has a number of interesting features that make it particularly suitable for analyzing the macroeconomic effects of discretionary fiscal policy. First and foremost, it allows potential asymmetries in the response to discretionary fiscal shocks. This is because the estimated impulse response functions are no longer linear, allowing the propagation and the effects of the shocks to depend on the set of initial conditions as well as on the size and sign (expansionary vs. contractionary) of the shock. This is a particularly useful feature of our empirical study, as it allows us to analyze the potential effects of Greece's new austerity programme (2013-2016), which is implemented in a deeply recessionary output regime.

Second, by endogenizing the transition variable (*i.e.,* the variable by which different regimes are defined) we effectively allow the possibility of a regime switch following a structural fiscal shock. In the latter case, the impulse response functions depend on the history of the endogenous variables in the period leading to the specific point in time in which the shock occurs as well as on both the size and the sign of the shock itself.

[1] See Monokroussos & Thomakos (2012) - *Greece Macro Monitor "Fiscal Multipliers in deep economic recessions and the case for a 2-year extension in Greece's austerity programme"; Eurobank Research, October 2012.* http://www.eurobank.gr/Uploads/Reports/ECONOMY%20AND%20MARKETSfiscal%20multipliers.pdf

Drawing on the results of our empirical study, we summarize below a number of key views and policy proposals related to Greece's present fiscal austerity programmme.

The estimated multipliers of the present empirical study appear to broadly confirm the main results of our earlier paper on the size and regime-dependence of fiscal multipliers in Greece. More specifically,

The response of real output to discretionary shocks in government current spending on goods and services and/or government tax revenue depends on the regime in which the shock occurs as well as on the size and direction (expansionary vs. contractionary) of the initial shock.

In general, expansionary or contractionary shocks taking place in lower output regimes (economic downturns) appear to have much larger effects on output - both on impact and on a cumulative basis - than shocks of similar sign and size occurring in upper regimes (economic expansions).

In lower regimes in particular, the contractionary effects on output from a negative fiscal shock (spending cut or tax hike) rise with the absolute size of the shock. In the same vein, the expansionary effects on output from a positive fiscal shock (spending hike or tax cut) increase with the absolute size of the shock. Similar effects apply for fiscal shock taking place in an upper output regime, though to a much lesser extent.

Relative to the present fiscal adjustment programme in Greece, our empirical results appear to support one of the main arguments made in our earlier paper on fiscal multipliers; namely that in favor of a more gradual implementation profile of the austerity programme for 2013-2016. This is especially because, the new austerity programme is heavily front-loaded, relying mainly on steep cuts in government expenditure items understood to have large fiscal multipliers *e.g.* wages and pensions.

Our empirical results also suggest that, it would be more preferable to implement fiscal adjustment in Greece though higher tax revenue than lower government spending as the former would have much milder effects on output that the latter, both on impact and on a cumulative basis.

Indeed, given the overall size of Greece's fiscal adjustment programme in 2013-2016, our multiplier estimates suggest that Greek GDP will decline by up to €1.89 cumulatively over a three-year period per €1 discretionary decrease in real government spending on goods and services. Yet, the corresponding impact on domestic GDP would be much more benign if the aforementioned adjustment were to exclusively come through higher government revenue *i.e.,* up to €0.5 cumulatively over a three-year period per €1 increase in government net tax revenue.

It is important to emphasize here that the latter point *does not* necessarily constitute an outright call for a further increase in indirect or direct tax rates in Greece, which, in any case, remain high relative to the rest of the euro area. It highlights, instead, the urgency to repair the country's revenue collection mechanism, via aggressive public sector restructuring.

Moreover, our estimates argue in favor of higher public investment spending in the current depressionary trajectory in the Greek economy as a means of boosting short- and medium-term economic growth. In particular, our GIRF estimates imply among others that for a 5% YoY positive discretionary shock in the public investment program, real output rises by between €2.91 and €3.99 cumulatively over a 12 quarter period per €1 increase in real investment expenditure.

As a final note to this section, we emphasize that the results of our new paper on fiscal multipliers as well as those of other relevant studies in the international literature should be interpreted with extreme caution, not least because:

- considerable uncertainty and diversion of views continue to exist as regards the macroeconomic effects of discretionary fiscal policy changes, both on theoretical and empirical grounds;
- multiplier estimates tend to be not only regime- and type-of-shock-specific, but also estimation method-dependent;
- a relevant problem related to our empirical study is the lack of availability of a long-enough history of fiscal data for Greece *i.e.,* one spanning an adequate number of economic expansions and downturn phases;
- an important finding of some recent empirical studies on the effects of fiscal policy is that multipliers tend to decline with the potency and intensity of market doubts over the sustainability of a country's fiscal position;
- the latter effective provides an important argument in favor of a more front-loaded fiscal austerity programme in Greece;

- yet there may be a significant number of other factors that may affect the shape and the magnitude of output responses to discretionary fiscal policy changes; one such factor is the degree of liquidity constrains facing households, with a number of recent studies documenting higher multipliers for economies in which a large share of domestic economic agents are liquidity constrained (as is the case in the current trajectory in Greece).

The rest of this paper is structured as follows: ***Section 2*** takes a closer look at relevant definitions, determinants and estimation methods of fiscal multipliers; ***Section 3*** provides a brief overview of recent fiscal developments in Greece; ***Section 4*** presents our empirical results; and ***Section 5*** concludes.

2. Fiscal multipliers: definition, determinants & estimation

2.1 What is the fiscal multiplier?

The term *fiscal multiplier* refers to the ratio of a change in output (ΔY) to an exogenous change in the fiscal balance, be it a change in government spending (ΔG) or a change in government revenue (ΔT).[2] Depending on the time horizon considered, there are several relevant ratios that fit the term fiscal multiplier:

The *impact* multiplier, defined as the ratio of a *contemporaneous* change in output (at time t_0) to an exogenous change in the fiscal balance at time t_0 *i.e.,* $\Delta Y(t_0) / \Delta G(t_o)$.

The multiplier at some future point in time (say, N period from now), defined as the ratio of a change in output at time t_0+N to an exogenous change in the fiscal balance at time t_0 *i.e.,* $\Delta Y(t_0 + N) / \Delta G(t_o)$.

The *cumulative* multiplier, defined as the ratio of the cumulative change in output over an exogenous change in the fiscal balance over a time horizon of N periods *i.e.,* $\Sigma\Delta Y(t_0 + i) / \Delta G(t_0)$, with i = 0, 1,…,N.

The *peak* or *maximum* multiplier, defined as the ratio of the largest change in output over any time horizon N to an exogenous change in the fiscal balance at time t_0, *i.e.,* max $\Delta Y(t_0 + N) / \Delta G(t_o)$, for every N.

2.2 What are the determinants of the fiscal multiplier?

Prior theoretical and empirical work on the response of main macroeconomic aggregates to exogenous fiscal shocks has shown that the *size* and, in certain instances, the *sign* of the fiscal multiplier can be *country-*, *estimation method-*, and *economic conditions-specific*. In general, it appears that quite diverse views continue to exist among professional economists and policy makers as regards the quantitative and qualitative effects of fiscal policy. [3]

From a purely theoretical perspective, neoclassical models would predict that a positive shock to government spending would lead to a crowding out of private consumption, while Keynesian and some neo-Keynesian models would predict the opposite effect. To complicate things further, uncertainty regarding the size (or even the sign) of the fiscal multiplier in developing and emerging markets is even higher, not only because of the scarcity of timely and reliable national and government account statistics, but also because of a long history of fiscal profligacy and sovereign debt crises that have blurred the efficacy of any fiscal expansion.

Based on an extensive literature review on the topic, Spilimbergo et al. (2011) provide some stylized facts on the potential size and determinants of fiscal multipliers. As per the said study, the size of the multiplier is large if: **a)** "leakages" are limited *i.e.,* only a small part of the fiscal stimulus is channeled to savings or imports; **b)** monetary conditions are accommodative (*i.e.,* a fiscal stimulus does not lead to an increase in the interest rate); and **c)** the country's fiscal position is sustainable following a fiscal expansion.

[2] A more extensive note on relevant definitions and the determinants of fiscal multipliers can be found in *e.g.* Spilimbergo et al, IMF Staff Position Note (09/11).

[3] See e.g. Perotti (2004).

Taking a closer look at the conditions highlighted above, the authors clarify that:

a) "Leakages" are limited if:

- The propensity to import is relatively small, meaning that, on a *ceteris paribus* basis, large *closed* economies and/or economies featuring barriers to trade have larger multipliers than *open* economies with no barriers to trade.
- The measures mainly target *liquidity constrained* consumers. That is, an exogenous fiscal shock (*e.g.* increase in government spending) does not lead to a rise in precautionary savings by consumers in anticipation of higher taxation in the future. On the contrary, liquidity constrained households spend a significant portion of the windfall (*e.g.* wage increase or increased government purchases of goods and services that boost household income) to increase current consumption.
- The size of the *automatic stabilizers* (i.e., the output elasticity of government revenue and spending) is relatively small, meaning that the automatic offsets to an exogenous fiscal shock are limited.
- Domestic economic conditions are recessionary and the economy is far from its *full employment* equilibrium. If such conditions prevail, an increase in government spending does not necessarily lead to an increase in interest rates that could, in turn, crowd out private investment.
- The fiscal stimulus has a larger spending component relative to tax cuts (and vice versa), as the initial shock could have a more immediate impact on aggregate demand, while households may save part of a tax cut.

An important point to make here is that the above condition may not apply to countries featuring *unsustainable* fiscal positions. In the latter case, an unwarranted fiscal expansion could further exacerbate investor worries about fiscal sustainability, leading to a further increase in sovereign bond yield spreads and domestic interest rates, causing a crowding out of private investment and reducing the multiplier.

b) Monetary conditions are accomodative if:

- A fiscal shock (*e.g.* increased discretionary government spending) does not put upward pressure on the nominal interest rate. On the latter point, a number of recent empirical studies have documented that the fiscal multiplier can rise by a factor of 2 or 3 if the nominal interest rate is at (or very close to) the lower nominal bound of zero percent.
- The exchange rate is fixed.

Arguably, the latter situation does not necessary apply to a number of crisis-hit euro area economies. Although the ECB policy rate is currently 0.75% and short-term euro area interbank rates are close to zero, domestic monetary conditions in Greece and elsewhere remain extremely tight due to the ongoing recession and the domestic liquidity squeeze.

c) As per a relevant argument provided in the previous section, one would expect the fiscal multiplier to be, *ceteris paribus*, lower the more unsustainable a country's fiscal position is considered to be.

Other factors that can influence the size of the fiscal multiplier include:

a) *Degree of financial market deepening and intermediation.* A relatively low degree of financial intermediation in the domestic economy usually implies that liquidity-constrained households and businesses can not easily borrow to intertemporally smooth consumption and investment and thus, a positive fiscal impulse can lead to higher current consumption (and less precautionary saving) than otherwise the case.

b) *General macroeconomic and financial conditions in the domestic economy and externally.* As noted in Spilimbergo et al (2011), heightened uncertainty in the midst of the global economic and financial crisis induced U.S. consumers to increase precautionary savings, decrease their marginal propensity to consume and thus, reduce the size of the multiplier. That is demonstrated by official data showing that the 2008 U.S. tax rebate has been largely saved. On the other side of the spectrum, one could convincingly argue that the crisis may have actually increased the size of the fiscal multiplier, as the ensuing credit crunch has raised the proportion of liquidity-constrained households and, furthermore, monetary authorities in major industrialized countries have reduced their nominal policy rates towards the zero percent bound. In view of the ambiguous effects of the global economic and financial crisis on the size of the fiscal multipliers, the aforementioned authors caution against re-estimating the size of the multiplier in the present trajectory, on the basis that the recent crisis may have caused structural breaks in relevant macroeconomic time series utilized in conventional estimation methods.

2.3 What is the size (and the sign) of the fiscal multiplier?

As we have already noted, the size of the fiscal multiplier can be country-, estimation method- and regime-specific. In an IMF staff note prepared in March 2009 for the G-20 Ministerial Meeting, a range of fiscal multipliers was used[4]. The low set of multipliers included 0.3 on revenue, 0.5 on capital spending, and 0.3 on other spending. The high set of multipliers included o.0 on revenue, 1.8 on capital spending, and 1 for other spending. Cross-country VAR estimates of fiscal multipliers range from negative to 0.5, in part because of higher fiscal sustainability concerns in lower income countries. However, these estimates can be downwardly biased because the lack of accurate data leads to attenuation bias. As regards the sign of the fiscal multiplier, many empirical studies document a positive multiplier for an exogenous government spending shock (*e.g.* increase in government consumption of goods and services) and a negative multiplier for a government revenue shock (higher taxation), with the former exceeding the latter in absolute terms. However, other studies have actually documented quite diverse results as regards the size (and the sign) of the fiscal multiplier. At the extreme, a fiscal expansion can have contractionary implications for the domestic economy (and vise versa), especially if it exacerbates fiscal sustainability concerns. To complicate things even further, an increase or decrease in different government expenditure or revenue categories[5] can have quite different effects on output, with the diversity of estimated multipliers increasing even further if one considers the response of individual components of domestic GDP (e.g. private consumption vs. investment; imports vs. exports).

2.4 What do existing theories say about the size of the fiscal multiplier?

In the traditional Keynesian view, fiscal policy is the main tool for stabilizing output, especially in deep economic downturns. This is because, the argument goes, in periods of steep economic contraction (or even depression, such as the one that hit the U.S. economy in 1930s), monetary policy is incapable of supporting the economy, since the interest rate is already at/or very close to the zero nominal bound, effectively leaving *deficit-financed* government spending increases and/or tax cuts as the only available policy instrument to increase aggregate demand. Simply put, a *discretionary* government spending increase in a trajectory characterized by idle resources in the economy would not only boost aggregate demand directly, but it would also trigger a chain reaction of increased demand from households and businesses who have seen their incomes rising as a result of the government intervention. This is especially when the spending expansion is not financed by an increase in taxation and the existence of idle resources prevents an increase in domestic interest rates that could, otherwise, crowd out private investment. In a similar argument, a deficit-financed tax cut would leave more disposable income to the consumers, facilitating a rise in demand, with the size of the output response depending on households' marginal propensity to consume (and generally being different in size compared to that triggered by an *equiproportional* positive spending shock).

As widely known, the 1970s and 1980s saw a notable decline in the perception of fiscal policy as an important *fine tuning* tool of the economy along with a renewed interest in the role of money in output fluctuations. One can cite several reasons explaining this development, including among others, the inability of old Keynesian economics to explain the simultaneous occurrence of high unemployment and inflation in the 70s as well as large time lags experienced in the ratification progress and the implementation of countercyclical fiscal policy packages in prior decades (*e.g.* the tax cut enacted under the Kennedy Presidency to deal with the recession of 1959-1960). Nonetheless, the 2007/2008 world financial crisis and the accompanying severe recession generated renewed interest among governments, central banks and the academia in the Keynesian view of the role of

fiscal policy as an important macro stabilization tool. As a result, many industrialized countries (among others, U.S. and Germany) introduced huge fiscal stimulus packages to help their economies emerge from the post-crisis recession.

Although the prevailing view is that the aforementioned packages helped many countries recover from the crisis, there still seems to be a wide disagreement over the efficacy of countercyclical fiscal policy in stabilizing output. As discussed earlier, a number of empirical studies has shown that the sign and the size of the fiscal multiplier can depend not only on the particular phase of the business cycle (and the timing of a given fiscal shock), but also on a multitude of other factors, including, among others, fiscal policy credibility, liquidity constrains facing households, economic openness and whether or not the interest rate is at/or near the zero percent nominal bound. No wonder then that wide disagreement continues to exist as regards the fiscal multiplier.

Returning now to the existing theoretical literature on fiscal multipliers, the neoclassical *real business cycle* ((RBC) model predicts that a deficit-financed government spending shock can generate a small positive output response, which is lower in size than the shock itself. This is because the revenue shock boosts the present discounted value of future expected tax payments, creating a negative wealth effect that dampens consumption, promotes labor supply and compresses the real wage (*e.g.* Baxter and King, 1993). On the other hand, tax shocks that are not accompanied by discretionary changes in government expenditure have no impact on output, since lower taxes

today will need to be offset by higher taxes in the future, leaving their present discounted value unchanged (the so-called *Ricardian Equivalence*).

Yet, the introduction of frictions can alter the aforementioned results, changing the size and/or the sign of the fiscal multiplier. For instance, the existence of borrowing constraints in an otherwise standard RBC model can generate a small positive output response to a negative tax shock (tax cut), while amplifying the negative wealth effects of a positive spending shock.[6] Separately, the introduction of implementation delays in the analysis of government investment in a RBC model can generate small or even negative responses of output and labor supply in the short term.[7]

On their part, new-Keynesian (NK) models introduce real and nominal rigidities in a stochastic dynamic general equilibrium model, demonstrating, broadly in line with the RBC model, that the wealth effect tends to prevail over other propagation mechanisms. In general, NK models find a small positive output response to a temporary increase in discretionary government expenditure (*i.e.,* estimated multiplier of less than one), though the introduction of further frictions can amplify the effects of fiscal shocks.[8] For instance, the introduction of *rule-of-thump* (myopic) consumers increased the multiplier because limits the share of *forward-looking* agents who are subject to the negative wealth effect, while rule-of-thump agents can respond quite strongly to changes in taxes, especially if the latter are lump-sum.[9] Introducing labor market frictions (*e.g.* unionized wage bargaining) to the aforementioned framework can further increase the output response to a give fiscal shock, as it reduces the decline of real wages in response to an increase of labor supply by forward-looking agents, which, in turn, compresses further the income of rule-of-thump consumers.

2.5 Estimation Methods

Various methodological approaches have been developed to study the effect of fiscal policy changes on economic activity, with much of empirical research in this area being based on the linear Structural Vector Autoregression (SVAR) model or the linearized Dynamic General Equilibrium (DSGE) model. Alternative identification approaches, including, in particular, the narrative approach of Ramey and Shapiro (1998) and Romer and Romer (2010) rely primarily on public information to identify the nature of fiscal shocks. Although the latter approach provides a convenient (and more plausible) method of identification, it seems to restrict itself to the study of a very limited class of shocks, especially military spending build-ups and tax changes that are unrelated to the current state of the economy (recession vs. expansion) or short-term policy considerations.[10]

Another important limitation of all three methodological approaches highlighted above is that, by construction, they rule-out *state-dependent* multipliers. Yet, recent theoretical and empirical work has emphasized that government spending multipliers may be larger in recessions than expansions.[11] These recent findings seem to be in agreement with earlier Keynesian arguments in favor of using discretionary fiscal policy in recessionary periods to stimulate aggregate demand. Intuitively, when the economy has a slack, expansionary government spending shocks are less likely to crowd out private consumption or investment.

Using an estimation approach similar in many respects to the *Smooth Transition Autoregressive (STAR) models* developed in Granger and Teravista (1993), Auerbach and Gorodnichenko (2010) estimate spending multipliers that are approximately zero in expansions and as high as 2.0 in recessions. Other recent studies broadly confirm the existence of sizeable cyclical variations of fiscal multipliers. Among others, Bachmann and Sims (2011), report that the spending multiplier is approximately zero in expansions and approximately 3 in recessions. Separately, Shoag (2010) examines state-level variation in government spending and finds that the multiplier is approximately 3.0-3.5 when labor markets have a slack (recession) and approximately 1.5 when there is no slack (expansion).

[4]See http://www.imf.org/external/np/g20/pdf/031909a.pdf.
[5]E.g. wage hikes or cuts, higher/lower government purchases of goods and other services, hikes or cuts in the personal income tax rates or the rates for corporate taxation and/or social security contributions.
[6] See e.g. Callegari (2007) and Batini et al. (2012).
[7]See e.g. Leeper et al. (2010).
[8]See e.g. Cwik and Wieland (2009) and Cogan et al. (2010).
[9]See e.g. Batini et al. (2012).
[10] For a more thorough discussion on these and other related issues see e.g. Auerbach and Gorodnichenko (2010)

In an earlier paper (see Monokroussos & Thomakos (2012), we presented an empirical investigation of the multipliers for a range of different government revenue and expenditure categories in Greece, utilizing the classic SVAR approach developed in Blanchard and Perotti (2002) and extended further in Perotti (2004). As a second step, we applied a variant of the Smooth Transition Vector Autoregression (STVAR) model presented in Auerbach and Gorodnichenko (2011) to investigate the time- and regime-dependent properties of Greece's fiscal multipliers.

The main results of our earlier paper can be summarized as follows:

- Our SVAR model estimated government spending multipliers that were not far away from what had been estimated for Greece in a number of earlier empirical studies by the IMF and others *i.e.,* multipliers in the vicinity of 0.5.
- Yet, our STVAR model estimated *strongly significant* government spending multipliers of size *higher than* one in recessionary phases along with negative (and broadly *insignificant*) multipliers for periods of economic expansion.
- This latter finding was particularly pronounced for government *wage* expenditure, where the estimated multiplier was found to be as high as 2.35 (and strongly significant) in recessionary regimes and negative (and largely insignificant) in economic expansions.
- Based on the aforementioned findings, we then proceeded to estimated the size of potential output losses due to fiscal austerity as well as the ensuing increases in the debt to GDP ratio and the government borrowing requirement, under a number of different scenarios regarding the implementation profile of a new austerity package for 2013-2016 domestic authorities were negotiating back then with the EC/ECB/IMF troika as a prior action to the resumption of official funding to Greece.
- By and large, we interpreted our empirical results as providing a fairly strong argument in favor of a 2-year extension in the Greek economic adjustment programme (eventually granted to the country by its official lenders) along with a more gradual implementation profile of related expenditure cuts and revenue generating measures.

2.6 Threshold Vector Autoregressions (TVARs)

In the present paper, we employ a multivariate threshold autoregressive model (TVAR) to estimate regime-dependent multipliers for a range of key government revenue and expenditure aggregates in Greece. The methodology we use is basically an adaptation of the approached proposed by Balke (2000) and Athanasova (2003) and extended more recently by, among others, Calza and Sousa (2006), Afonso et al. (2011), Baum and Koester (2011) and Batini et al. (2012).

Threshold Vector Autoregressions (TVARs) are piecewise linear models with different autoregressive matrices in each regime. The regimes are determined by a transition (i.e., threshold) variable, which can be either an exogenous variable or one of the endogenous TVAR variables (as is the case in the present paper).[12] The TVAR model has a number of interesting features that make it suitable for our empirical analysis. First and foremost, it allows potential asymmetries in the response to discretionary fiscal shocks. This is because the estimated impulse response functions are no longer linear, allowing the propagation and the effects of the shocks to depend on the set of initial conditions as well as on the sign (expansionary vs. contractionary) and the size of the shock (*e.g.* 1 S.D. vs. 2 S.D.s expenditure cut). This is a particularly useful feature of our empirical study, as it allows us to analyze, among others, the potential effects of Greece's new austerity program (2013-2016), which is implemented in a deeply recessionary output regime such as the present one.

Second, by endogenizing the transition variable (*i.e.,* the variable by which different regimes are defined) we effectively allow the possibility of a regime switch following a structural fiscal shock. In the latter case, the impulse response functions depend on the history of the endogenous variables in the period leading to the specific point in time when the shock occurs as well as on both the size and the sign of the shock itself. Besides accommodating possible asymmetries in the effects of discretionary fiscal shocks, the TVAR framework enable us as to make a quantitative assessment as regards the probability or a regime switch following a given fiscal shock. For instance, we could estimate the probability of remaining in a recessionary regime after applying a discretionary government spending cut of a given size and compare it with the probability of remaining in a similar regime after implementing a spending reduction of a much lower size.

In general, the TVAR model can generate more than one critical threshold values and, by implication, more than two regimes. However, this study focuses on a model with only two regimes, a framework deemed adequate to analyze the effects of fiscal policy over the different facets of the business cycle. In what follows, we provide a general description of the TVAR model estimated in the present empirical study, skipping much of technical detail that can be found elsewhere in the literature, see e.g. Tsay (1998) and Baum & Koester (2011).

[11] See e.g. Christiano et al. (2009); Woodford (2010); Auerbach and Gorodnichenko (2010, 2011); Bachmann and Sims (2011); and Shoag (2011).

Let a vector $y_t = (y_{1t},\ldots,y_{kt})'$ of *k* stationary endogenous variables and *T* observations, describing a finite p-order VAR of the form:

$$y_t = \Gamma_o + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \ldots + \Gamma_p y_{t-p} + u_t \quad (1)$$

where Γ_o is a *k*-dimensional vector of deterministic terms; Γ_i *(i= 1,…,p)* are *kxk*-dimensional coefficient matrices ; and u_t is a sequence of serially uncorrelated random vectors with zero mean and covariance matrix Σ_u.

Equation (1) can be rewritten more compactly as follows:

$$y_t = \Gamma X_t + u_t \quad (1.1)$$

where $\Gamma = (\Gamma_o, \Gamma_1, \ldots, \Gamma_p)$ and $X_t = (1, y_{t-1}, \ldots y_{t-p})'$.

Based on the above notation, the TVAR model can be written as follows

$$y_t = \Gamma^1 X_t + \Gamma^2 X_t I\,(z_{t-d} \geq z^*) + u_t \quad (2)$$

where, z_{t-d} is a threshold variable determining the prevailing regime of the system at time *t-d,* with *d* being a possible delay lag parameter; $I\,(.)$ is an indicator function, which equals 1 if the threshold variable z_{t-d} is equal or higher than the threshold value z^* and 0 otherwise. Notably, the coefficient matrices Γ^1 and Γ^2 as well as the contemporaneous error matrix u_t are allowed to vary across regimes. Moreover, both the lag *d* and the regime threshold value z^* are unknown parameters that can be estimated along with the rest of the model parameters.

As is the case with the linear VAR, the reduced-form *contemporaneous* errors of the non-liner TVAR model (2) are not necessarily uncorrelated with each other (i.e., Σ_u matrix is not diagonal**)**. This effectively means that the structural TVAR errors (and, by implication, the discretionary fiscal shocks) can not be identified, unless one is willing to impose certain identifying restrictions in the parameters of the primitive system. While In Monokroussos and Thomakos (2012), we applied the Blanchard and Perotti (2002) identification approach to our linear VAR model, in the present study we apply the Cholesky decomposition for identifying out TVAR structural errors.

Our empirical study determines whether or not our TVAR model (2) involves threshold behavior by applying the Tsay (1998) multi-variate threshold approach, which effectively applies a white noise test to the *predictive* residuals of an arranged regression. Once a threshold system behavior is confirmed (as is the case with our empirical study), we follow Koop (1996) and Koop, Resaran and Potter (1996) to estimate generalized impulse response functions (GIRF) for a number of different specifications of our TVAR model, so as to capture potential non-linearities in the response of key macro variables (e.g. GDP) to discretionary fiscal shocks. Formally, the generalized impulse response function is estimated as follows:

$$\text{GIRF} = E[X_{t+m} / \varepsilon_t, \varepsilon_{t+1} = 0, \ldots, \varepsilon_{t+m} = 0, \Omega_{t-1}] - E[X_{t+m} / \varepsilon_t = 0, \varepsilon_{t+1} = 0, \ldots, \varepsilon_{t+m} = 0, \Omega_{t-1}]$$

where E denotes the expectation operator; m is the forecasting horizon; Ω_{t-1} is the information set at time t-1 ; and ε_t is a given fiscal shock of a specific sign and size In our study, we implement shocks for each period within one regime and then we take regime averages to obtain the generalized impulse response functions. Our methodology allows the regimes to switch after fiscal shocks and thus, the estimated GIRFs depend on the size and sign of shocks.

3. A brief review of recent fiscal developments in Greece

Rampant expenditure growth on the back of broadly irresponsible wage and hiring policies in the broader public sector conspired with untargeted social spending, widespread tax evasion and adverse demographics to result in a hugely unsustainable fiscal position in the period following the outbreak of the 2007/2008 global financial crisis. Greece's structural primary balance underwent a cumulative deterioration of more than 18.5ppts-of-GDP in 2001-2009, with the corresponding deficit reaching ca 14.5%-of-GDP at the end of that period. Notably, the bulk of the aforementioned deterioration can be attributed to an expansion of social spending (particularly, health and pension expenditures) by more than 6ppts of GDP (*Table 1.1*).[13]

In response to a further sharp rise in Greek sovereign bond spreads in late 2009 and during the first months of the following year, Greece signed in May 2010 a €110bn financing programme with its Eurozone partners and the IMF (henceforth, 1st adjustment programme), aiming to provide adequate government financing for the coming 2-3 years and to assist the country gradually reestablish access to international funding markets, starting in FY-2012. The

aforementioned programme came with strict conditionality that was laid out in a Memorandum of Understanding (MoU) agreed with official lenders. The three main strategic pillars of the 1st adjustment programme were: (I) re-establish fiscal sustainability; (ii) reclaim competitiveness losses and facilitate a return to positive and sustainable medium-term economic growth; and (iii) safeguard stability of the domestic financial system.

Table 1.1 – Greece: General government revenues & expenditures compared to EU average
(in percent of GDP)

	2001	2008	2009	2010	2011	EU avg. 2008-10 1/
Revenue	40.9	40.7	38.0	39.5	41.0	44.3
Indirect taxes	13.3	12.4	11.3	12.0	12.7	12.8
Direct taxes	8.6	8.0	8.3	7.7	8.3	12.7
Social contributions	12.6	13.2	12.7	13.1	12.4	13.9
Non-tax and other	6.5	7.0	5.7	6.7	7.7	5
Total expenditure	45.3	50.6	53.8	50.2	50.3	49.6
Wages	10.4	12.0	13.4	12.1	12.0	10.9
Social benefits	15.4	19.6	21.1	20.8	21.6	20.7
Other current spending	7.3	8.1	8.9	7.7	6.7	11.1
Interest	6.5	5.1	5.1	5.8	6.9	2.7
Investment	5.8	5.7	5.2	3.9	3.1	4.3

1/ Averages for sub-categories of expenditure refer to the 2008-09 period.

Following a pretty strong start in the initial period after the signing of the 1st adjustment programme, the reforms drive broadly stalled amid increasing social resistance to domestic austerity policies and heightened investor doubts over the ability of euro area governments and institutions to deal with the crisis. Responding to that difficult situation, and in effort to prevent a Greek sovereign default that could have severe consequences for the stability of the euro area as a whole, Greece and its official lenders signed in March 2012 a new bailout agreement (henceforth, 2nd adjustment programme), covering the period 2012-2014. Under the new bailout, €130bn of new EFSF/IMF funding was earmarked for Greece so as to (i) implement a restructuring of privately-held Greek sovereign debt (total notional amount of PSI-eligible debt = €206bn); (ii) complete a €50bn domestic bank recapitalization plan; and (iii) cover the overall borrowing requirement for the period 2012-2014.[14] Similarly to the 1st adjustment programme, the 2nd programme came with strong conditionality aiming to restore further the country's fiscal position, erase past competitiveness losses and stabilize domestic financial conditions. The 2nd programme also incorporated certain important concessions (*i.e.,* improved terms on official lending), including, among others, a lengthening of the maturities of (and a reduction in the interest rates on) old EU bilateral loans as well as new loans to Greece from the EFSF. As a prior action to the 2nd bailout agreement, the Greek Parliament voted in February 2012 an auxiliary budget (€3.2bn worth of expenditure-side measures), so as to facilitate fulfillment of the agreed fiscal targets for FY-2012. Furthermore, as part the conditionality underlying the new programme, the Greek government committed to identify by the end of May 2012 a new austerity package for the period 2013-2014. Agreement between the Greek government and the EC/ECB/IMF troika on the new package was delayed due to the prolonged pre-election period in Greece, resulting in a considerable delay in the disbursement of a €31.3bn EFSF/IMF loan tranche that was originally planed for June 2012.

[12]For a more thorough presentation of the technical aspects and special features of theThreshold Vector Autoregression model see e.g. Baum and Koester (2011) and Afonso et al. (2011).
[13]A more comprehensive review of the magnitude and causes of Greece's fiscal deterioration in the period before the outbreak of the 2007/2008 global crisis can be found in e.g. IMF Country Report No. 12/57, March 2012.

Following several rounds of painful negotiations and after broadly succeeding to bring the adjustment programme back on track, Greece's new coalition government eventually reached agreement with the troika on a new fiscal package for the period 2013-2016, mainly consisting of expenditure cuts (Table 1.2)

The new package effectively implies a 2-year extension of the implementation horizon envisaged in the initial conditionality framework of the 2nd bailout agreement[15] and follows an austerity programme worth ca €49bn (22.5 ppts-of-GDP) applied in the period 2010-2012. Out of the full package of new fiscal measures, the Greek Parliament approved in November 2012 the measures to be implemented in 2013-2014 (€13.5bn). Furthermore, additional measures (up to €4bn) for the period 2015-2016 are to be identified and agreed with the troika as a prior action to the 5th programme review (August 2013). The implementation horizon of the new austerity programme is heavily front-loaded with €9.2bn of measures implemented in FY-2013, mainly consisting of cuts in wages, pensions and special benefits (€6bn).

Table 1.2 – Package of new austerity measures 2013-2016/1
(Percent of GDP)

New Fiscal Measures	2013-14	2015-16
Expenditure Measures	5.10	0.04
Compensation of employees	0.79	0.01
Social Security transfers	3.23	0.04
Subsidies	0.09	0.01
Intermediate consumption	0.75	-0.01
Gross fixed capital formation	0.24	0.00
Revenue Measures	2.06	0.02
Direct taxes	0.90	0.01
Indirect taxes and sales	0.61	0.00
Social security contributions	0.38	0.00
Total	7.15	0.06
Memorandum item:		
Tax administration gains	0.34	1.30

Source: IMF staff estimates
1/ Fiscal measures introduced at the first review

Upon parliamentary endorsement of the new fiscal package, the 26/26 November 2012 Eurogroup announced a number of relief measures for Greece, aiming to bring the country's gross public debt ratio to 124%-of-GDP in FY-2020 (and to levels below 110%-of-GDP by 2022) and to cover most of the government borrowing gap indentified for the period 2013-2016.[16] Furthermore, following the successful completion of a government debt buyback scheme, the Eurogroup of 13 December 2012 announced the unlocking of official funding to Greece, endorsing a €49.1bn cumulative EFSF disbursement over the period December 2012-March 2013 (€52.5bn including the IMF contribution).[17]

As a final note to this section, the fiscal consolidation progress attained by Greece so far is quite impressive by historical standards, especially considering the overall size of output losses recorded in the last 5 years (cumulative real GDP contraction of nearly 20ppts since H2 2008). The general government primary deficit has been reduced from levels around 10.4%-of-GDP in FY-2009 to an estimated 1%-of-GDP in FY-2012, with the revised adjustment programme now targeting a broadly balanced position this year (along with primary surpluses between 1.5%-of-GDP and 4.5%-of-GDP over the period 2014-2016). Despite this impressive progress, however, the primary balance still remains some way off its debt-stabilizing level (around +1.5%-of-GDP, according to our estimates), while a vigorous implementation of the new fiscal measures is required in order to facilitate fulfillment of the agreed fiscal targets.

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[14]A comprehensive analysis on the main components and modalities the 2nd bailout programme for Greece can be found in *Eurobank EFG Research, 20 March 2012, "New bailout programme for Greece: Conditionality, implications for sovereign solvency and valuation of the Greek PSI deal"* .
http://www.eurobank.gr/Uploads/Reports/6312GREECE%20MACRO%20FOCUS%20March%202%202012.pdf
[15] 4.5%-of-GDP primary surplus target moved to 2016, from 2014 in the initial programme.
[16]A thorough analysis on the potential impact of the relief measures announced at the 26/27 November 2012 Eurogroup can be found in *Greece Macro Monitor, "Successful debt buyback opens the way for the unlocking of official funding to Greece, implementation of new package of debt relief measures", Eurobank Research, December 13, 2012.*
http://www.eurobank.gr/Uploads/Reports/GREECE%20MACRO%20FOCUS%20December%2013%202012.pdf
[17]The allocation of the said disbursement is as follows: €23bn for the completion of a recapitalization scheme for Greek banks, €11.3bn for financing the debt buyback operation and the rest for servicing public debt.

4. Empirical Study

4.1 Data description and definition of variables

Our empirical study is conducted with quarterly data on main real activity and fiscal indicators for Greece, reported by Eurostat.[18] The data for output (and its main components) as well as inflation (based on the GDP deflator) are taken from Greece's national income accounts, while the main government expenditure and revenue aggregates constitute actual (not interpolated) quarterly general government statistics compiled in ESA-95 accounting terms. In their initial form, all time series are comprised of non-seasonally adjusted data. All series are converted to *real* terms by dividing with an appropriate deflator index – the GDP deflator is used for government expenditure and revenue series - and they are then transformed into seasonally adjusted series by applying the U.S. Census X11 methodology.[19] *Table 2.1* below provides a summary of the raw data and the notation of the variables utilized in our empirical study. In addition to the time series depicted below, the following general government expenditure and revenue aggregates are utilized: (i) real general government primary spending on goods and services, ***RGSPEND,*** constructed as the sum of *RGCONA* and *RGFCF* variables presented in *Table 2.1;* and (ii) ***RGREV***, constructed as the total *general government revenue variable, RTGREV*, presented in *Table 2.1* net of transfers and property income.

Table 2.1 - Raw data and definition of variables

	Notation	Data series (all non-seasonally adjusted)	Scale	Unit
Data from National Income Accounts	GDP	Gross domestic product at market prices	Current prices	Millions of euro
	CON	Final consumption expenditure	Current prices	Millions of euro
	HCON	Final consumption expenditure of households	Current prices	Millions of euro
	GCON	Final consumption expenditure of general government	Current prices	Millions of euro
	XPORT	Total exports	Current prices	Millions of euro
	MPORT	Total imports	Current prices	Millions of euro
	PGDP	GDP deflator	Index	Base 2000
	PCON	Consumption deflator	Index	Base 2001
	PHCON	Household consumption deflator	Index	Base 2002
	PGCON	Government consumption deflator	Index	Base 2003
	PXPORT	Export deflator	Index	Base 2004
	PMPORT	Import deflator	Index	Base 2005
	RGDP	Real GDP	Volume	Current prices/deflator
	RCON	Real consumption	Volume	Current prices/deflator
	RHCON	Real household consumption	Volume	Current prices/deflator
	RGCON	Real government consumption	Volume	Current prices/deflator
	RXPORT	Real exports	Volume	Current prices/deflator
	RMPORT	Real imports	Volume	Current prices/deflator
Data from Government Accounts	GCONA	Final consumption expenditure	Current prices	Millions of euro
	GFCF	Gross fixed capital formation	Current prices	Millions of euro
	TGEXP	Total general government expenditure	Current prices	Millions of euro
	TGREV	Total general government revenue	Current prices	Millions of euro
	WEXP	Compensation of employees, payable	Current prices	Millions of euro
	RGCONA	Real final consumption	Volume	Current prices/GDP deflator
	RGFCF	Real gross fixed capital formation	Volume	Current prices/GDP deflator
	RTGEXP	Real total general government expenditure	Volume	Current prices/GDP deflator
	RTGREV	Real total general government revenue	Volume	Current prices/GDP deflator
	RWEXP	Real compensation of employees, payable	Volume	Current prices/GDP deflator

Source: Eurostat

[18] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes.
[19] See U.S. Department of Commerce, Bureau of the Census

4.2 Model specifications

In our empirical study we estimate a 3-variable TVAR model, consisting of the following endogenous variables: real government spending on goods and services (G_t), real government taxes net of transfers and property income (T_t) and real output (Y_t). Note that these are among the main variables used in Blanchard-Perotti (2002) and Perotti (2004) seminal studies as well as in a vast number of earlier empirical papers on the effects of fiscal policy.

In an effort to assess the potential effects of structural fiscal shocks on real output we estimate a number of alternative specifications, allowing our G_t variable to represent different subcomponents of total general government outlays, including: real general government primary spending on goods and services, (***RGSPEND***) and real government investment expenditure (***RGFCF***)

In addition, and as a test for robustness, we estimated a number of different model specifications, allowing our G_t, T_t and Y_t variables to represent annual (YoY) growth rates; quarterly (QoQ) growth rates or moving averages of YoY or QoQ growth rates. We also ran a number of models with our Y_t variable representing actual output deviations from trend GDP growth (estimated by applying the HP filter). In the *Empirical Results and Interpretation* Section 4.3 of this paper we present the estimated GIRFs for a number of specifications estimated in year-on-year (YoY) terms. The results for the alternative variable transformation models are broadly similar (in qualitative terms) to those of the YoY growth specifications and are available upon request.

As we noted earlier (*Section 2.6*), our study employs a recursive identification scheme for structural stocks (Cholesky decomposition), with our baseline specification utilizing the following ordering of variables:

$$y_t = (G_t, T_t, Y_t)^T \qquad (3.1)$$

We realize, of course, that the assumed ordering of variables constitutes a highly-debatable issue on pure theoretical and practical grounds (see e.g. Baum & Koester (2011)). For that reason, and as a robustness check, we estimate a full range of alternative specifications for the following ordering of variables, which allows some flexibility as regards the interplay of automatic fiscal stabilizers (and can be arguably seen as being more in sync with the Blanchard and Perotti (2002) identification approach):

$$y_t = (Y_t, T_t, G_t)^T \qquad (3.2)$$

4.3 Empirical results and interpretation

Tables 3.1 to 3.5 below show the estimated generalized impulse response functions (GIRFs) for a range of assumed structural fiscal shocks of varying signs and sizes. All variables enter our TVAR model in YoY real seasonally adjusted terms (see also section 4.1 of this document). Note that the TVAR lag order is estimated by applying the normal information criteria in the linear VAR estimation, while the threshold lag *d* and the critical threshold value z^* are unknown parameters estimated alongside the rest of model parameters. Our TVAR specifications include a constant term and a time dummy (***D2009***) that takes the value of 1 for ***t*** = Q1 2009 onwards and 0 otherwise. Inclusion of the said dummy is to account for a break in the tax revenue series that occurred in FY-2009. Finally note that *Tables 3.1-3.5* report the estimated multipliers as derivatives expressed in euro terms. This is done by multiplying the estimated multiplier value by the ratio of the response variable (in euros) to the mean of the respective impulse variable in euros.

4.3.1 General government current expenditure shocks in expansionary & contractionary output regimes

Table 3.1 shows the response of output (real GDP) in a TVAR model which assumes the following ordering of endogenous variables $y_t = (G_t, T_t, Y_t)$, where G_t represents general government real primary spending on goods and services (***RGSPEND)***; T_t is total general government revenue net of transfers and property income (***RGREV)***; and Y_t stands for real output (***RGDP***). Here our threshold variable is Y_t, our shock variable is G_t and the assumed lag orders for the TVAR system and the threshold variable are 2 and 1, respectively. *Graphs 3.1.1. to 3.1.3* in the Annex section of this document provide a visual depiction of the generalized impulse responses (estimated in YoY percentage terms) corresponding to *Table 3.1*, while Graph 3.1.4 (Annex) offers a visual representation of the critical threshold.

Table 3.1 presents the multipliers (output responses) to exogenous shocks in the assumed impulse variable (***RGSPEND***). Here we estimate impulse-responses for positive G_t shocks (*i.e.,* discretionary increases in real government spending on goods and services) and negative G_t shocks (*i.e.,* discretionary cuts in real government spending on goods and services) of three different sizes: 1.5% YoY, 3% YoY and 5% YoY. The selection of these shock sizes has some relevance with the present Greek austerity programme, as the FY-2013 Budget

envisages a ca 3% YoY *real* contraction in central government ordinary budget expenditure and public investment outlays net of interest costs, which constitutes a good proxy of our ***RGSPEND*** variable. The estimated multipliers are for two discrete output regimes *i.e., Upper regime* ($z_{t-d} \geq z^*$) and *Lower regime* ($z_{t-d} < z^*$). Finally, note that the multiplier values of Table 3.1 presented in red color signify insignificance at the 10% confidence level.

As depicted in *Table 3.1*, discretionary shocks in real government spending on gods and services (***RGSPEND***) generally have different effects on real output, depending on the particular regime ("expansionary" vs. "contractionary") in which the shock occurs as well as on the size and the sign of the shock itself. In particular, for a negative spending shock taking place when the economy is in a lower (i.e., "contactionary") regime, real output falls *on impact* by €0.59 (per €1 decline in real government spending) when the shock size is 1.5% YoY; by €1.18 (per €1 decline in real government spending) when the shock size is 3% YoY; and by €2 (per €1 decline in real government spending) when the magnitude of the shock is 5% YoY. On the other hand, for negative government spending shocks occurring when the economy is in an upper (i.e., "expansionary") regime, real output declines again *on impact* by €0.09 (per €1 decline in real government spending) when the shock size is 1.5% YoY; by €0.18 (per €1 decline in real government spending) when the shock size is 3% YoY; and by €0.30 (per €1 decline in real government expenditure) when the magnitude of the shock is 5% YoY.

For positive government spending shocks (i.e., expenditure increases) the response of output is much more pronounced (on impact) in lower output regimes than when the shock occurs in upper (i.e., "expansionary") regimes. These results are broadly in line with the multiplier values estimated in Monokroussos & Thomakos (2012) and appear to support the old Keynesian view in favor of activist fiscal policy (i.e., fiscal stimulus) to deal with deep economic contractions.

From a longer-term perspective, our cumulative multiplier estimates (for 4, 8 and 12 quarters ahead) suggest that the magnitude of the (contractionary) effect on output as a result of a negative shock in government current spending increases with the size of the initial shock and is larger when the latter occurs when the economy is in a lower regime. To draw a parallel with the present fiscal austerity programme in Greece, the decrease in central government ordinary budget expenditure and investment outlays net of interest costs envisaged in the FY-2013 Budget (*i.e.,* ca €2.74bn or around 3% YoY in real terms) points to a cumulative contraction (fiscal drag) of real output by ca €2.93bn (ca 1.8%ppts-of-GDP) after 1 year an by €5.18bn (ca 2.7ppts-of-GDP) after a period of 12 quarters (3 years). For positive current expenditure shocks (government spending increases on goods and services), our multiplier estimates point to higher output responses in lower than in upper regimes, with the size of the impact increasing with the magnitude of the initial shock.

Table 3.1 – Output response to government current expenditure shocks

(G;T;Y) - G shock						
	Impact multiplier					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.59	-0.59	1.18	-1.18	2.00	-2.00
Upper regime	0.09	-0.09	0.18	-0.18	0.30	-0.30
	Cumulative multiplier (4 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.54	-0.54	1.07	-1.07	1.82	-1.78
Upper regime	0.39	-0.39	0.78	-0.78	1.28	-1.35
	Cumulative multiplier (8 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.87	-0.85	1.66	-1.73	2.84	-2.81
Upper regime	0.49	-0.52	0.97	-1.04	1.67	-1.79
	Cumulative multiplier (12 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.92	-0.92	1.82	-1.89	3.13	-3.05
Upper regime	0.54	-0.55	1.01	-1.12	1.78	-1.93

As a final note to this section, for relative mild expenditure shocks (+/-1.5% YoY in real terms), our cumulative multiplier estimates remain below 1 even after the passage of 12 quarters, regardless of whether the initial shock takes place in an upper or lower output regime. A more thorough interpretation of this result would arguably require the estimation of responses of different GDP components (private vs. public consumption, investment and net exports) to given shocks in government expenditure. Yet, a preliminary explanation would attribute that result to macroeconomic spillovers and other effects, generating a kind of Ricardian response on the part of economic agents to discretionary fiscal shocks.

4.3.2 Government net revenue shocks in expansionary & contractionary output regimes

Table 3.2 below shows the response of output in a TVAR model which assumes the following ordering of endogenous variables $y_t = (G_t, T_t, Y_t)$, where G_t represents general government real primary spending on goods and services (***RGSPEND***); T_t is total general government revenue net of transfers and property income (***RGREV***); and Y_t stands for real output (***RGDP***). Here our threshold variable is Y_t, our shock variable is T_t and the assumed lag orders for the TVAR system and the threshold variable are 2 and 1, respectively. *Graphs 3.2.1. to 3.2.3* in the Annex section of this document provide a visual depiction of the generalized impulse responses (estimated in YoY percentage terms) corresponding to *Table 3.2*, while Graph 3.2.4 (Annex) offers a visual representation of the critical threshold.

Table 3.2 – Output response to government net revenue shocks

(G;T;Y) - T shock						
	Impact multiplier					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.09	0.09	-0.19	0.19	-0.31	0.31
Upper regime	0.00	0.00	0.00	0.00	0.00	0.00
	Cumulative multiplier (4 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.10	0.09	-0.19	0.18	-0.30	0.33
Upper regime	-0.04	0.04	-0.07	0.02	-0.12	0.12
	Cumulative multiplier (8 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.26	0.27	-0.52	0.49	-0.82	0.92
Upper regime	0.04	-0.06	0.10	0.04	0.16	-0.15
	Cumulative multiplier (12 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.31	0.30	-0.54	0.51	-0.82	0.97
Upper regime	0.08	-0.10	0.15	0.07	0.25	-0.23

Table 3.2 presents the multipliers (output responses) to exogenous shocks in the assumed impulse variable (***RGREV***). Here, we again estimate impulse-responses for positive T_t shocks (*i.e.,* hikes in real tax revenue net of transfers and property income) and negative T_t shocks (*i.e.,* real net tax cuts) of three different sizes: 1.5% YoY, 3% YoY and 5% YoY. Again, the estimated multipliers are for two discrete output regimes *i.e., Upper regime* ($z_{t-d} \geq z^*$) and *Lower regime* ($z_{t-d} < z^*$).

As in the case of government spending shocks, expansionary fiscal policy changes encompassing net tax cuts (i.e., negative ***RGREV*** shocks) broadly have a positive effect on output, especially when the shock occurs while the economy is a lower regime. On the other hand, discretionary fiscal policy changes encompassing net tax hikes (i.e., positive ***RGREV*** shocks) tend to reduce output, especially when the shock takes place in a lower output regime.

4.3.3 Fiscal adjustment through tax hikes or spending cuts?

An interesting question arising here is whether it is preferable to implement a targeted fiscal adjustment though higher taxation or, alternatively, via lower government spending. This question is of particular relevance for Greece's updated fiscal adjustment programme (2013-2016), which primarily relies on lower government spending on wages, pension, special benefits and pubic investment projects (see *Table 1.2*). The estimated generalized impulse responses depicted in Tables 3.1 and 3.2 can assist us to answer this question, by additionally noting that the level of our ***RGSPEND*** variable was around 2.04 times that of our ***RGREV*** variable in 2011.

Let us assume a *negative* discretionary ***RGSPEND*** shock of, say, 3% YoY occurring in a lower output regime. That shock would be tantamount to a *positive* discretionary ***RGREV*** shock of double size (6% YoY). Then, based on the GIRFs presented in Tables 3.1 & 3.2, one could credibly claim that, on a ceteris paribus basis, it would be more preferable to implement the targeted fiscal adjustment though higher tax revenue than lower government spending as the former would have much milder effects on output that the latter, both on impact and on a cumulative basis. Indeed, by the aforementioned tables, one can infer that a €1 discretionary decrease in real government spending on goods and services (***RGSPEND)*** would reduce real output by €1.89 cumulatively over a three-year period, while a net tax hike (***RGREV)*** of a similar magnitude would reduce output by less than €1 over the same period. A similar result has been documented in some recent empirical studies for industrialized economies (see e.g. Batini et al. 2012) and supports the case for dealing with Greece's tax evasion problem in a more forceful way.

4.3.4 Structural identification and robustness checks

As we have indicated earlier in this document (*Section 2.6*), our study employs a recursive identification scheme for structural stocks (Cholesky decomposition), with our baseline specification utilizing the following ordering of variables:

$$y_t = (G_t, T_t, Y_t)^T$$

However, we realize that the aforementioned ordering of variables constitutes a highly-debatable issue on both theoretical and practical grounds (see e.g. Baum & Koester (2011)). For that reason, and as a robustness check, we estimate a full range of alternative specifications for the following ordering of variables (which arguably allows more flexibility as regards the interplay of automatic fiscal stabilizers):

$$y_t = (Y_t, T_t, G_t)^T$$

where G_t is taken to represent general government real current spending (***RGSPEND)***, T_t is general revenue net of transfers and property income (***RGREV***) and Y_t stands for real output (***RGDP***). ***Tables 3.3 & 3.4*** below depict GIRFs for this particular ordering of variables and for shocks in the G_t and T_t variables. Although the values for the estimated impulse responses in the tables below differ from those in ***Tables 3.1 & 3.2***, the general policy implications for both cases remain qualitative similar, regardless of the ordering of variables assumed in the estimated TVAR model.

Table 3.3 – Output response to government current expenditure shocks

(Y;T;G) - Gshock						
	Impact multiplier					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.00	0.00	0.00	0.00	0.00	0.00
Upper regime	0.00	0.00	0.00	0.00	0.00	0.00
	Cumulative multiplier (4 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.29	-0.29	0.56	-0.57	0.96	-0.97
Upper regime	0.11	-0.10	0.20	-0.19	0.33	-0.36
	Cumulative (8-quarter)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.49	-0.48	0.92	-0.93	1.58	-1.59
Upper regime	0.29	-0.30	0.56	-0.56	0.89	-0.98
	Cumulative multiplier (12 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.56	-0.54	1.05	-1.06	1.82	-1.80
Upper regime	0.37	-0.36	0.72	-0.70	1.16	-1.24

Table 3.4 – Output response to government net revenue shocks

(Y;T;G) - Tshock						
	Impact multiplier					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	0.00	0.00	0.00	0.00	0.00	0.00
Upper regime	0.00	0.00	0.00	0.00	0.00	0.00
	Cumulative multiplier (4 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.08	0.09	-0.16	0.17	-0.29	0.27
Upper regime	0.04	-0.04	0.01	-0.07	0.12	-0.10
	Cumulative multiplier (8 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.18	0.21	-0.34	0.37	-0.64	0.60
Upper regime	0.11	-0.13	0.02	-0.21	0.34	-0.36
	Cumulative multiplier (12 quarters)					
Shock Size	1.5%YoY		3% YoY		5% YoY	
Shock Sign	pos.	neg.	pos.	neg.	pos.	neg.
Lower regime	-0.24	0.29	-0.46	0.51	-0.87	0.79
Upper regime	0.13	-0.15	0.09	-0.27	0.38	-0.45

4.3.5 Public investment expenditure shocks in expansionary & contractionary output regimes

In this section we take a closer look at a key subcomponent of our government spending on goods and services variable (***RGSPEND);*** namely public investment expenditure (***RGFCF***) as well as its potential impact on output. In Monokroussos and Thomakos (2012) we documented a much higher multiplier for government wage expenditure than these of other important sub-components of ***RGSPEND***.[20] In the present empirical study, we found a similar result in lower regimes and for negative spending shocks[21], with the government wage spending multiplier estimated to be as high as two times the multiplier of government current spending on goods and services. Our motivation to concentrate here on public investment expenditure primarily stems from our belief that, in the present depressionary environment in the Greek economy, it is of outmost importance to implement policies to help jump-start economic growth, with a targeted stimulus in the pubic investment program being an important candidate, especially in view of the huge destruction of physical (and human) capital that took place over the last 5-6 years.

Table 3.5 below depicts the estimated *impact* and *cumulative* responses (4, 8, & 12 quarters ahead) of real output (Y), to shocks in real public investment budget (PIB) expenditure occurring in lower output regimes and having different initial signs and sizes. As indicated by the first column of this table, we estimate two distinct TVAR model specifications, encompassing different ordering of endogenous variables. Namely: $y_t = (PIB_t, T_t, Y_t)$ and $y_t = (Y_t, T_t, PIB_t)$, where PIB_t represents real public investment outlays **(RGFCF)**; T_t is total general government revenue net of transfers and property income (***RGREV)***; and Y_t stands for real output (***RGDP***). Here our threshold variable is Y_t and our shock variable is PIB_t. In addition, the assumed lag orders for the TVAR system and the threshold variable are 2 and 1, respectively.

Table 3.5– Output response to public investment expenditure shocks

Public investment spending shocks in lower output regime						
	Impact multiplier					
Shock Size	**1.5%YoY**		**3% YoY**		**5% YoY**	
Shock Sign	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
(PIB,T,Y) Model	0.42	-0.42	0.83	-0.82	1.38	-1.38
(Y,T,PIB) Model	0.00	0.00	0.00	0.00	0.00	0.00
	Cumulative multiplier (4 quarters)					
Shock Size	**1.5%YoY**		**3% YoY**		**5% YoY**	
Shock Sign	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
(PIB,T,Y) Model	0.51	-0.58	1.16	-1.18	1.98	-1.85
(Y,T,PIB) Model	0.31	-0.30	0.65	-0.60	1.01	-1.00
	Cumulative multiplier (8 quarters)					
Shock Size	**1.5%YoY**		**3% YoY**		**5% YoY**	
Shock Sign	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
(PIB,T,Y) Model	0.82	-0.92	2.04	-2.08	3.37	-3.31
(Y,T,PIB) Model	0.68	-0.67	1.36	-1.26	2.34	-2.29
	Cumulative multiplier (12 quarters)					
Shock Size	**1.5%YoY**		**3% YoY**		**5% YoY**	
Shock Sign	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
(PIB,T,Y) Model	0.80	-0.94	2.31	-2.38	3.99	-3.75
(Y,T,PIB) Model	1.65	-0.85	1.70	-1.54	2.91	-2.83

[20] In FY-2011, total compensation of employees payable and government gross fixed capital formation accounted for ca 55% and 12.5% of government current expenditure on goods and services, respectively.
[21] Related results are available upon request.

By and large, our empirical results ***(Table 3.5)*** argue strongly against a further curtailing of the public investment budget (PIB). On the contrary, our estimates argue in favor of higher public investment spending in the current depressionary trajectory in the Greek economy as a means of boosting short- and medium-term economic growth. Indeed, our GIRF estimates imply among others that for a 5% YoY positive discretionary shock in the public investment program, real output rises by between €2.91 and €3.99 cumulatively over a 12 quarter period per €1 increase in real investment expenditure.

5. *Concluding remarks and policy implications*

Drawing on the results of our empirical study (Tables 3.1-3.5), we summarize below a number of key views and policy proposals related to Greece's present fiscal austerity programmme.

The estimated multipliers of the present empirical study appear to broadly confirm the main results of our earlier paper on the size and regime-dependence of fiscal multipliers in Greece (see Monokroussos and Thomakos (2012)). More specifically,

The response of real output to discretionary shocks in government current spending on goods and services and/or government tax revenue depends on the regime in which the shock occurs as well as on the size and direction (expansionary vs. contractionary) of the initial shock.

In general, expansionary or contractionary shocks taking place in lower output regimes (economic downturns) appear to have much larger effects on output - both on impact and on a cumulative basis - than shocks of similar sign and size occurring in upper regimes (economic expansions).

In lower regimes in particular, the contractionary effects on output from a negative fiscal shock (spending cut or tax hike) rise with the absolute size of the shock. In the same vein, the expansionary effects on output from a positive fiscal shock (spending hike or tax cut) increase with the absolute size of the shock. Similar effects apply for fiscal shock taking place in an upper output regime, though to a much lesser extent.

Relative to the present fiscal adjustment programme in Greece, our empirical results appear to support one of the main arguments made in our earlier paper on fiscal multipliers; namely that in favor of a more gradual implementation profile of the austerity programme for 2013-2016. This is especially because, as explained in *Section 3* of the present paper, the new austerity programme is heavily front-loaded, relying mainly on steep cuts in government expenditure items understood to have large fiscal multipliers *e.g.* wages and pensions.

Based on the main results of *Tables 3.1-3.5* and also taking into account the main components of Greece's new fiscal programme for the period 2013-2016 (*Table 1.2*) we derive some preliminary estimates regarding the recessionary impact (fiscal drag) of the new austerity measures on Greek GDP.

Specifically, our empirical results suggest that cumulative GDP losses due to fiscal measures could range between **€11.2bn** and **€19.6bn** (or between **5.9** and **10.4** points of projected 2013 GDP) over a three years period. ***A note of caution***: The latter results should be treated with extreme caution, not least because:

- as we have already discussed, considerable uncertainty and diversion of views continue to exist as regards the macroeconomic effects of discretionary fiscal policy changes, both on theoretical and empirical grounds;
- multiplier estimates tend to be not only regime- and type-of-shock-specific, but also estimation method-dependent;
- a relevant problem related to our empirical study is the lack of availability of a long-enough history of fiscal data for Greece *i.e.,* one spanning an adequate number of economic expansions and downturn phases;
- an important finding of some recent empirical studies on the effects of fiscal policy is that multipliers tend to decline with the potency and intensity of market doubts over the sustainability of a country's fiscal position;
- the latter effective provides an important argument in favor of a more front-loaded fiscal austerity programme in Greece;
- yet there may be a significant number of other factors that may affect the shape and the magnitude of output responses to discretionary fiscal policy changes;
- one such factor is the degree of liquidity constrains facing households, with a number of recent studies documenting higher multipliers for economies in which a large share of domestic economic agents are liquidity constrained (as is the case in the current trajectory in Greece).

As we have noted in *Section 4.3.3* of this paper, our empirical results suggest that, it would be more preferable to implement fiscal adjustment in Greece though higher tax revenue than lower government spending as the former would have much milder effects on output that the latter, both on impact and on a cumulative basis.

Indeed, given the overall size of Greece's fiscal adjustment programme in 2013-2016, our multiplier estimates suggest that Greek GDP would decline by up to €1.89 cumulatively over a three-year period per €1 discretionary decrease in real government spending on goods and services. Yet, the corresponding impact on domestic GDP would be much more benign if the aforementioned adjustment were to exclusively come through higher government revenue *i.e.,* up to €0.5 cumulatively over a three-year period per €1 increase in government net tax revenue.

It is important to emphasize here that the latter point *does not* necessarily constitute an outright call for a further increase in indirect or direct tax rates in Greece, which, in any case, remain high relative to the rest of the euro area. It highlights, instead, the urgency to repair the country's revenue collection mechanism, via aggressive public sector restructuring.

Finally, our estimates argue in favor of higher public investment spending in the current depressionary trajectory in the Greek economy as a means of boosting short- and medium-term economic growth. In particular, our GIRF estimates imply among others that for a 5% YoY positive discretionary shock in the public investment program, real output rises by between €2.91 and €3.99 cumulatively over a 12 quarter period per €1 increase in real investment expenditure.

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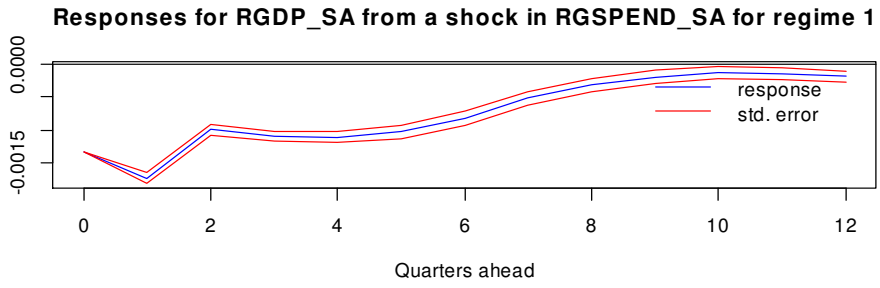
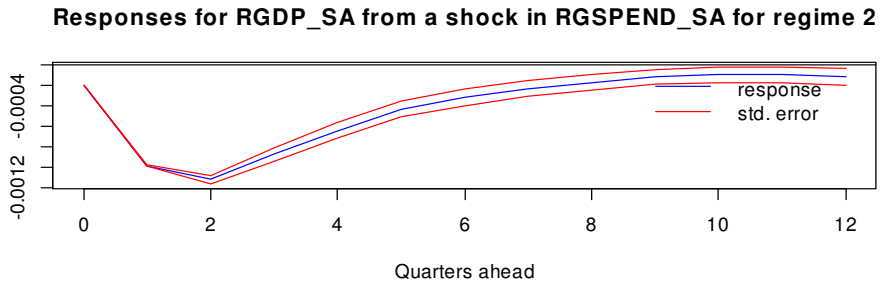
Annex - Generalized impulse responses

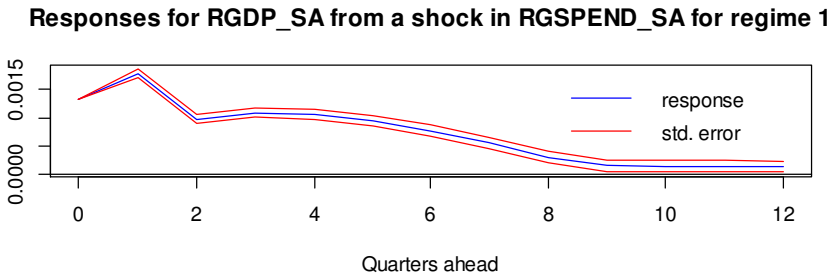
Graph 3.1.1

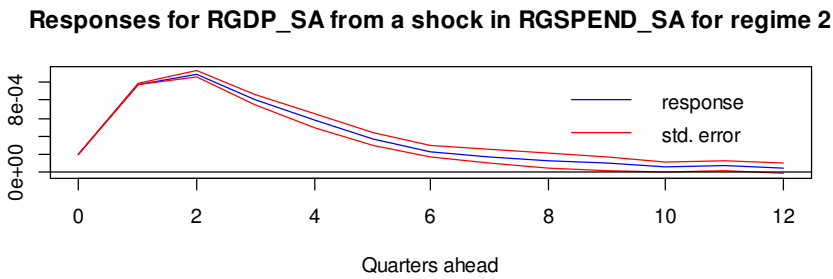
(G_t, T_t, Y_t) – Negative G_t shock (-1.5% YoY) in regime 1 (lower) and regime 2 (upper)





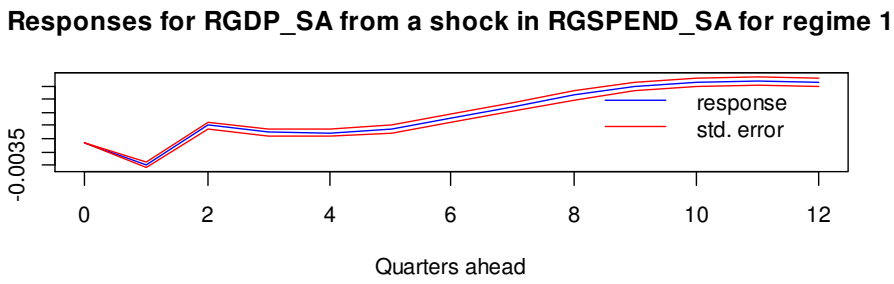
(G_t, T_t, Y_t) – Positive G_t shock (+1.5% YoY) in regime 1 (lower) and regime 2 (upper)

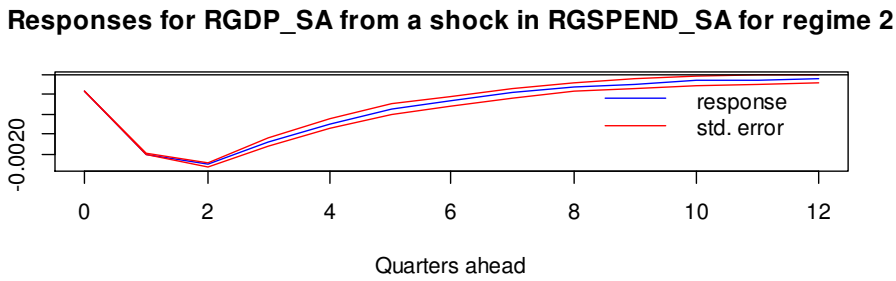




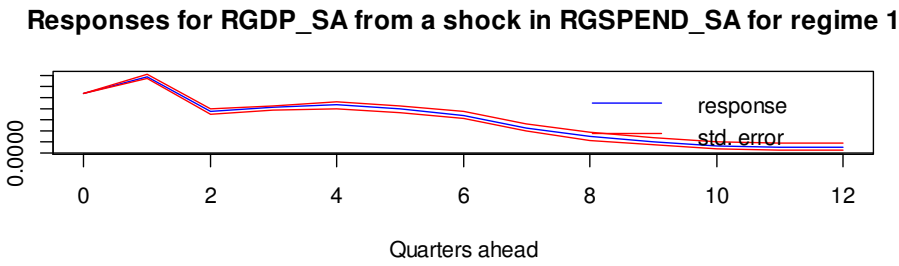
Graph 3.1.2

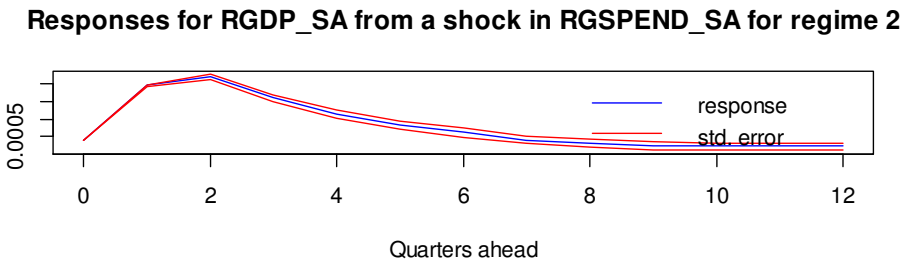
(G_t, T_t, Y_t) – Negative G_t shock (-3 YoY) in regime 1 (lower) and regime 2 (upper)





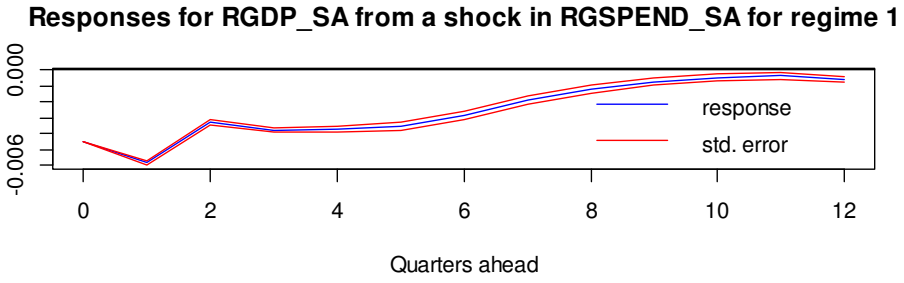
(G_t, T_t, Y_t) – Positive G_t shock (+3 YoY) in regime 1 (lower) and regime 2 (upper)

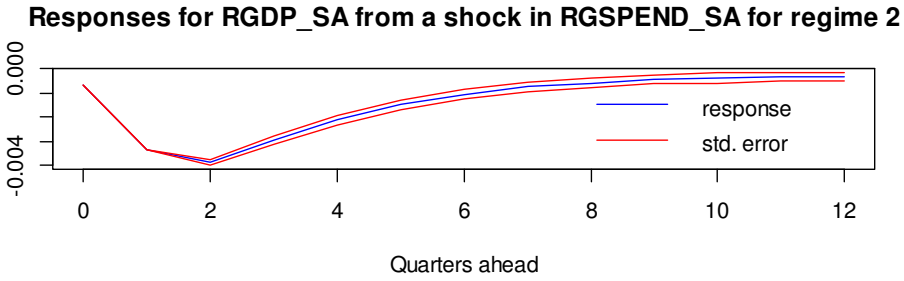




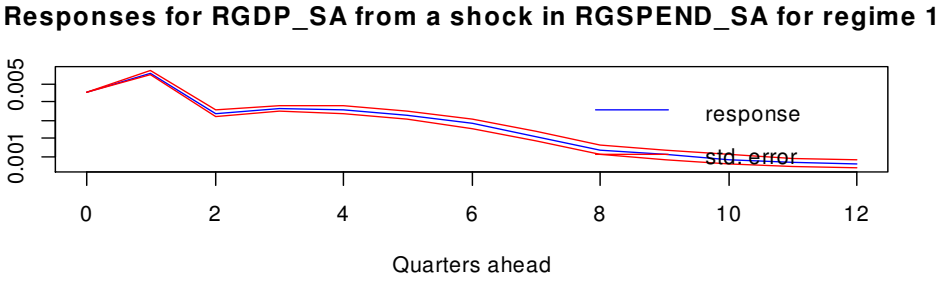
Graph 3.1.3

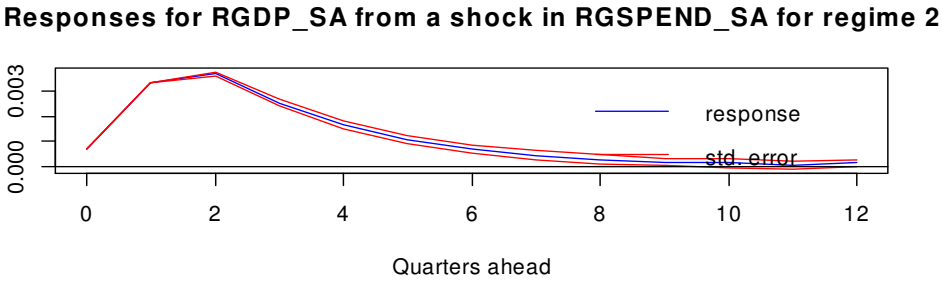
(G_t, T_t, Y_t) – Negative G_t shock (-5 YoY) in regime 1 (lower) and regime 2 (upper)





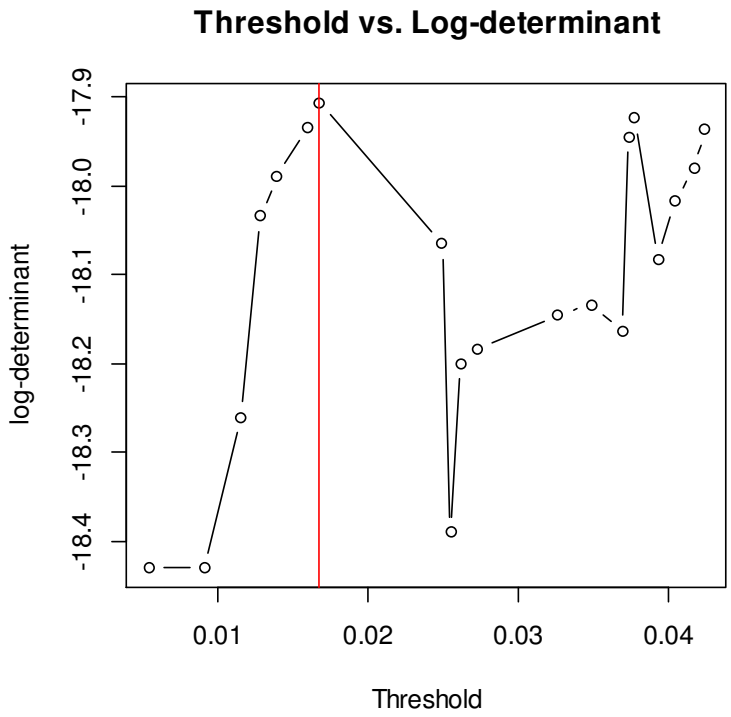
(G_t, T_t, Y_t) – Positive G_t shock (+5 YoY) in regime 1 (lower) and regime 2 (upper)





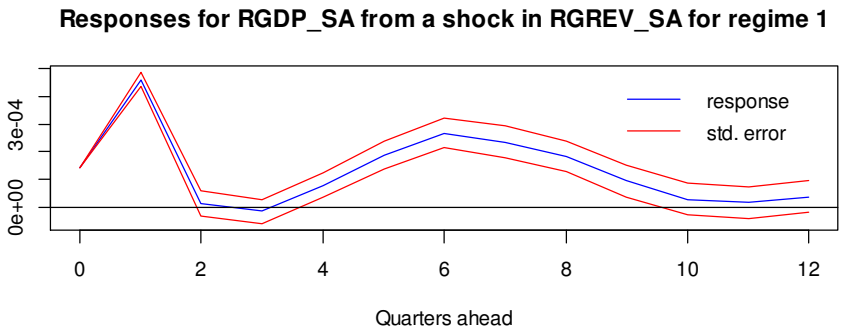
Graph 3.1.4

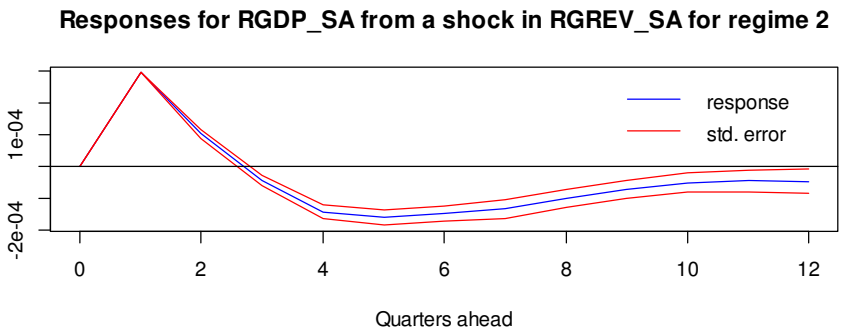
Critical threshold for TVAR model specification $y_t = (G_t, T_t, Y_t)$



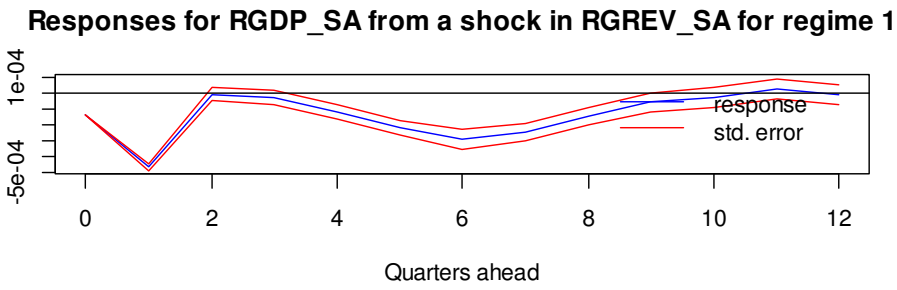
Graph 3.2.1

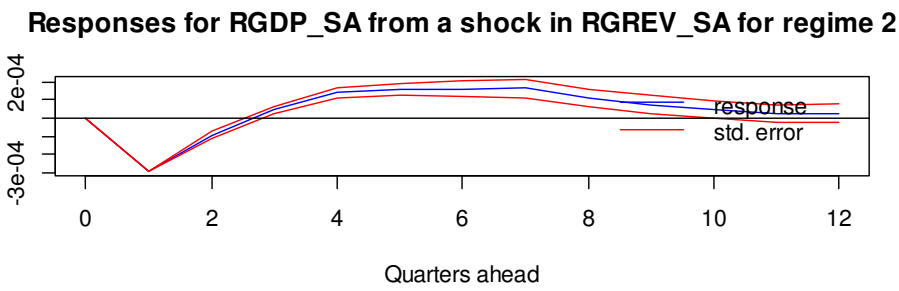
(G_t, T_t, Y_t) – Negative T_t shock (-1.5% YoY) in regime 1 (lower) and regime 2 (upper)





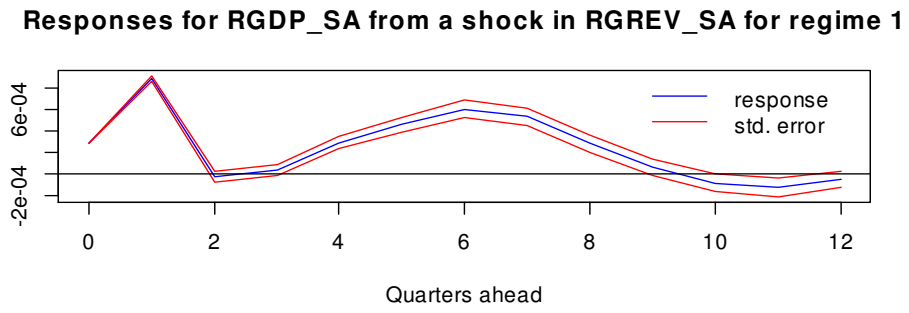
(G_t, T_t, Y_t) – Positive T_t shock (+1.5% YoY) in regime 1 (lower) and regime 2 (upper)

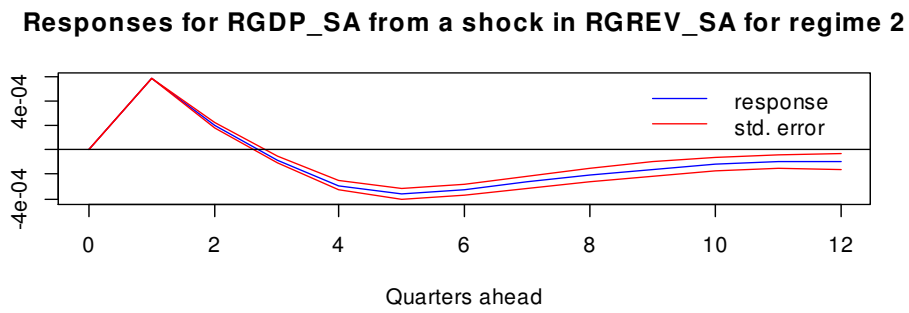




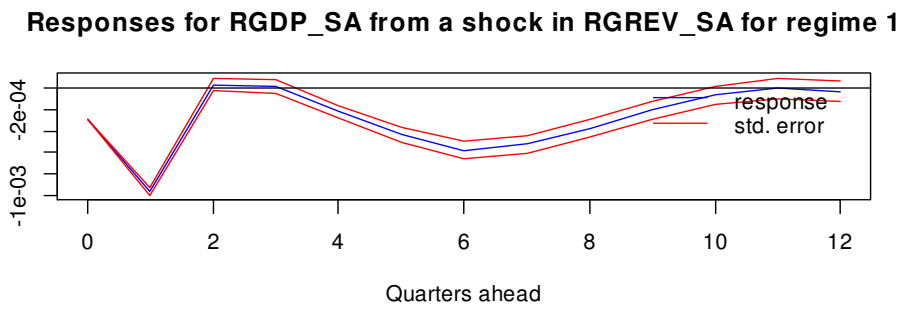
Graph 3.2.2

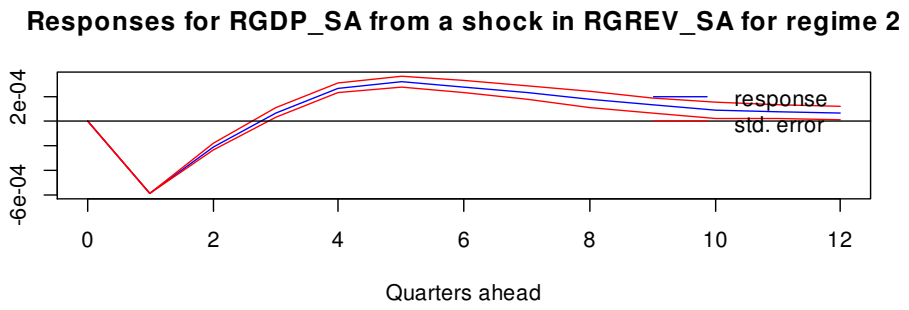
(G_t, T_t, Y_t) – Negative T_t shock (-3% YoY) in regime 1 (lower) and regime 2 (upper)





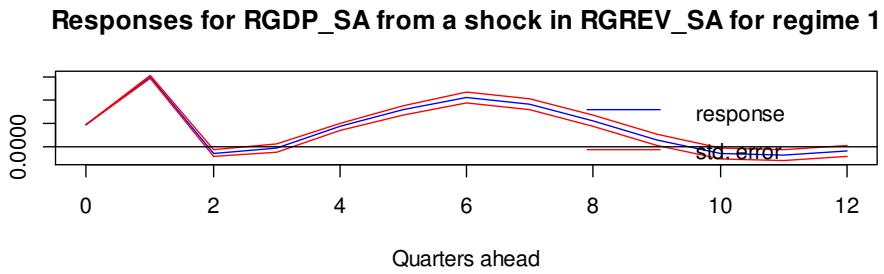
(G_t, T_t, Y_t) – Positive T_t shock (+3% YoY) in regime 1 (lower) and regime 2 (upper)

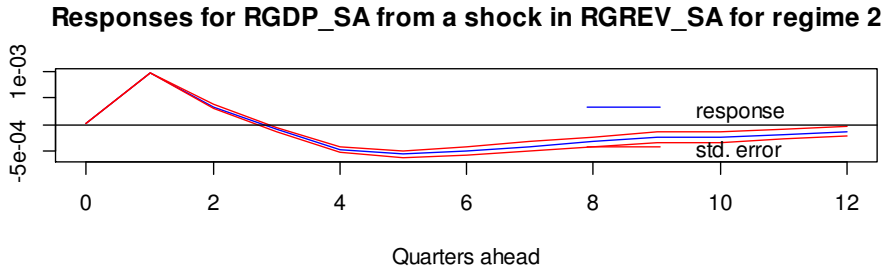




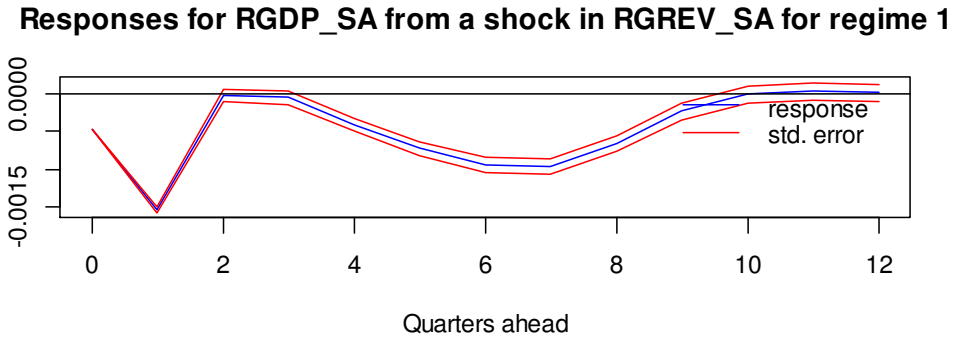
Graph 3.2.3

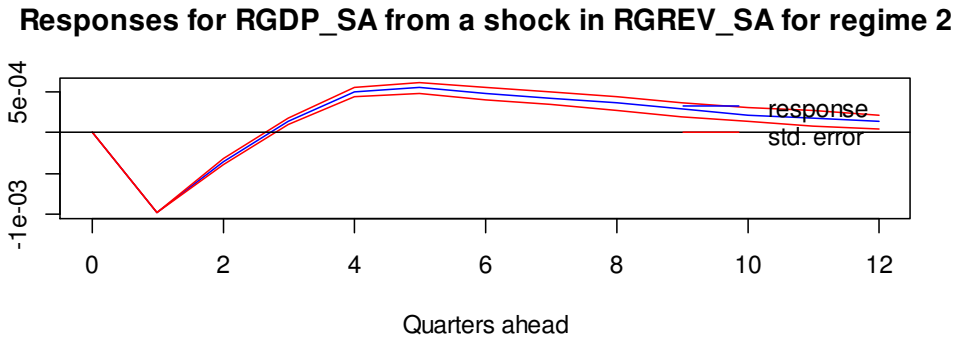
(G_t, T_t, Y_t) – Negative T_t shock (-5% YoY) in regime 1 (lower) and regime 2 (upper)





(G_t, T_t, Y_t) – Positive T_t shock (+5% YoY) in regime 1 (lower) and regime 2 (upper)





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