

## The Effects of Fiscal Consolidation on Macroeconomic Indicators in Cyprus

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### Abstract

This paper implements a recently developed econometric model, the Factor-Augmented Vector Autoregression (FAVAR), to estimate the dynamic effects of fiscal consolidation policies on key macroeconomic variables, such as aggregate output, price level, employment, private consumption, investment and interest rate. The results of our analysis show that fiscal retrenchment efforts in the form of either a government expenditure reduction or a government revenue increase, lead to a fall in GDP driven by the negative responses of investment, private consumption and employment. As a result of the contractionary effects of consolidation on economic activity, inflation decelerates. Fiscal tightening based on expenditure reduction results in a larger contraction in output than consolidation through an equivalent revenue rise, especially in the medium term. Thus, the policy mix between expenditure cutbacks and tax increases matters as it influences the cost of fiscal consolidation in terms of lost output. Within two years, GDP falls cumulatively by 1.0% and 0.6% as a response to fiscal consolidation amounting to 1.0% of GDP, associated with spending cuts and equivalent revenue increases respectively.

**Keywords:** Fiscal consolidation, fiscal shocks, factor-augmented VAR, impulse response function.

### 1. Introduction

The global financial crisis and subsequent economic downturn has led to the accumulation of imbalances and left many European countries with large public debts that form a significant proportion of their GDP. Greece, Ireland, Portugal, Spain and more recently Cyprus had to resort to financial aid from European mechanisms and the International Monetary Fund conditional on the implementation of major fiscal consolidation strategies. These strategies were based on the belief that fiscal consolidation would ultimately set the scene for economic expansion and debt sustainability. However, recent experience has shown that austerity measures have resulted in severe contraction in economic activity and rise

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in unemployment to historically record levels, without significant improvements in national debt-to-GDP ratio.

In countries implementing fiscal consolidation policies output growth underperformed the projections prepared by international organisations. Blanchard and Leigh (2013) show that fiscal multipliers used in the computation of growth projections have been too low since the onset of the recent financial crisis. The value of fiscal multipliers depends, among other things, on the state of the economy (crisis vs. normal times), the degree of openness of the economy, monetary policy and exchange rate regime, the nature of fiscal consolidation (temporary vs. permanent measures), the composition of fiscal consolidation (revenue vs. expenditure measures) and the degree of fiscal consolidation of trading partners (e.g. Bousard et al. 2012). Therefore, the availability of estimates of the effects of fiscal policies on output is of paramount importance for forecasting and policy-making. This study aims to provide formal estimates of the impact of fiscal policy shocks on various macroeconomic variables in Cyprus. The need for such estimates for Cyprus has been pressing as the implementation of the Economic Adjustment Programme and the introduction of the Fiscal Compact necessitate the rigorous evaluation of the effects of fiscal measures on the economy.

The impact of fiscal consolidation is not restricted to programme countries but has a wider applicability as many countries around the globe have accumulated large public debts. Whether and under what conditions reductions in government budget deficits are accompanied by long periods of recessions, lie in the heart of policy debate and reignite empirical and theoretical controversies. On the one hand, standard Keynesian models suggest that fiscal adjustment policies cause recessions. On the other hand, neoclassical models emphasize the role of individuals' expectations and supply-side effects, implying that under certain circumstances fiscal consolidation plans can be expansionary or at least non-recessionary.<sup>1</sup>

Giavazzi and Pagano (1990) find that fiscal adjustments have very little or no negative effect on output. For example in Ireland and Denmark fiscal consolidation plans were followed by high economic growth. They stress, however, that these plans can have non-Keynesian impact only if they are

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<sup>1</sup> Fiscal adjustment plans can have stimulating impact on private consumption if agents believe that such adjustments will increase their lifetime income. If consolidation is delayed, consumers will expect higher tax increases in the future, which, given the non-linear increase in the distortionary effects of taxation, will have a more disruptive effect on future output and income. By contrast, timely consolidation can improve expectations of future income. Furthermore, in countries with high public debt ratios, restrictive fiscal policies can reduce the risk of default and, in turn, boost the confidence in future policies; the subsequent interest rate decline can spur economic activity.

considerably large and persistent. Alessina et al. (2012) use information on fiscal plans adopted by 16 OECD countries over a period of 30 years to analyse the impact of fiscal adjustment on macroeconomic variables. They find that the effects of fiscal consolidation depend on their composition (tax increases vs. expenditure reductions) and on whether spending cuts are permanent or transitory. The cost in terms of lost output due to consolidation is much higher in the case of tax hikes compared to spending cuts; adjustments based on permanent measures are less costly than “stop and go” ones. Erceg and Linde (2013) demonstrate that in a currency union fiscal consolidation is contractionary and more costly compared to the case where monetary policy is independently set.

Other studies, using mainly Structural Vector Autoregression (SVAR) models, find that positive shocks on government spending stimulate output at least in the short run (e.g. Blanchard and Perotti 2002; Cimadomo and Benassy-Quere 2012; Giordano et al. 2007). Moreover, there is evidence that positive shocks on taxes suppress output (e.g. Blanchard and Perotti 2002; Cimadomo and Benassy-Quere 2012). Positive effects of government spending on consumption is found, contrary to the predictions of neoclassical models where consumption is expected to fall due to negative wealth effects (e.g. Blanchard and Perotti 2002; Fatas and Mihov 2001; Giordano et al. 2007). The results regarding the response of investment to positive fiscal shocks vary between negative (e.g. Blanchard and Perotti 2002), insignificant (e.g. Fatas and Mihov 2001) and positive (e.g. Giordano et al. 2007).

Nevertheless, the majority of studies on the effects of fiscal policy shocks employ SVAR models where fiscal shocks are identified as unexpected exogenous changes in either government spending or taxes. While this approach is computationally simple and can provide plausible results (under identification assumptions), it is severely criticized. According to critics, VAR models, in order to conserve degrees of freedom typically contain only a handful of variables that cannot convey all the relevant information. The fact that the researcher observes less information than economic agents could lead to biased results and some contentious findings. A second problem arising from the use of SVAR analysis for fiscal policy is that changes in fiscal policy take time to be implemented and therefore are anticipated by economic agents. Since agents expect changes in fiscal policy in the very near future they adjust their decision-making in advance. Thus, what the econometrician identifies as exogenous fiscal shock is in fact the result of previous policy changes.

One way to tackle the anticipation problem is the so called “narrative approach” as in, for example, Romer and Romer (2010), Devries et al. (2011) and Alesina et al. (2012). These studies identify multi-period

consolidation changes in fiscal policy (tax increases or government spending cuts) by collecting records of official documents. Furthermore, as Alesina et al. (2012) stated “*shocks identified through narrative method are modelled independently and therefore are not affected by the possibility that some variables are omitted in the estimation*”. Nevertheless, narrative approach studies provide impulse response functions for a small subset of variables that scholars and policy makers are interested in; this is the third limitation of VAR models.<sup>2</sup> Besides the fiscal effects on output, researchers and policy makers are also interested in the effects on other variables that are typically ignored in such small scale models. Since the understanding of the transmission mechanism of fiscal shocks is crucial for conducting fiscal policy, some other techniques should be employed to overcome the aforementioned shortcomings.

Advances in econometrics and statistics provide a natural solution to the dimensionality problem of VAR models. In particular, utilising factor analysis in a VAR framework overcomes the deficiency of information in standard VAR models. Factors are a statistical instrument to shrink the dimensionality of a large dataset and at the same time exploit all the available information about its co-variation. Thus augmenting the VAR framework with a small number of factors (Factor-Augmented VAR - FAVAR) the rich interrelation between fiscal policy shocks and the real economy is adequately captured. Furthermore, the inclusion of many business and consumer confidence indicators in the dataset addresses the anticipation problem commonly found in fiscal policy literature.

This study employs a FAVAR model to estimate the effects of fiscal policy shocks on economic activity in Cyprus. More precisely, we investigate the implications of fiscal consolidation (expenditure cut, tax rise, deficit reduction) on various macroeconomic aggregates of the Cypriot economy, such as output, price level, employment, private consumption and investment. Fiscal retrenchment efforts being either a government expenditure reduction or a government revenue increase, lead to a fall in GDP driven by the negative responses of investment, private consumption and employment; as a result of the contraction in economic activity inflation decelerates.

The rest of the paper is organised as follows. Section 2 outlines the empirical specifications and describes the data. Section 3 presents and discusses the results of the empirical analysis. Section 4 concludes.

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<sup>2</sup> For instance, the effects on labour, output components, private consumption and investment.

## 2. Empirical specification and data

### 2.1. Empirical specification

The FAVAR can be viewed as a VAR model which includes a vector of observed variables  $Y_t$  and a vector of unobserved variables  $F_t$ , i.e. the factors. The factors summarise the information in a large set of economic series with a smaller number of variables. By augmenting the VAR with a small number of factors the information set is enhanced considerably without greatly increasing the dimensionality of the model. Details on the FAVAR model are given in the Appendix.

To investigate the effects of fiscal policy on macroeconomic variables we use two different specifications of the FAVAR model in terms of the fiscal variables included. The first specification uses total general government expenditure and revenue and the second employs government surplus/deficit as a percentage of GDP. In particular the vector of observable economic variables is specified as follows:

$$Y_t = (GGE_t, GGR_t, GDP_t, CPI_t) \quad (\text{Specification A})$$

$$Y_t = (DEF_t, GDP_t, CPI_t) \quad (\text{Specification B})$$

where  $GGE_t$  and  $GGR_t$  represent total general government expenditure and revenue respectively,  $GDP_t$  denotes total output, measured by real GDP and  $CPI_t$  denotes the overall price level, measured by the Consumer Price Index;  $DEF_t$  is general government deficit/surplus as a percentage of GDP. All variables except  $DEF_t$  are expressed in first differences of logarithms and all series are standardised prior to estimation of the model.

In order to obtain distinct representations of the various aspects of the economy, the factors are estimated from two different blocks of data. One set of factors is extracted from a dataset of domestic series (mostly leading indicators) and another from a group of foreign and international variables. The number of domestic and foreign factors included in the FAVAR is chosen using information criteria (Bai and Ng 2002) vis-à-vis the availability of degrees of freedom in estimation. Table A1 (Appendix) shows the values of different information criteria for the choice of the number of factors together with the percentage of variation explained by each factor. Domestic economy is summarised in the FAVAR model by one factor as suggested by the second information criterion; the factor explains about 16% of the variation in the dataset. The dataset of foreign and

international series is represented by two factors accounting for about 45% of the variation in the data.<sup>3</sup>

In the FAVAR model domestic factors are ordered after the observable variables in  $Y_t$  followed by the foreign/international factors.<sup>4</sup> Thus, fiscal variables are ordered first followed by GDP, CPI, domestic and foreign factors. This structure assumes that output, prices and other aspects of domestic (e.g. interest rates, consumption, investment, employment) and foreign economy respond contemporaneously to fiscal shocks, but fiscal policy reacts with a lag to other domestic or foreign macroeconomic shocks.

Prior to studying the effects of fiscal shocks, the lag length of the FAVAR was selected and the stability of the models was checked. For both specifications a lag order of two was chosen based on information criteria. Furthermore, both systems satisfy the stability condition (see Table A2-A3).

## 2.2. Data

The fiscal variables used in the analysis namely (i) total government expenditure and (ii) total government revenue were obtained from the Quarterly General Government Accounts (Statistical Service) and were expressed in constant (2005) prices using GDP deflator. Total government revenue and expenditure were used to construct a deficit/surplus series as a percentage of GDP.

The first graph in Figure 1 shows the evolution of real government expenditure and revenue (seasonally adjusted) over the period 1995Q1-2013Q2. Both series follow an upward trend up until 2008 with expenditure historically exceeding revenue except in 2005Q1 and during 2007-2008. After 2008 a slowdown is observed in expenditure growth followed by a reduction in 2012-2013. Government revenue declined after 2008 and remained well below expenditure until the end of 2012. The second graph in Figure 1 plots general government deficit/surplus as a percentage of GDP (seasonally adjusted). Fiscal deficit widened over 2002-2004 as a result of the slowdown in 2002-2003 and the subsequent decline in government revenue that was not accompanied by a cutback in spending. A similar pattern is registered after 2008; deficit, however, has been narrowing since the second half of 2012.

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<sup>3</sup> The two information criteria suggest six or five factors (explaining 65% and 62% of the data variance respectively) but the inclusion of such a large number of factors in the FAVAR model would limit the degrees of freedom and the accuracy of the estimates.

<sup>4</sup> Contemporaneous dependence of domestic factors on foreign factors and  $Y_t$  is removed.

For the remaining variables in the analysis we used seasonally adjusted quarterly data over the period 1995Q1-2013Q2 covering domestic real economy (output, consumption, investment, imports, exports, employment, unemployment, indices of industrial production and retail trade, tourist arrivals, etc.), foreign economies (GDP and industrial production), domestic and foreign prices, interest rates, stock exchange indices and economic sentiment indicators, as well as domestic deposits, loans and reserves, and exchange rates.<sup>5</sup> In total we used 200 variables.

All non-stationary variables were rendered stationary via an appropriate transformation such as first differences of levels or logarithms.<sup>6</sup>

### 3. Results

The estimated FAVAR model in Specification A is used to simulate the responses of macroeconomic variables to the following:

- i. a negative shock to total government expenditure equal to one percent of (annual) GDP;
- ii. a positive shock to total government revenue equal to one percent of (annual) GDP.<sup>7</sup>

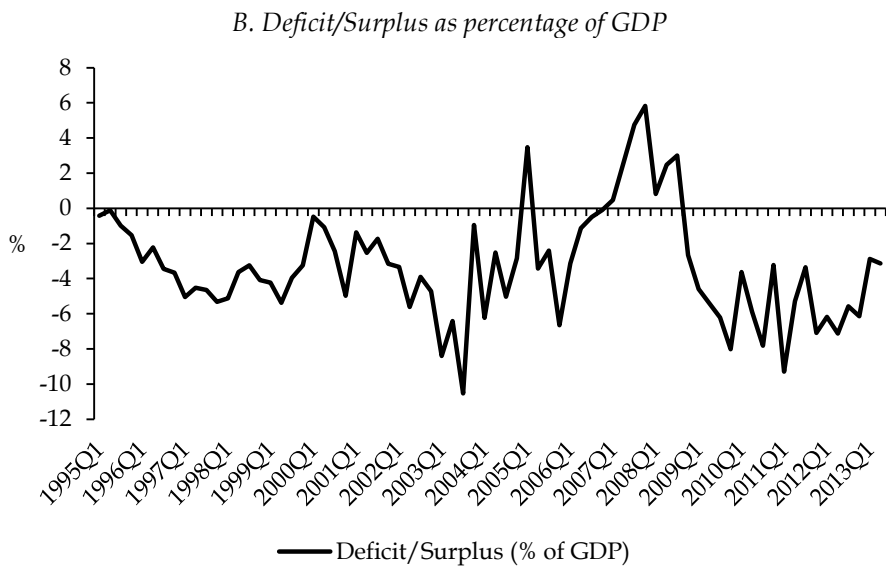
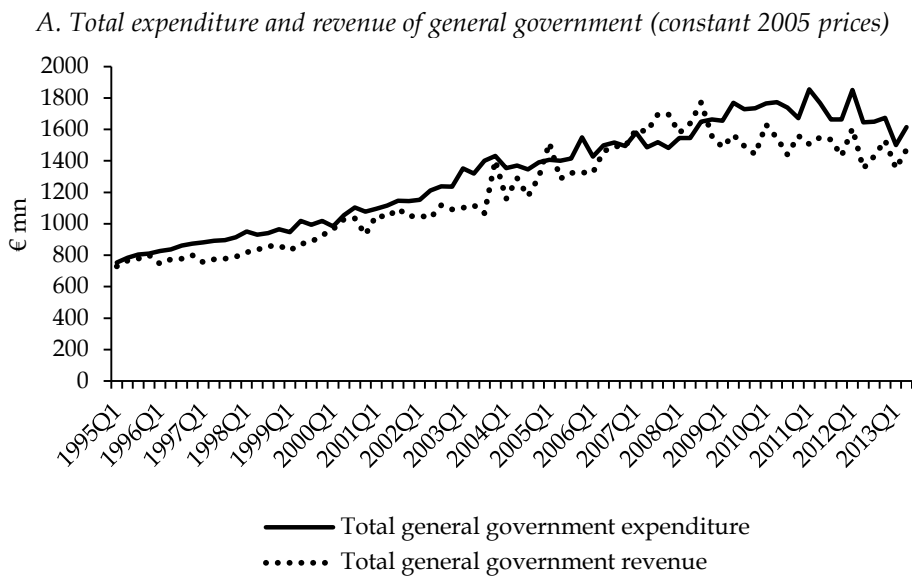
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<sup>5</sup> The data were obtained from the Statistical Service of Cyprus, Central Bank of Cyprus, Eurostat, European Commission (DG-ECFIN) and Datastream.

<sup>6</sup> The complete list of variables in the dataset along with their transformations are available upon request.

<sup>7</sup> The expenditure shock corresponds to a reduction in public spending of about EUR 144 million (constant 2005 prices) and the revenue shock equals an increase in taxes and contributions of about EUR 144 million (constant 2005 prices). According to the Cyprus Economic Adjustment Programme the agreed consolidation measures for 2013 and 2014 amounted to at least EUR 351 million (about EUR 298 million in constant 2005 prices) and EUR 270 million (about EUR 229 million in constant 2005 prices) respectively (European Commission 2013; IMF 2013).

FIGURE 1

*Fiscal data, seasonally adjusted*

The direction of the two shocks can be viewed as simulating fiscal consolidation efforts via limiting spending (e.g. public sector wage bill, pensions, social transfers, government subsidies, intermediate consumption and public investment) and raising revenue (e.g. direct and indirect taxes, social contributions). Figure 2 and 4 plot the impulse response functions (IRFs) of fiscal variables, GDP and CPI for the shocks described in (i) and (ii) respectively. The 68% bootstrapped confidence intervals are also shown.<sup>8</sup> Similarly, Figure 3 and 5 show the IRFs of variables of interest that are included in the factors (domestic) and are not treated as directly observable. The responses of employment, interest rate, private consumption and investment are shown.<sup>9</sup> The plotted IRFs shown are in terms of percentage changes of the macro variables except in the case of interest rate where the response is in percentage points.<sup>10</sup>

A negative shock to government expenditure leads to a small decline in GDP on impact (-0.2%). However, the negative reaction of GDP grows larger as horizon increases. Output contracts cumulatively by about 0.6% and 1% in the first and second year after the shock respectively. Government revenue drops initially by 3% as a response to the expenditure shock but afterwards the effects die out. The large decline of government revenue on impact is partly driven by the lost tax revenue as a result of the expenditure shock that affects to a great extent the compensations of public sector employees. The price level does not exhibit any significant reaction to the expenditure shock although some downward price pressures arise about a year later.

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<sup>8</sup> A bootstrap technique was applied to compute the confidence intervals as the models included generated regressors (see Appendix for details). The confidence intervals were obtained as the 32nd and 68th percentile of the bootstrapped distribution constructed using 3000 replications. The 68% confidence interval is typically used in this literature (e.g. Blanchard and Perotti 2002; Cimadomo and Benassy-Quere 2012).

<sup>9</sup> The relevant interest rate in this context would be a long-run (e.g. 10-year) interest rate on government bonds which is not available as a continuous time series from 1995 onwards in the case of Cyprus. Nevertheless, we present the response of a consumer interest rate.

<sup>10</sup> The IRFs obtained from the FAVAR estimated in standardised first differences of the (logs or levels) series were transformed back to the original units and then cumulated; IRFs show the change (percentage or percentage points) in the level of the series as a response to a shock to the fiscal variable.

FIGURE 2

*Impulse response functions of fiscal variables, GDP and CPI,  
negative government expenditure shock*

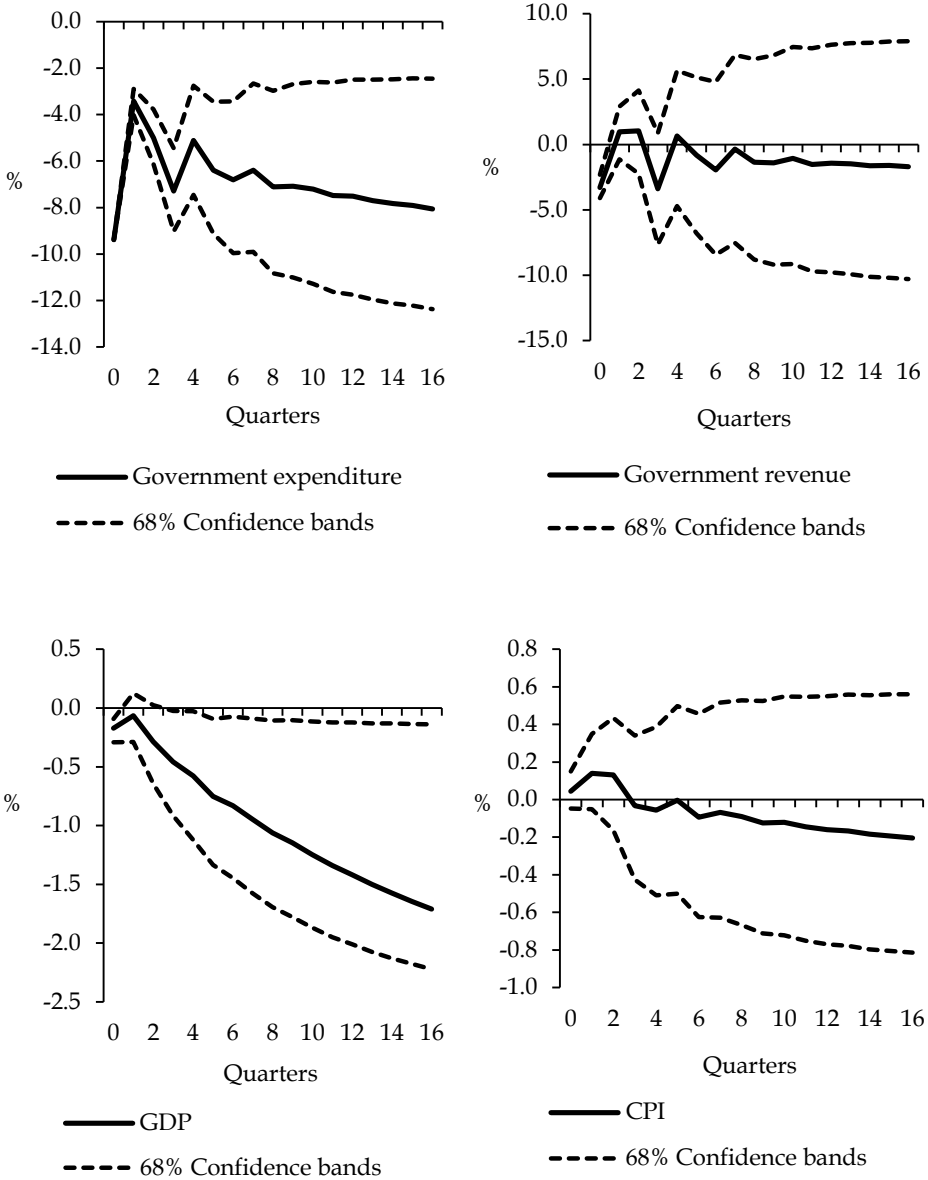


FIGURE 3

*Impulse response functions of other macro variables,  
negative government expenditure shock*

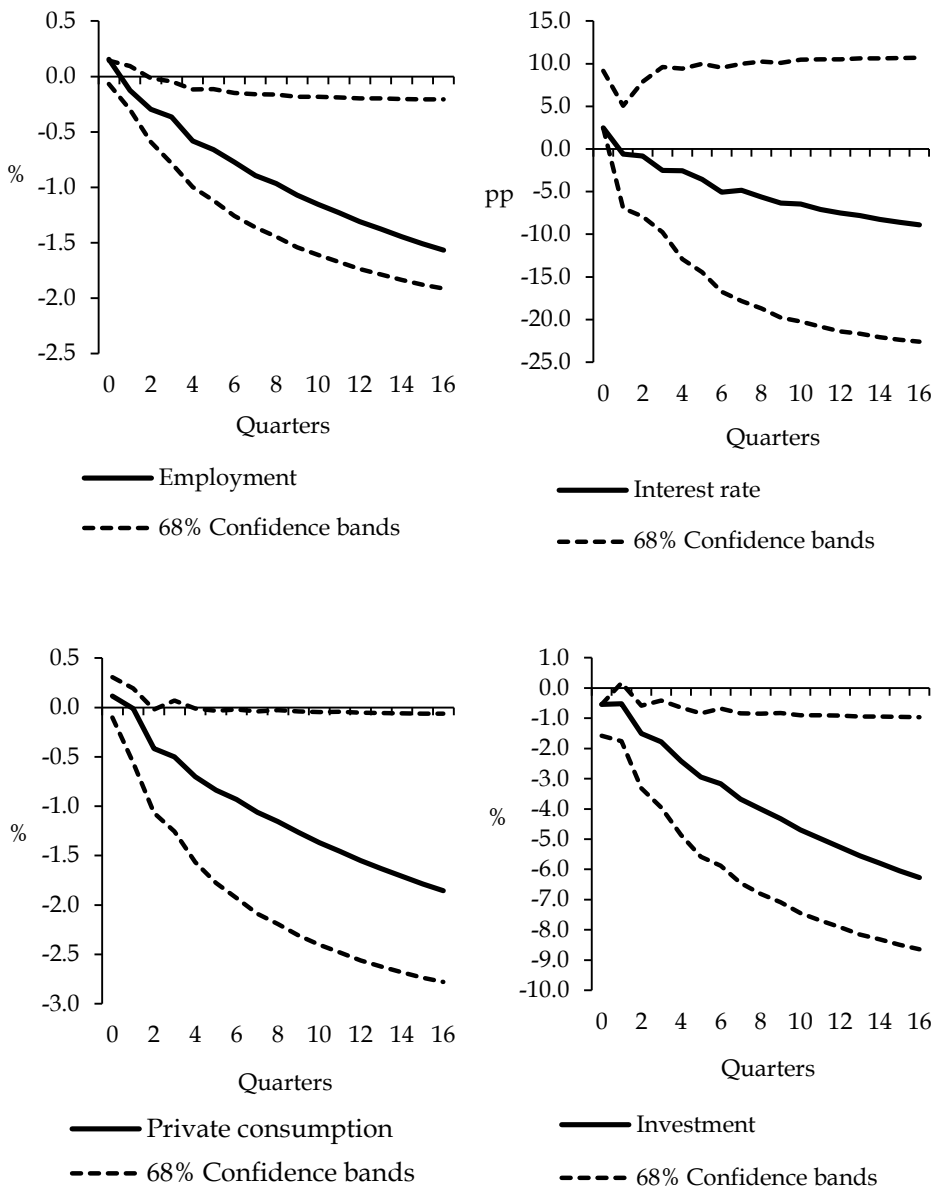
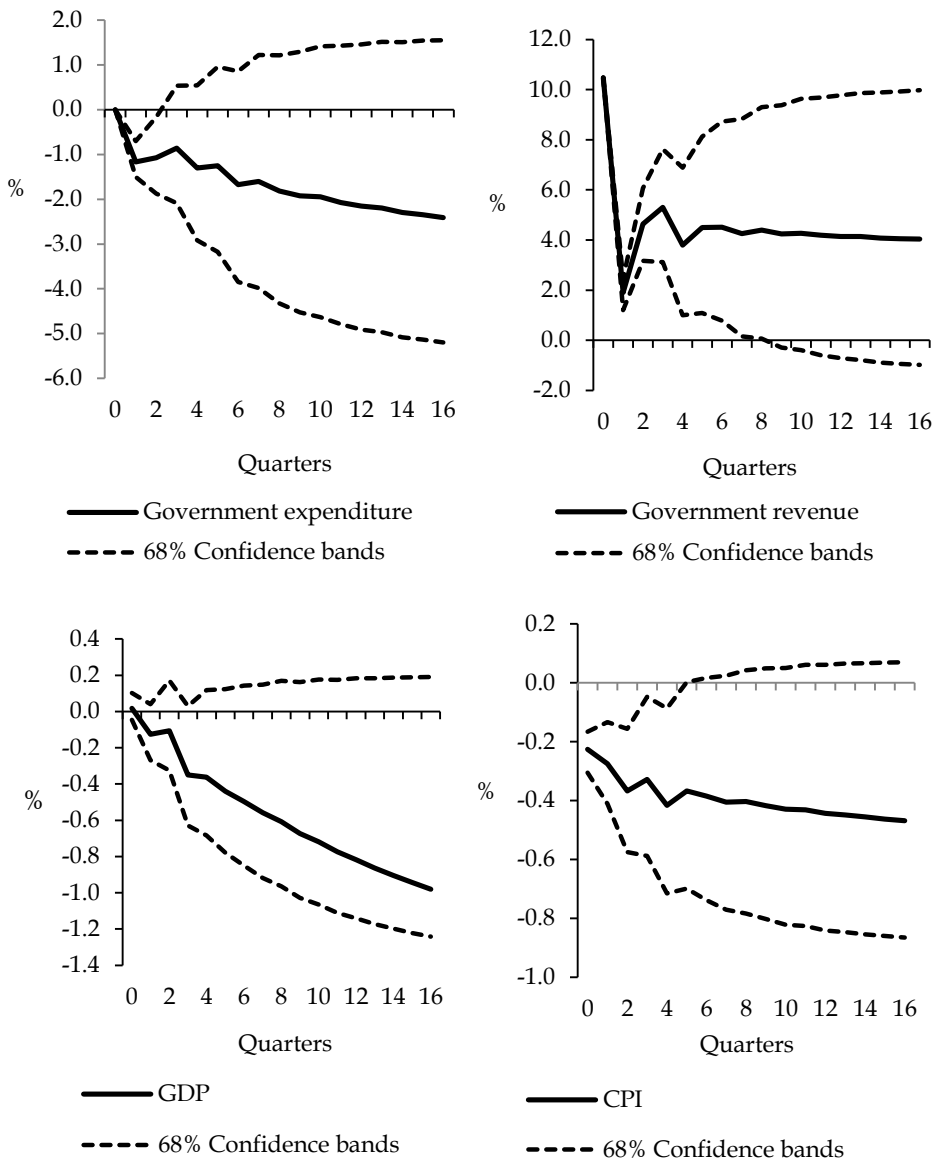


FIGURE 4

*Impulse response functions of fiscal variables, GDP and CPI, positive government revenue shock*



The responses of other macro variables to the expenditure shock are also negative as shown in Figure 3. The reaction of employment and private consumption is insignificant on impact but about a year after the shock employment and consumption fall by 0.6% and 0.7% respectively. The effect of the shock on investment is larger than on the other macro variables and significant even on impact. Investment declines by 0.5% in the quarter of the shock and by 2.4% about a year after that; subsequently it continues to contract albeit at slower rates. The effects of government expenditure reduction on market interest rate are not found to be significant.

A positive shock on government revenue driven by, for example, a rise in taxes and contributions results in almost no change in output on impact; subsequently GDP falls but at a smaller rate compared to the output decline triggered by the expenditure shock. As a reaction to the revenue shock, GDP contracts by 0.4% in the first year. The price level falls by 0.2% and 0.4% on impact and within the first year respectively, as a response to the positive revenue shock; afterwards the effects of the shock on CPI fade away. The aggregate price level reacts more strongly to the revenue than to the expenditure shock.

The strongest response to the revenue shock is estimated for investment and employment. Both series react instantly with a decline; in the first year employment and investment are lower by 0.5% and 1.5% respectively. After the first year the effect of the shock on employment becomes smaller and eventually vanishes. The response of investment to the revenue shock appears more persistent. Private consumption also reacts negatively to the revenue shock; the shock entails lower disposable income, through higher direct taxes and/or higher consumer prices via higher indirect tax rates, and consequently lower real income. The consumer interest rate increases on impact; afterwards the effect of the shock dies out and becomes statistically insignificant.

The FAVAR model in specification A does not allow us to examine the impact of simultaneous shocks to both government expenditure and revenue. In specification B the fiscal variable of interest is represented by government deficit/surplus as a percentage of GDP. Thus, specification B allows us to translate the two independent shocks to expenditure and revenue into a single shock to deficit. The estimated FAVAR model in specification B is used to simulate the responses of macro variables to a shock to government deficit generated by a negative shock to government

expenditure and a positive shock to revenue equal to one percent of annual GDP each.<sup>11</sup>

Figure 6 and 7 show the IRFs of various macro variables to the positive shock on deficit, along with the 68% bootstrapped confidence intervals. Fiscal consolidation measures that curb government spending and raise government revenue via increases in taxes and contributions, lower GDP on impact by as little as 0.1%. The response of GDP to such a shock is quite persistent. Output contracts throughout the horizon but the effects of the shock become smaller after the second year. Cumulatively GDP falls by 1.2% and 3.0% in the first and second year respectively as a response to the deficit shock.

As a result of the fiscal consolidation shock which triggers adverse effects on output, the price level reacts negatively on impact; it declines by 0.2%. Afterwards, CPI exhibits a hump-shaped response which is not found to be statistically significant. The reaction of the price level fades away faster than that of output. The cumulative drop in CPI is estimated at about 0.4% during the first two years after the shock.

Employment reacts negatively to the deficit shock as it declines by 0.1% on impact and by 0.8% (cumulatively) in the first year. The initial response of private consumption to the shock is rather counter-intuitive. It increases on impact and declines quite fast after the second quarter. However, the response of private consumption is consistent with the dynamic reaction of the consumer interest rate to the shock. Interest rate drops on impact by about 2 percentage points, possibly as a result of low demand for borrowing initiated by government through its expenditure cutback. Subsequently interest rate rises slowly before the effects of the shock die out.

The effect of the deficit shock on investment is insignificant both on impact and during the first year. Afterwards investment falls rapidly until the end of the horizon when it stabilises at about 18% below its pre-shock level. The effects of the deficit shock on investment are much more persistent than those on employment or consumption.

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<sup>11</sup> The shock to deficit as a percentage of annual GDP equals two percentage points. The shock simulated amounts to fiscal consolidation measures of about EUR 288 million (in constant 2005 prices).

FIGURE 5

*Impulse response functions of other macro variables,  
positive government revenue shock*

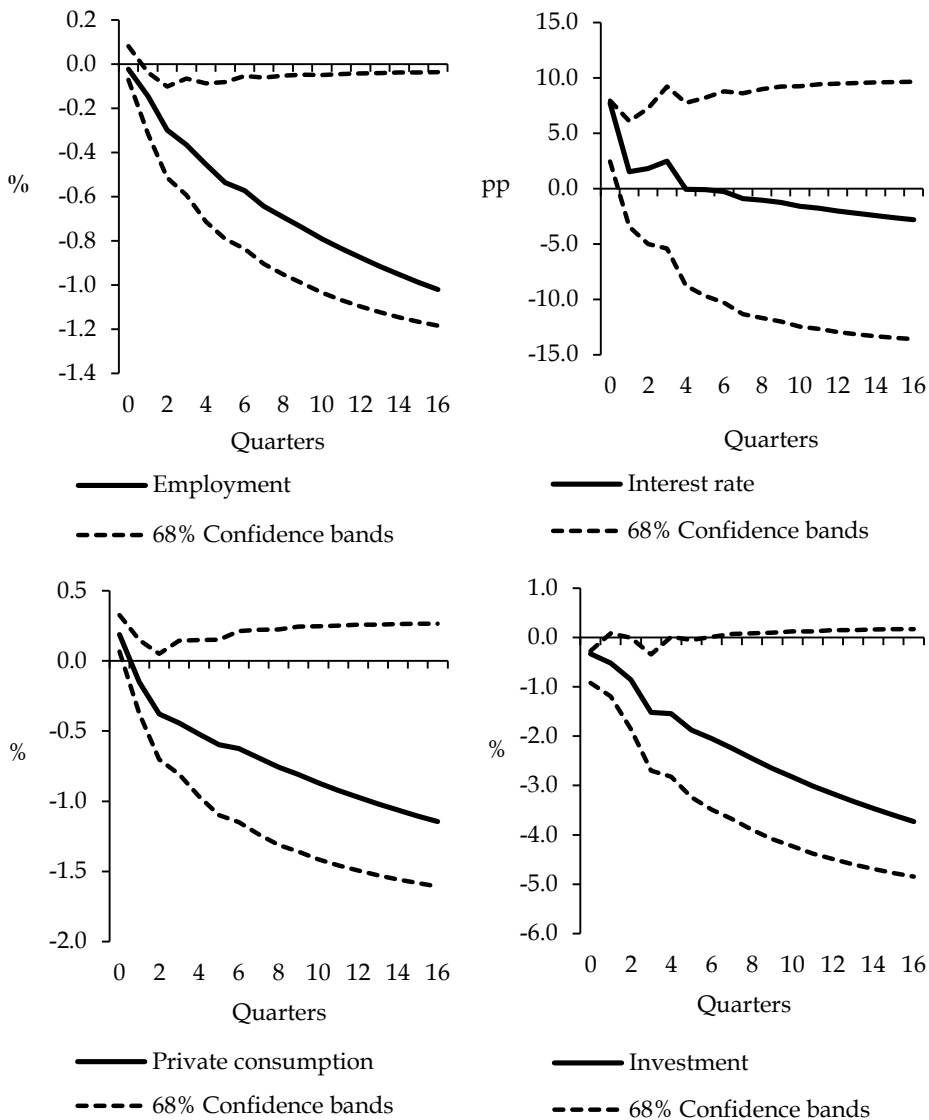


FIGURE 6

*Impulse response functions of deficit, GDP and CPI,  
positive deficit shock*

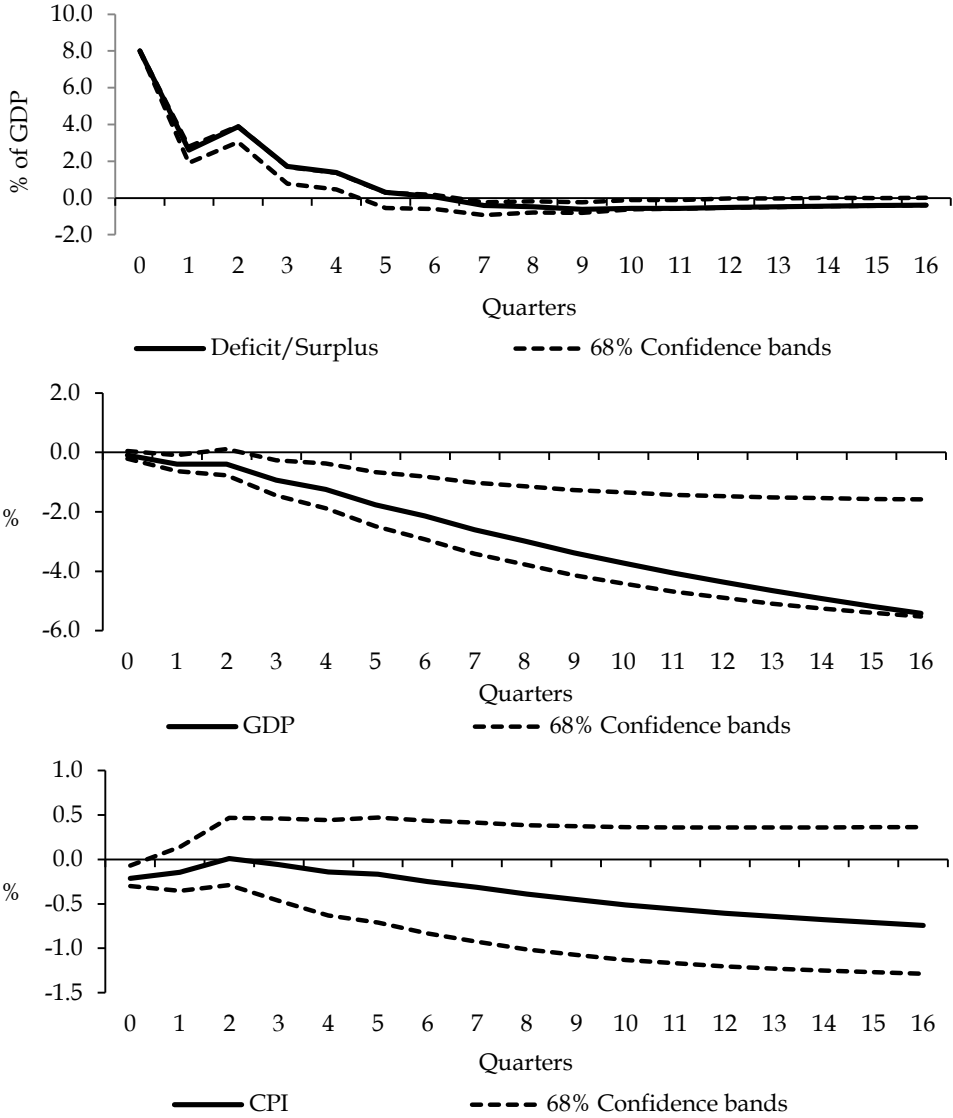


FIGURE 7

*Impulse response functions of macro variables,  
positive deficit shock*

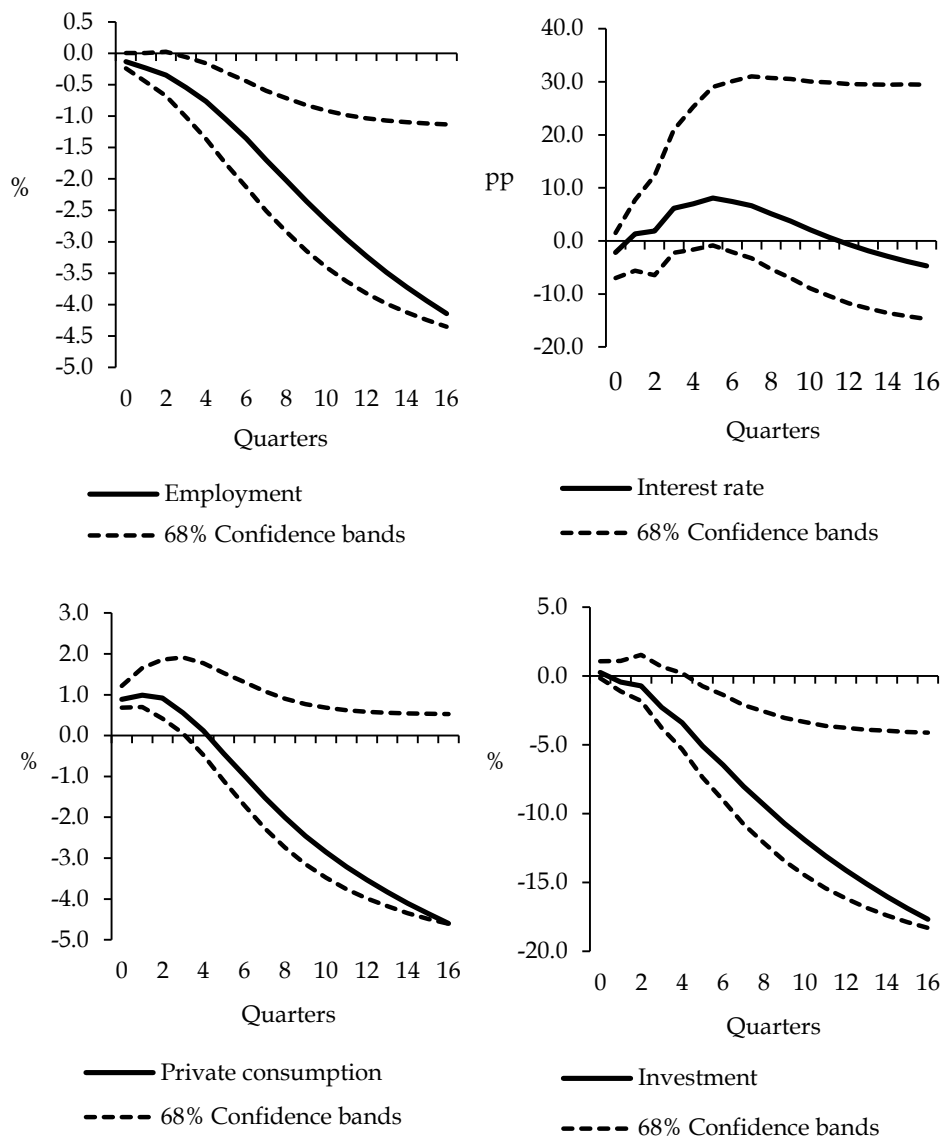


Table 1 summarises the effects of all fiscal consolidation shocks considered on the different macro series at various points of the horizon. All types of shocks result, at least a year after the shock, in a decline in GDP. The shock to deficit can be viewed as simulating simultaneously a reduction in expenditure and an increase in revenue, and therefore its impact on GDP is stronger than the effects of the two distinct shocks. Moreover, the reaction of GDP to the deficit

shock is more negative than the sum of the effects of the two separate shocks in the first and second year. Employment and investment, which are the main drivers of activity decline in the case of the deficit shock, exhibit a more negative response to the combined shock than the sum of the responses to the two distinct shocks only in the medium term.

Looking separately at the expenditure and revenue shocks we find that the former leads to a larger output contraction driven on impact by the more negative reaction of investment and subsequently intensified by the more adverse reaction of employment and consumption. The faster reaction of prices to the revenue shock seems to restrain the contraction in aggregate output through a smaller drop in private consumption and subsequently employment and investment compared to the case of a negative expenditure shock.

The results of the analysis indicate that fiscal retrenchment based on expenditure cuts affects economic activity more adversely than consolidation based on revenue increases, via higher taxes and contributions, due to the stronger negative reaction exhibited by investment, private consumption and employment. Apart from the faster reaction of the price level in the case of a revenue shock that could lead to a smaller output contraction, we discuss two possibilities which could explain the larger GDP decline in the case of a negative expenditure shock.

The negative government spending shock which leads to cuts in public sector salaries, pensions and social transfers is estimated to be followed by a larger drop in private consumption compared to an equivalent positive revenue shock as the spending shock might affect a larger proportion of lower income consumers (e.g. pensioners, social assistance recipients) with higher marginal propensity to consume. The revenue shock associated with increases in direct and indirect taxes tends to influence more strongly higher as opposed to lower income households, thus consumption is affected to a smaller degree.

It should be noted that here we look at the reaction of aggregate investment. Historically, public investment constitutes about 12% of total investment; moreover about 7.5% of government expenditure goes to investment spending. A negative shock on government expenditure, therefore, triggers a direct drop in investment via reduced public investment, and consequently lower employment. A positive government revenue shock is followed by a smaller reduction in investment, compared to the case of a negative expenditure shock, as the effects of the revenue shock on investment are rather indirect. The reduction in aggregate investment is possibly driven by the decline in private investment due to

TABLE 1  
*Effects of fiscal consolidation shocks on macroeconomic variables*

Macro variable	GDP			CPI			Employment			Private consumption			Investment		
	Expenditure	Revenue	Deficit (% of GDP)	Expenditure	Revenue	Deficit (% of GDP)	Expenditure	Revenue	Deficit (% of GDP)	Expenditure	Revenue	Deficit (% of GDP)	Expenditure	Revenue	Deficit (% of GDP)
On impact	-0.2	0.0	-0.1	0.0	-0.2	-0.2	0.2	0.0	-0.1	0.1	0.2	0.9	-0.5	-0.3	0.3
Four quarters after the shock	-0.6	-0.4	-1.2	-0.1	-0.4	-0.1	-0.6	-0.5	-0.8	-0.7	-0.5	0.1	-2.4	-1.5	-3.4
Eight quarters after the shock	-1.1	-0.6	-3.0	-0.1	-0.4	-0.4	-1.0	-0.7	-2.0	-1.2	-0.8	-2.0	-4.0	-2.5	-9.4

higher taxes (e.g. profit taxes) and by subdued consumer demand because of higher indirect taxes (e.g. VAT) and lower disposable income.

As a result of the more negative responses of private consumption and investment to the government expenditure shock, employment, especially in the medium term contracts by more compared to the case of a positive revenue shock.

#### **4. Conclusions**

The objective of this study was the investigation of the dynamic effects of fiscal retrenchment policies on key macroeconomic variables using a Vector Autoregression model augmented by factors that summarise a large number of domestic and foreign series. This framework of analysis known as Factor-Augmented Vector Autoregression (FAVAR) has been widely used in the recent literature to examine the effects of fiscal policy. The FAVAR model allows us to trace the effects of fiscal shocks not only on the variables which are directly included in the VAR model i.e. fiscal variables, GDP and prices, but also on a number of other macroeconomic series of interest, such as employment, private consumption, investment and interest rate.

The results of our analysis show that fiscal consolidation efforts being either a government expenditure reduction or a government revenue increase, lead to a fall in GDP driven by the negative responses of investment, private consumption and employment. As a result of the contractionary effects on economic activity, inflation decelerates. Similar reactions of macroeconomic variables to fiscal policy shocks were found by other studies in the literature. Blanchard and Perotti (2002) find that a positive shock on government spending is followed by an increase in output and consumption, while a positive tax shock (tax increase) leads to a decline in output and private investment. Fatas and Mihov (2001) find that a positive shock to government spending is followed by an increase in consumption and employment. Other studies (e.g. Cimadomo and Benassy-Quere 2012; Giordano et al. 2007) also report a positive output reaction to expansionary government spending shocks. Furthermore, it is found that a tax cut can stimulate the economy (e.g. Cimadomo and Benassy-Quere, 2012 for Germany; Mountford and Uhlig 2009).

Our analysis for Cyprus reveals that fiscal tightening based on expenditure reduction results in a larger contraction in output than consolidation based on revenue increase especially in the medium term. Within two years, GDP falls cumulatively by 1.0% and 0.6% as a response to fiscal consolidation (amounting to 1.0% of GDP) associated with spending cuts and equivalent

revenue increases respectively. Thus, the policy mix between expenditure cutbacks and tax increases matters as it influences the cost of fiscal consolidation in terms of lost output. This finding is the opposite of that reported in Alessina et al. (2012) where they find that tax hikes are much more costly in terms of output loss than spending cuts; their estimated effects however are the average across a number of OECD countries and fiscal consolidation plans. Erceg and Linde (2013) demonstrate that in a currency union an expenditure-based consolidation depresses output by more than a tax-based consolidation during the first three years; they conclude that the composition of fiscal consolidation should take into account the monetary policy regime of the country as the latter affects the cost of the consolidation.

Regarding the size of the estimated effects compared to studies for other countries we can loosely infer the following. The short-term response of output (four quarters) to the government expenditure shock is close to that found in other studies for the United Kingdom and Germany but lower than the responses estimated for France, Italy, Spain, Portugal and the Euro Area (see Boussard et al. 2012, Table 1). However, the medium-term reaction of output to the expenditure shock estimated for Cyprus is closer to that reported for the Euro Area (see Boussard et al. 2012, Table 1). The short- and medium-term reaction of output to a government revenue shock (tax increase) for Cyprus found here, resembles that estimated for Germany, France and the Euro Area (see Boussard et al. 2012, Table 2).

Overall, our results show that fiscal tightening policies of magnitude similar to that in the Cyprus Economic Adjustment Programme, that aim to reduce government deficit can lead, *ceteris paribus*, to a decline in GDP in the first and second year after the enforcement of the measures by 1.0% and 3.0% respectively. The framework of analysis developed here, however, is more general and can be used to analyse the effects of other fiscal policies on macroeconomic indicators. The model can be extended by including more detailed sub-categories of government expenditure (e.g. compensation of employees, intermediate consumption, public investment, social transfers, interest payments, etc.) and revenue (e.g. income tax, indirect tax, contributions, etc.) in order to simulate the impacts of more specific government policies on the macroeconomy.

## Appendix

### A.1. Factor-Augmented Vector Autoregression (FAVAR) Model

Let  $X_t$  denote a  $N \times 1$  matrix that contains a large number of economic time series;  $Y_t$  is a  $M \times 1$  vector of endogenous variables that are a subset of  $X_t$ . The usual approach is to employ a VAR or structural VAR using data for  $Y_t$  alone to estimate various macroeconomic relationships. Nevertheless, in many applications, additional economic information (not fully captured by  $Y_t$ ) may be relevant to modelling the dynamics of the series in  $Y_t$ . Therefore, let us suppose that  $F_t$ , a  $K \times 1$  vector of unobserved factors, can summarize most of the information contained in  $X_t$ , i.e.  $K$  is “much smaller” than  $N$ . The unobserved factors can be viewed as reflecting concepts that cannot be easily represented by specific series but are captured by a wide range of economic variables (see e.g. Bernanke et al. 2005; Stock and Watson 2005).

The joint dynamics of  $(F_t', Y_t')$  and the static representation of a dynamic factor model  $(X_t, F_t, Y_t)$  are given by the following equations:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t \quad (1)$$

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \quad (2)$$

where  $\Phi(L)$  is a  $(K + M) \times (K + M)$  matrix lag polynomial of finite order  $d$ , whose parameters could be subject to a priori restrictions as in a structural VAR setup. The error term  $v_t$  has mean zero and variance-covariance matrix  $Q$ .  $\Lambda^f$  is a matrix of factor loadings with dimensions  $N \times K$ ,  $\Lambda^y$  is  $N \times M$ ;  $e_t$  is a mean zero vector of errors exhibiting some degree of cross-correlation.<sup>1</sup>

Factors  $F_t$  are unobserved and therefore must be estimated jointly with or prior to the estimation of equation (1). The dynamic evolution of each economic series in  $X_t$  is governed by the  $K$  factors and the  $M$  elements of the variables of interest  $Y_t$ , which are common to all elements of  $X_t$ , plus an idiosyncratic component. The static representation of the dynamic factor model described by equation (1) and (2) where  $F_t$  can also include lags of the factors allows the estimation of the space spanned by the factors by application of the principal components method

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<sup>1</sup> In the principal component method employed for the estimation of factors the cross-correlation between error terms in  $e_t$  tends to zero as the number of series in  $X_t$  (i.e.  $N$ ) becomes large (Stock and Watson 2002).

(see Stock and Watson 1998, 2002, 2005). Then the FAVAR model (1) can be estimated using a smaller number of variables ( $K + M$ ) than the dimension of  $X_t$ . Moreover, the FAVAR model nests the simple VAR model.

Equations (1) and (2) can be estimated in two ways: (i) a two-step procedure based on principal components and (ii) a single-step Bayesian maximum likelihood (Bernanke et al. 2005). Here we use the two-step procedure which has the advantage of being computationally simple and easy to implement. Furthermore, in contrast to the Bayesian maximum likelihood method, it requires fewer distributional assumptions and allows for some cross-correlation in the idiosyncratic error terms  $e_t$ .

In the first step of the two-step procedure the space spanned by the factors of the data matrix  $X_{0t}$ , denoted by  $\tilde{F}_{0t}$  is estimated by the first  $K$  principal components of  $X_{0t}$ , where  $X_{0t}$  is the part of the matrix  $X_t$  that does not include  $Y_t$  as the latter is treated as being directly observable.<sup>2</sup> Stock and Watson (2002) showed that the principal components method yields consistent estimators when both cross section and time series dimensions are sufficiently large.

In the second step  $\tilde{F}_{0t}$  can replace  $F_t$  in the FAVAR model and subsequently equation (1) can be estimated as a standard VAR. Furthermore, like a standard VAR, the FAVAR model requires assumptions/restrictions for the identification of policy shocks. Here identification is achieved by employing a recursive ordering of the variables (i.e. Cholesky identification scheme) where fiscal variables are ordered first, followed by other macroeconomic variables of interest (output and prices) and factors.<sup>3</sup> A similar variable ordering, where macro series such as output and prices respond contemporaneously to a fiscal shock, is followed in other works studying the effects of fiscal policy (e.g. Giordano et al. 2007; Perotti 2004).

The estimation of the FAVAR model in the second step involves the estimated factors  $\tilde{F}_{0t}$  and therefore generated regressors, thus confidence intervals for the impulse response functions obtained from the FAVAR are computed using a bootstrap technique (Kilian 1998).

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<sup>2</sup> In the principal component estimation a normalisation is imposed on the estimated factors and their loadings in order to reach a unique solution as alternative sets of factors and loadings that span the same space as  $\tilde{F}_{0t}$  can be found.

<sup>3</sup> Other identification schemes which are available in the VAR literature (e.g. Leeper et al. 1996; Bernanke and Mihov 1998) can also be employed in the FAVAR setup.

## A.2. Estimation of factors, selection of lag order and stability conditions

TABLE A1

### *Estimation of the number of factors*

No. of factors	Domestic data			Foreign / international data		
	ICP1	ICP2	% of variance explained by factor	ICP1	ICP2	% of variance explained by factor
0	-0.01	-0.01	-	-0.01	-0.01	-
1	-0.10	-0.08	16.15	-0.34	-0.33	33.81
2	-0.10	-0.07	7.42	-0.43	-0.40	10.65
3	-0.09	-0.05	6.17	-0.48	-0.44	7.21
4	-0.07	-0.01	4.67	-0.53	-0.48	6.19
5	-0.05	0.03	4.19	-0.55	-0.49	4.37
6	-0.02	0.07	3.69	-0.55	-0.47	3.20
7	0.01	0.11	3.65	-0.54	-0.45	2.62
8	0.04	0.15	3.32	-0.53	-0.43	2.45
9	0.07	0.20	2.93	-0.52	-0.41	2.28
10	0.10	0.24	2.70	-0.51	-0.39	2.04
Estimated no. of factors	2	1		6	5	
No. of variables (cross section)	92			103		
No. of periods (time series)	73			73		

TABLE A2

### *Criteria for lag order selection*

No. of lags in FAVAR	Specification A			Specification B		
	Final prediction error	AIC	BIC	Final prediction error	AIC	BIC
0	0.00126	13.19	13.42	0.00130	10.38	10.58
1	0.00017	11.19	13.00*	0.00020	8.48	9.84*
2	0.00013*	10.87	14.27	0.00018*	8.38*	10.91
3	0.00028	11.53	16.52	0.00027	8.73	12.42
4	0.00015	10.69*	17.26	0.00033	8.80	13.66

Note: The symbol “\*” denotes the number of lags selected by each statistic.

TABLE A3

*Stability conditions, eigenvalue modulus*

Specification A	Specification B
0.94164	0.93641
0.71949	0.73457
0.71949	0.73457
0.67348	0.70614
0.64187	0.67487
0.64187	0.51149
0.62883	0.51149
0.62883	0.49386
0.55577	0.45726
0.55577	0.45726
0.39885	0.39220
0.39885	0.07414
0.39482	0.93641
0.39482	0.73457

*Note:* The modulus of all eigenvalues is less than unity and therefore the systems satisfy the stability condition.

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