Macroeconomic Shocks and the Fiscal Stance within the EU: A Panel Regression Analysis

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Abstract
The recent global financial crisis has had a diverse effect on countries' fiscal stance, especially throughout the EU. This paper examines the impact of macroeconomic shocks, including those to government revenues and expenditures, on EU countries' fiscal stance, on aggregate, and within the EU's sub-regions as defined by the length of countries' membership in the EU and their level of indebtedness. The fiscal stance is measured by means of the government deficit, and the impact of macroeconomic shocks is examined using impulse responses from a structural vector autoregression (SVAR) model estimated on annual panel data. The analyzed system of macroeconomic variables includes, government revenues and expenditures, GDP growth, CPI inflation, the interest rate, the terms of trade, and the real effective exchange rate. The paper discusses the policy implications and the challenges for the EU and its sub-regions concerning the fiscal policy setting and balanced fiscal stance.

Keywords: Macroeconomic shocks, Fiscal Stance, European Union, Panel Data Analysis, Structural Vector Autoregression Models.

JEL codes: E62, H68, E37

1. Introduction

The global financial and economic crisis revealed important fiscal vulnerabilities as governments responded with various policy measures including increased government spending to resurrect their despaired economies. The vulnerabilities that materialized in developed economies were the result of accumulated risk exposures by the governments over the medium term, and triggered by macroeconomic and financial shocks. In this respect the fiscal stance of the Euro Area and EU countries was one of the most affected. However, the initial exposures and shocks that uncovered the accumulated vulnerabilities and made them take shape varied importantly across the EU. This variation provides a useful sample to study the impact of macroeconomic shocks on fiscal stance including due to the EU countries' harmonized institutional and legal environments.

This paper thus investigates the impacts of basic macroeconomic and financial shocks on the fiscal stance in the EU, including by looking into the differences between those impacts across the eurozone and new EU member countries. The macroeconomic shocks of interest include the demand (GDP) and supply (CPI inflation) shocks and the financial shock as approximated by the interest rate shock. In addition, discretionary changes in government expenditures and revenues are considered. For this purpose, the paper estimates a structural VAR model encompassing basic macroeconomic, financial and fiscal variables with the use of a pooled panel regression approach. The estimated pooled SVAR model is then used to derive impulse response functions (IRFs) and study the dynamics of the variables of interest to shocks identified by the model based on the EU countries' data.

We find that the fiscal stance (deficits) of Euro Area (EA12) could be relatively more vulnerable to government expenditure and revenue shocks compared to new EU Member States

(EU12). [1] On the other hand, the fiscal stance in EU12 shows vulnerability to a GDP (demand) shock because the increase in revenues after positive GDP shock is often outpaced by greater expenditure increases in EU12. The estimated vulnerabilities appear to stem from a disproportionate policy response, mostly on the government expenditure side and a lacking discipline to diminish pro-cyclical fiscal spending.

Our paper fits into the literature analyzing the character (cyclicality) and effects of fiscal policy in the EA and EU. Recently, probably due to the impact of the financial and economic crisis, the role of public budgets has been intensively analyzed in both academic and policy-oriented literature. In addition, since the role of fiscal policy in the monetary union is crucial, a significant bulk of recent research efforts was oriented towards the EA and EU. The influential contributions by Fatas and Mihov (2003) and Gali and Perotti (2003) seem to be the cornerstones of the contemporary analysis of fiscal policy. In line with our results, Crespo-Cuaresma et al. (2011), depict fiscal deficits to be an important potential source of idiosyncratic macroeconomic fluctuations in Europe. They conclude that individual fiscal policies, reflecting rather national priorities, may become a potential source of asymmetric shocks with likely harmful effects in the performance of monetary policy in a monetary union. Using an estimated DSGE model for the EA to study the effects of fiscal stabilization policies, Ratto et al. (2006) analyze the effects of fiscal stabilization via government consumption, investment, transfers and wage taxes. They find empirical evidence for systematic countercyclical fiscal policy in the EA. In addition, they find fiscal policy to be effective in stabilizing GDP in the presence of demand and supply shocks. Estimating separate fiscal policy reaction functions in good and bad times, Turrini (2008) analyzes the cyclical behavior of fiscal policy in the EA countries over the period 1980-2005. He concludes that the average stance of fiscal policy is expansionary when output is above potential, thus denoting a pro-cyclical bias in good times, although no strong evidence of a cyclical bias is found in bad times which supports our evidence on the character of fiscal policy in the EU.

The remainder of the paper is organized as follows. Section two describes the applied model and estimation methodology. Section three describes the data and the data sources. Section four discusses the estimation results. And, section five concludes.

2. Model and Estimation Methodology

We use a panel vector autoregression (PVAR) model to estimate the impact of macroeconomic shocks on fiscal variables and other main macroeconomic fundamentals within the EU (see also Melecky and Raddatz, 2011). The PVAR relates the macroeconomic and fiscal variables of interest to their lagged values and can be written as:

$$A_0 x_{i,t} = \sum_{j=1}^{q} A_j x_{i,t-j} + \theta_i + \theta_t + \gamma_i t_t + \varepsilon_{it} \qquad (1)$$

where $x_{i,t} = (TT_{i,t}, EXP_{i,t}, GDP_{i,t}, INF_{i,t}, R_{i,t}, REV_{i,t})'$, $x_{i,t}$ is the vector of endogenous variables including the percentage change in the terms-of-trade index, the (log of) real government expenditures (EXP), GDP per capita in constant 2000 US dollars (GDP), the inflation rate (INF), nominal interest rate (R), and government revenues (REV). The main focus of the paper is on EXP, GDP and REV, but we include inflation and interest rates in the vector of endogenous variables as controls for other macroeconomic conditions. This set includes all the conventional macroeconomic variables typically included in macro models (see Monacelli (2005), Linde et al (2008), and Adolfson (2001), among others). The parameters θ_i and θ_t are country and year fixed-effects that capture long run differences in all the variables across countries, and the impact of global factors that are common to all countries in the sample and can be understood as the world business cycle. The coefficient γ_i captures

[1] The EA12 countries include Belgium, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal and Finland. EU12 countries include Bulgaria, The Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia.

a country-specific trend. The residual term $\varepsilon_{i,t}$ corresponds to an error term that is assumed to be *i.i.d* ~ (0, σ).

The number of lags, q, is assumed to be equal to one due to the small number of observation for some new EU member state especially Bulgaria and Romania. Nevertheless, even after eliminating these two countries the conventional lag length selection criteria (Akaike and Schwartz information criteria) point to the optimal selection of one lag for the VAR at hand. The model parameters are contained in matrices A_j, and the structural interpretation of the results depends on the identification of the parameters of the contemporaneous matrix A_0. Although we are interested in analyzing the impulse response function for the government deficit, we do not include it explicitly as a variable into the model. The model includes logs of expenditure and revenues, which are by definition always positive. The logged government deficit is constructed based on the dynamics of the two variables and their steady state (average) shares in the deficit in the studied countries.

The main identification assumption imposes a diagonal structure on the A_0 matrix. This implies that the terms of trade respond to other macroeconomic variables only with a lag. Further, output, inflation, interest rates and revenues respond contemporaneously to changes in expenditures, but government expenditures respond to changes in a country's economic conditions and fiscal revenues only after a year. Similarly, revenues are assumed to respond contemporaneously to changes in expenditures, GDP, inflation, and interest rates, but these variables respond to shocks to revenues only with a one year lag. The assumptions on the ordering of the fiscal variables relative to GDP are similar to those in Blanchard and Perotti (2002) and Ilzetzki et al. (2010). The ordering of inflation and interest rates relative to output also follow the standard ordering in the monetary policy literature (Christiano et al., 1998). The identification assumptions translate into the following matrix of contemporaneous relations (A_0),

$$A_0 = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{2,2} & 0 & \cdots & \cdots & 0 \\ 0 & a_{3,2} & a_{3,3} & 0 & \cdots & 0 \\ 0 & a_{4,2} & \vdots & a_{4,4} & 0 & 0 \\ 0 & a_{5,2} & \vdots & \vdots & a_{5,5} & 0 \\ 0 & a_{6,2} & a_{6,3} & a_{6,4} & a_{6,5} & a_{6,6} \end{bmatrix} \tag{2}$$

The model described in equation (1) corresponds to a PVAR, because we assume that the dynamics, represented by the different parameters and matrices, are common across the different cross-sectional units (countries) included in the estimation, which are indexed by i. This is a standard assumption in this literature (see Broda (2004); Uribe and Yue (2006)). We estimate the parameters of equation (1) for the cases where the series are trend stationary in levels. The residuals are stationary and overall well behaved given the structure of the model.

The model parameters are estimated by SURE and used to recover the impulse-response functions (IRF) of the endogenous variables in equation (1) to the structural shocks using the variance-covariance matrices of reduced form errors derived from these coefficients.[2] The confidence bands for the IRF come from parametric bootstrapping on the model assuming normally distributed reduced form errors.

[2] The use of SURE is standard for the estimation of the reduced form equation. It is equivalent to estimating the model equation by equation by OLS, but is more efficient because it takes into account contemporaneous correlations among variables. It also directly estimates the variance-covariance matrix of reduced-form residuals. We use only the two-step version of the estimator for reasons of speed, but when iterated until convergence the SURE estimators are equivalent to the maximum likelihood estimators.

3. Data Description

The data series for all EU countries were obtained from the AMECO database, except for the interest rate series which was taken from the IMF's International Financial Statistic and for Bulgaria and Romania supplemented by authors calculation based on national and IMF country desk information before 2000. The detailed data sources are provided in Table 1.

Table 1: Employed Data Series and Their Sources

Variable	Source	Notes
Terms of Trade	Terms of trade goods and services	year 2000=100
Government Expenditures	Total expenditure: general government	Mrd EUR; ESA 1995
Government Revenue	Total revenue: general government	Mrd ECU/EUR; ESA 1995
Nominal GDP	Gross domestic product at current market prices	Mrd ECU/EUR
GDP Deflator	Price deflator gross domestic product at market prices	year 2000 = 100
CPI	Harmonised consumer price index (All-items)	year 2005 = 100
Interest Rate	long term real interest rate >5 years, various sources	Eurostat, IMF IFS, Haver Analytics, Bloomberg, ECB, OECD

Source: AMECO, IMF IFS, and authors computation

The real GDP is constructed from the nominal GDP and the GDP deflator. The long-term real interest rate is obtain for most countries from the Eurostat except for Bulgaria, the Czech Republic and Estonia for which it is taken from IMF IFS; Romania and Slovenia for which it is taken from the ECB database; and Slovakia for which it is taken from the OECD database. For the purpose of the regression estimation all variables are in logs. Table 2 in the Appendix provides data summary statistics for the employed data series in the panel structure.

4. Discussion of Estimation Results

Table 2 reports the VAR reduced-form estimates. All variables show significant positive autocorrelation, with the GDP one being the highest (0.879), and the interest rate one (0.310) the lowest. In accord with the identification assumption, the terms of trade dynamics, in column one, is not influenced by other domestic variables. Government expenditures are, in addition to their lagged value, significantly influenced by lagged GDP and the interest rate in a positive way. In contrast, lagged government expenditures have a negative effect on GDP. CPI inflation seems to also depend only on its lagged value similarly as the terms of trade. The interest rate is, in addition to its lagged value, influenced positively by the terms of trade. Finally, government revenues are influenced by their lagged value and GDP in a positive manner, and negatively by government expenditures. These estimates predetermine the direction and shape of the impulse response functions (IRFs) that we discuss next.

Table 2: Estimated Reduced-Form VAR for the EU

	TTpwt	gexppckd	gdppckd	dcpi	irate	grevpckd
TTpwt(-1)	0.468 (0.045)***	-0.045 (0.152)	-0.005 (0.117)	0.025 (0.040)	4.751 (1.144)***	-0.001 (0.139)
gexppckd(-1)	0.000 (0.000)	0.360 (0.074)***	-0.229 (0.055)***	-0.032 (0.020)	0.585 (0.540)	-0.182 (0.067)***
gdppckd(-1)	-0.000 (0.000)	0.231 (0.087)***	0.879 (0.065)***	0.027 (0.023)	0.309 (0.639)	0.395 (0.079)***

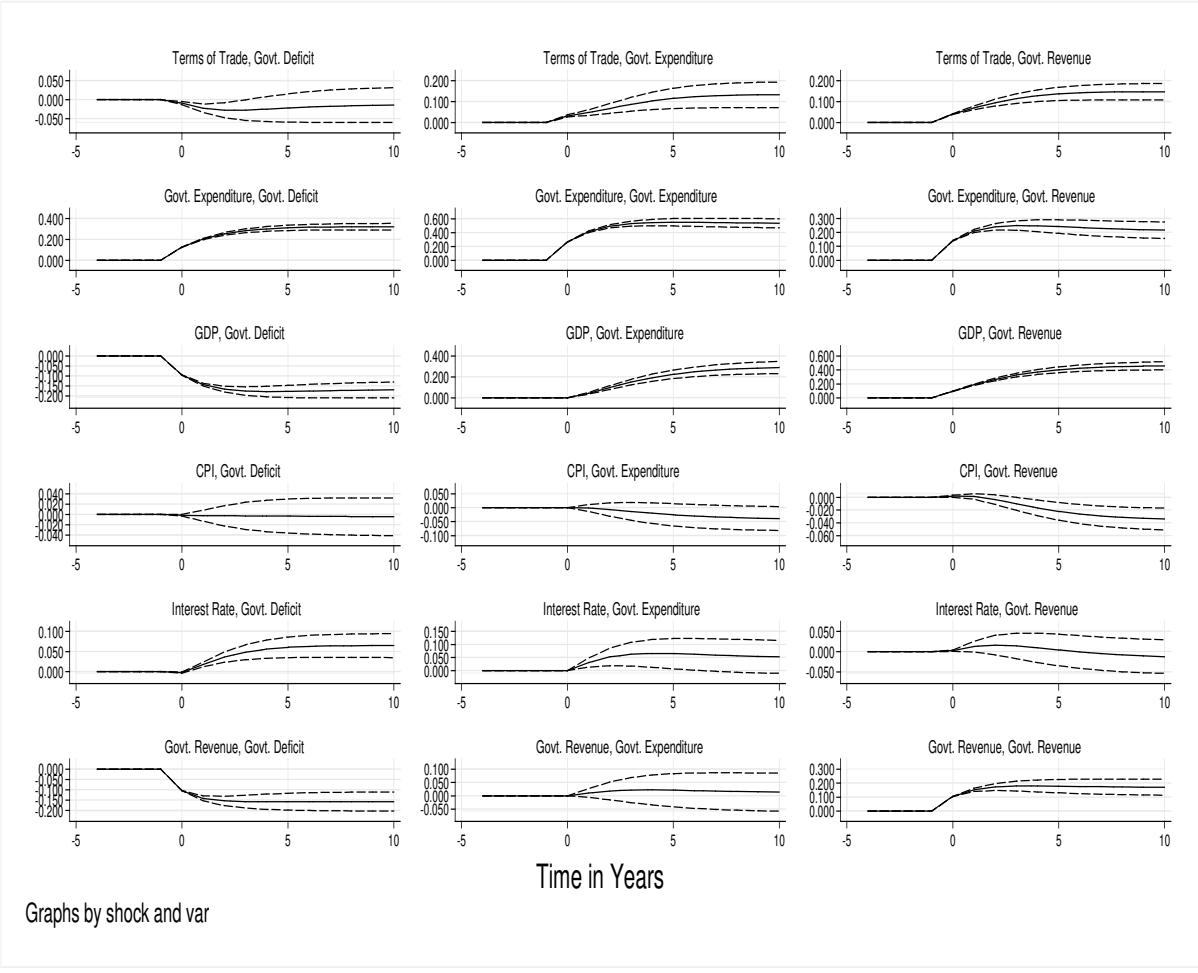
dcpi(-1)	0.000 (0.000)	-0.039 (0.154)	-0.180 (0.115)	0.329 (0.041)***	-1.023 (1.130)	-0.027 (0.139)
irate(-1)	-0.000 (0.000)	0.016 (0.008)**	0.001 (0.006)	-0.001 (0.002)	0.310 (0.057)***	0.006 (0.007)
grevpckd(-1)	0.000 (0.000)	0.084 (0.090)	0.003 (0.067)	0.029 (0.024)	-0.446 (0.664)	0.456 (0.082)***

Source: Authors' calculation. Note: * $p<0.1$; ** $p<0.05$; *** $p<0.01$; we do not report the coefficient estimates for cross-section and time-series dummy variables and the constant for brevity.

4.1 The EU Estimation Results

Figure 1 shows the estimated impulse response functions (IRFs) of the government deficit, government expenditure and government revenue to shocks that the model identified from data based on its structure and coefficient estimates. The mean IRFs are depicted by a solid line and their corresponding one-standard-deviation confidence intervals by dashed lines. We do not report the IRFs for the remaining endogenous variables for the sake of brevity, but these estimates are available from the authors.

Figure 1: Cumulative Impulse Responses based SVAR Estimated for the EU



Source: Authors' calculation

Consider the first column of Figure one which shows the IRFs of the government deficit to the terms of trade shock, the government expenditure shock (the discretionary changes in government expenditure), the GDP (demand) shock, the CPI inflation (supply shocks), the interest rate (monetary policy) shock, and the government revenue shock (the discretionary changes in government revenue), respectively. We find that government deficit of the EU countries responds significantly to shocks in government expenditure and interest rate shocks which force the deficit to increase by about 20 and five percent respectively. In contrast, significant negative IRFs are estimated when the EU economies are hit by a positive GDP shock or government revenue shock. The increase in interest rates (debt service charges) or government expenditure are expected to increase government deficit, and also the lowering of deficits after positive GDP and government revenue shocks is intuitive and could be labeled as an equilibrating policy response.

Next consider the second column of Figure 1 which describes the IRFs for government expenditure. The estimates suggest that government expenditures respond significantly to the terms of trade shock, the government expenditure shock, the GDP shock and the interest rate shock in a positive way. However, the cumulative response to the interest rate becomes insignificant after five years. We will discuss these IRFs in conjunction with the IRFs for the government revenues reported in the last column of Figure 1.

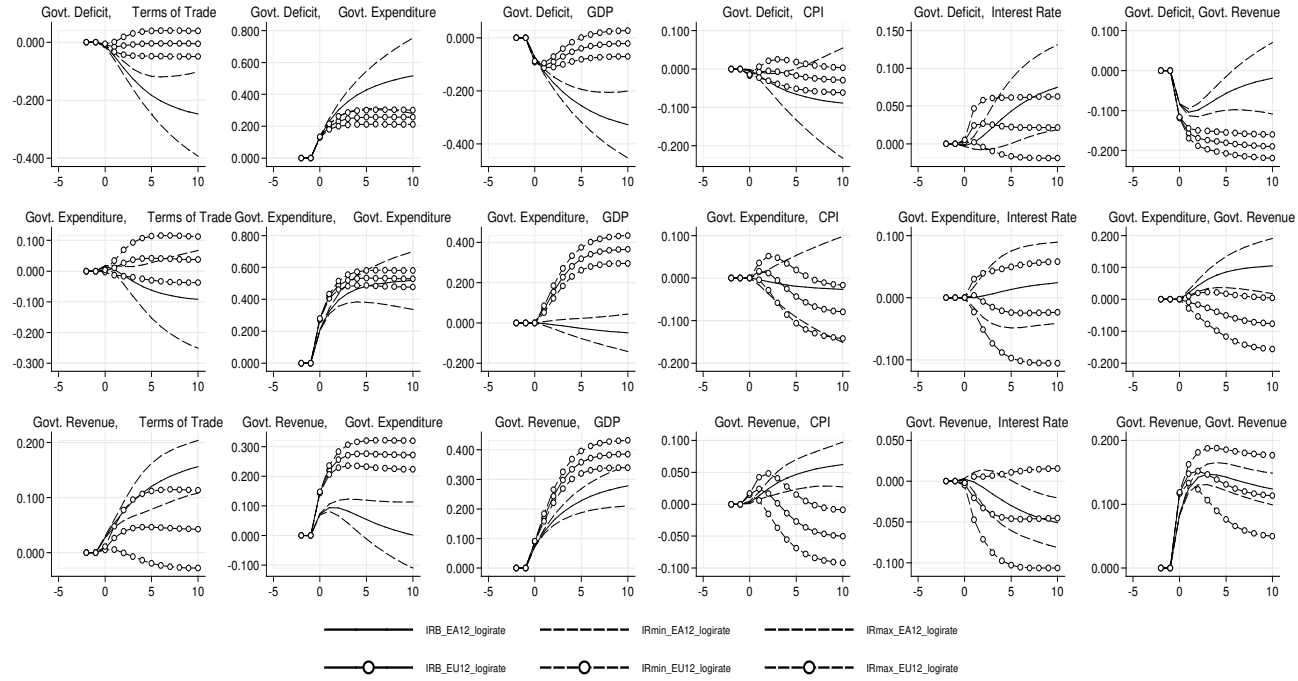
Government revenues in the EU increase significantly in response to the terms of trade, government expenditure, GDP and government revenue shocks, while they decrease significantly in response to the CPI inflation (negative supply) shock. One can observe in the first row of Figure 1 that the positive response of government expenditure and revenues after the terms of trade shock is of a similar magnitude and therefore the effect of the shock on the deficit is insignificant. Although the discretionary increase in government expenditures seems to be to some extent financed by rising government revenues, EU countries still get into significant deficit positions because the increase in their expenditures is about two times bigger than the revenue increase. The positive GDP (demand) shock increases government revenues in EU countries more than the countries raise their expenditures as a result of higher income. This ensures that the positive GDP shock lowers government deficits in EU countries. Even though government revenues decline significantly after an inflation (supply) shock, also government expenditures decline somewhat resulting in an insignificant change in the government deficit. After positive interest rate shock, government revenues tend to decline with about five year lag but rather insignificantly. Nevertheless, in combination with the estimated significant increase in government expenditure, as a result of the increased debt servicing cost, the estimated impact of the interest rate shock on the deficit is significantly positive. Finally, the discretionary increase in government revenues impact positively on government revenues, as expected, while EU countries manage to contain their expenditures and secure lowering of government deficits.

Due to the on-going debate on the fiscal discipline in the context of the recent fiscal crisis in the eurozone and some other EU countries, we will dissect the fiscal responses to the considered shocks for the old and new EU members next.

4.2 Comparing the Pools of Old and New EU Members

Figure 2 shows the comparison of IRFs of government deficit, expenditure and revenue to the structural shocks identified by the estimated SVARs for EA12 and EU12 countries. The impulse responses for EA12 are depicted by the solid lines with their one-standard-deviation confidence intervals described by the respective dashed lines. The IRFs for EU12 are then described by the circle lines where again the solid circle line depicts the mean response and the dashed circle lines show the associated confidence intervals. A significant difference in IRFs occurs when the IRFs and their confidence intervals for EA12 and EU12 countries do not overlap.

Figure 2: Comparison of Cumulative IRFs for the Old and New EU Member Groups



Source: Authors' calculation

Consider for instance the first column of Figure 2 which describes the impact of the terms of trade shock on the fiscal variables of interest. Since in the second and third panel the bands delineated by the IRF confidence intervals overlap we can concur that there is no significant difference between the EA12 and EU12 in the responses of government expenditures and revenues to terms of trade shocks. However, there appear to be a significant difference in the response of deficits to the term of trade shock across the EA12 and EU12. While for the EU12 both the response of government expenditures and revenues to terms of trade shock is not different from zero, for the EA12 the response of revenues is significantly positive. As a result, after a positive terms of trade shock, the EA12 countries on average reduce their deficits, while the EU12 countries' deficits remain unaltered. From now on we will discuss only the IRFs in Figure 2 for which we find significant differences between the EA12 and EU12.

Consider the second column of Figure 2, namely the last panel in that column, which shows significantly higher response of government revenues in EU12 than in EA12 after a discretionary increase in government expenditure (shock). Consequently the first panel of that column shows greater increase in government deficit in response to the government expenditure shock. This can lead to a conjecture that discretionary increases in government expenditure are financed to a significant extent by increases in government revenues in EU12 countries whereas in EA12 countries they are financed by new borrowings (debt). This could make the EA12 countries' fiscal stance more vulnerable to government expenditure shocks.

The IRFs in the third column suggest that a positive GDP shock increases revenues more prominently in EU12 than in EA12 (last panel). However EU12 tends to raise their government expenditures in view of increasing income while EA12 uses the increased revenues to significantly decrease their fiscal deficits and improve the fiscal stance. This results in a significantly different dynamics of fiscal deficits in the EA12 and EU12 after a positive GDP shock which makes the EU12 more vulnerable, especially in the medium term.

Consider now the fourth column which, in the last panel, shows that the responses of government revenue to an inflation (supply) shock differ significantly across the EA12 and EU12. Namely, for the EA12 as prices increase so does the revenues as presumably the tax base increases. On

the other hand, in the EU12, once a price shock occurs a negative supply shock seems to unfold that lowers the economy's income, the tax base and government revenues. Despite these contrasting differences in the reaction of revenues, the fiscal deficit does not respond significantly to the shock in either of the two blocks. This is mainly due to a counterbalancing decrease in government expenditures in EU12, and a great uncertainty about the response of government expenditures in EA12.

Since there are no significant differences detected by our estimates in regards to the response of the fiscal variables to an interest rate shock, we proceed with discussing the impact of the government revenue shock. These impacts are described in column six. The corresponding IRFs suggest that after a discretionary increase in (one-standard deviation shock to) government revenues the EA12 increases their government expenditure while EU12 tends to decrease their government expenditures. This results in significantly greater reduction of government deficits in EU12 than in EA12. However, for the latter this positive shock appears to be neutralized as the medium term (cumulative) impact on the fiscal deficit is close to zero. Nevertheless, this indicates vulnerability of the fiscal stance in EA12 countries to a positive revenue shock in the short term.

Overall we thus find based on our estimates that the fiscal stance of EA12 could be relatively more vulnerable to government expenditure and revenue shocks compared to EU12. On the other hand, the fiscal stance in EU12 could be relatively more vulnerable to a GDP (demand) shock. The estimated vulnerabilities could stem from a disproportionate policy response mostly on the government expenditure side and a lacking discipline in regards to containing pro-cyclical fiscal spending. This could provide an argument for advocating fiscal rules focused on government expenditure (IMF, 2009; Kopits, 2004).

5. Conclusion

This paper studied the impact of aggregate macroeconomic, financial and fiscal shocks on fiscal variables, including government revenues, expenditures and deficits of the Euro Area and other EU countries. The study was carried out with the use of estimated pooled SVAR model on EU countries data. We found that government revenues increase after the terms of trade, government expenditure, GDP and government revenue shocks. In contrast they tend to decline after the price (negative supply) shock. EU countries get into deficit positions after a discretionary increase in government expenditure despite some financing of this increase from additional government revenues. This is because the increase in their expenditures is about two times bigger than the additionally raised revenue increase. On aggregate, the EU countries are able to raise more revenues after a positive GDP (demand) shock while limiting their expenditures. This ensures that the positive GDP shock lowers government deficits in the EU. Similarly, a discretionary increase in government revenues tends to be accompanied by restrained fiscal expenditures, and this helps lower government deficits. However after a positive interest rate shock, the combination of an increase in government expenditure and declining revenues in the medium-term makes the deficit grow significantly.

When comparing the responses of fiscal variables for the Euro Area and the new EU member states, we find that the fiscal stance of the Euro Area could be relatively more vulnerable to government expenditure and revenue shocks compared to the new EU member states. Concerning the Euro Area vulnerability to expenditure shocks, it appears that discretionary increases in government expenditure could be financed by new borrowings (debt) as opposed to additional revenue collection and this worsens Euro Area countries' fiscal stance. What concerns the Euro Area vulnerability to fiscal revenue shocks, it arises because the EA12 increase their government expenditure after a discretionary increase in government revenues.

On the other hand, the fiscal stance in the new EU member states could be relatively more vulnerable to a GDP (demand) shock as the resulting increase in revenues is often outpaced by greater expenditure increases in the new EU countries. The estimated vulnerabilities could stem from a disproportionate policy response mostly on the government expenditure side and lacking discipline in regards to restraining pro-cyclical fiscal spending. This could advocate for fiscal rules to be focused on government expenditure rather than other fiscal variables.

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Appendix

Table 2: Summary Statistics of Employed Data Series Across Countries

	Averages					EU Membership	
Country	GDP per capita	Revenues to GDP	Expenditures to GDP	Deficit to GDP	Number of observations	EA 12	EU 12
Austria	14854	0.49	0.52	-0.03	22	•	
Belgium	14516	0.47	0.52	-0.05	20	•	
Bulgaria	2443	0.38	0.39	-0.01	14		•
Cyprus	8046	0.37	0.40	-0.03	14		•
Czech Rep	7810	0.40	0.45	-0.05	13		•
Denmark	18733	0.53	0.53	0.00	22		
Estonia	6689	0.39	0.38	0.01	15		•
Finland	15155	0.51	0.50	0.02	22	•	
France	14218	0.49	0.52	-0.03	21	•	
Germany	15202	0.44	0.46	-0.02	16	•	
Greece	7832	0.37	0.46	-0.08	17	•	
Hungary	5067	0.44	0.50	-0.05	14		•
Ireland	13722	0.38	0.42	-0.04	17	•	
Italy	11908	0.43	0.50	-0.07	22	•	
Latvia	4784	0.35	0.37	-0.02	12		•
Lithuania	4863	0.34	0.38	-0.04	12		•
Luxembourg	28758	0.42	0.40	0.02	16	•	
Malta	5678	0.38	0.43	-0.05	14		•
Netherlands	15295	0.48	0.51	-0.03	22	•	
Poland	4246	0.40	0.45	-0.05	14		•
Portugal	6392	0.35	0.40	-0.05	22	•	
Romania	2742	0.33	0.36	-0.04	8		•
Slovakia	6704	0.38	0.45	-0.07	16		•
Slovenia	12070	0.43	0.47	-0.03	11		•
Spain	9162	0.38	0.41	-0.03	16	•	
Sweden	17710	0.56	0.57	-0.01	18		
UK	13185	0.41	0.45	-0.04	22		

Source: Authors' Calculations