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Fiscal Shocks and Public Debt Dynamics in the European Union. New Evidence using Forecast-Error Identification*

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Abstract

This paper studies the effects of fiscal shocks on the dynamics of public debt and other fiscal and macroeconomic variables. The data are annual and cover all the members of the European Union from 2001 to 2024. The fiscal shocks are identified using orthogonalised forecast errors computed from European Commission forecasts, and the impulse responses are generated using local projections. Primary balance shocks lower government debt measured in per cent of GDP, but the effect is gradual and is initially modest. There are large differences in how revenue and expenditure measures affect the stock of public debt. Revenue shocks have gradual and statistically insignificant effects, while primary expenditure shocks have fast, relatively large and statistically significant effects. The effects on the public debt stock differ because the resulting fiscal reactions are different for revenue or spending shocks.

Keywords: Government debt, debt dynamics, fiscal policy, austerity, euro area
JEL Codes: H63, H68, E62

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1 Introduction

Many of the countries in the European Union have been under severe fiscal strain since the 1990s. Budget deficits have been large in several countries, and public debt has reached levels where debt servicing is challenging and policymaking is impeded. These fiscal strains were particularly evident during the global financial crisis and the subsequent sovereign debt crisis, and they then re-emerged after the Covid-19 pandemic. Increased demands for spending to build up national defence, fund the green transition and support ageing populations mean that the challenges afforded by high or increasing levels of public debt remain central in fiscal policymaking in the EU countries.

The fiscal governance framework of the European Union, including the Stability and Growth Pact, imposes limits on government deficits and public debt and is designed to ensure fiscal discipline and avert fiscal imbalances.[1] The revised governance framework that entered into force in 2024 pays particular attention to the sustainability of debt and requires all the EU countries to produce projections of their debt stock over time, including projections that show how different policy measures will affect that debt stock (Darvas et al. 2025).

Debt stocks and budgetary demands increasing in the European Union underscores the need for studies of how fiscal policy affects the debt stock. This paper seeks to quantify the effects of various fiscal shocks on the dynamics of government debt and on key fiscal and macroeconomic variables in the European Union. We consider primary balance shocks, revenue shocks and expenditure shocks. The panel data are annual and span more than two decades from the early 2000s to 2024. The fiscal shocks are identified using orthogonalised forecast errors computed from European Commission forecasts, and the impulse responses are generated using local projections. The analyses provide quantitative estimates of the effect of various fiscal shocks on the dynamics of public debt. The key aims of this research are to estimate how public debt affects different fiscal measures and to establish the factors that lie behind the differences there may be between the effects.

Numerous studies have investigated the relationship between fiscal policy measures and the resulting dynamics of public debt. We discuss the key studies in the next section. Some studies such as Georgantas et al. (2023), Patel and Peralta-Alva (2025) and Tkačevs and Staehr (2026) consider aggregate primary balance shocks and so provide aggregate or average estimates of their effect on public debt, and a lot of them find that the effect of such shocks on public debt is relatively

[1] The rapidly changing framework of fiscal governance in the EU and the repeated suspensions and exemptions indicate the complexity of designing such frameworks, including the tension between rules being enforceable and some flexibility being allowed (Debrun and Jonung 2019).

small, while some even find that the effect is close to zero. This being so would mean that austerity policies in the form of a positive primary balance shock may be relatively ineffective or even self-defeating because of macroeconomic outcomes like lower GDP growth or lower inflation, or the ensuing fiscal reactions.

Other studies have examined the effectiveness of specific fiscal policy measures, typically distinguishing between measures targeting revenues and those targeting expenditures. Alesina et al. (2019) discuss the mechanisms behind possible differences and provide new empirical evidence. The result in most studies is that expenditure-based fiscal shocks have a much larger effect on the debt-to-GDP ratio than revenue-based measures (Alesina and Ardagna 1998, Alesina et al. 2019, Beetsma et al. 2021). Though this finding is common across most studies, the underlying drivers of these results are typically less well understood and may differ across time and country samples.

This paper contributes to the literature on the effects of fiscal policy shocks by offering novel ideas for identifying such shocks, and by investigating how they affect debt accumulation in the EU countries. We identify the fiscal policy shocks using the errors made in forecasts of fiscal variables; very few other studies use forecast errors to identify fiscal policy shocks. We orthogonalise the forecast errors to expunge the possible effects of forecast errors for various macroeconomic variables in order to arrive at shocks that reflect unexpected changes in fiscal policy.

The results of the empirical analysis are also novel. We use annual panel data from the EU countries and forecasts from the European Commission to compute the fiscal shocks.[2] The focus is on the effect of various fiscal shocks on the dynamics of public debt, while the majority of fiscal policy studies compute the effects on GDP growth or the labour market. This paper investigates the effects of shocks not only to the primary fiscal balance, but also to revenues and primary expenditures separately.

Governments do not set fiscal policy in a vacuum. Fiscal variables like revenue, expenditure and the budget balance reflect a combination of discretionary policy decisions and responses to evolving macroeconomic conditions. At any point in time, both policymakers and professional forecasters form expectations about these outcomes that they base on the information available to them, which can include past fiscal developments, GDP growth, inflation, and other macro variables. We define a fiscal shock as the component of fiscal outcomes that is not anticipated within this information set. This corresponds to the forecast error in fiscal variables once it has been purged of predictable

[2] A lot of studies use data from the USA or fairly heterogeneous panels. The EU countries are at broadly the same level of development and share governance and surveillance frameworks, including the Stability and Growth Pact.

variation using standard controls. These residuals capture unanticipated deviations from expected fiscal paths, which can arise from discretionary policy changes, last-minute political compromises, implementation surprises, or unforeseen developments that affect fiscal execution. In this sense the shocks identified represent innovations to fiscal policy outcomes, rather than responses to the macroeconomic environment.

Our study of the effects of fiscal shocks in the European Union reveals that austerity in the form of primary balance shocks reduces real GDP and the GDP deflator, while the effect on long-term interest rates is uncertain but likely to be modest. The primary balance in per cent of GDP improves markedly, though the effect wanes over time. The public debt in per cent of GDP declines only a very little in the short term, but the decline increases over time.

The effects of revenue and expenditure measures differ. A positive revenue shock has gradual and statistically insignificant effects on the debt stock, as the improvement in the primary balance is subdued and the macroeconomic situation deteriorates. Austerity in the form of a negative primary expenditure shock improves the primary balance and over time reduces the public debt as a percentage of GDP. The effects of the two austerity shocks are different not because of differences in macroeconomic performance but rather because of differences in the fiscal reactions, as positive revenue shocks are followed by higher expenditures, while negative expenditure shocks are not followed by lower revenues.

The rest of the paper is organised as follows. Section 2 provides a brief review of the literature on fiscal shocks and government debt, with a particular focus on differences between revenue and expenditure shocks. Section 3 discusses the data and the methodologies used. Section 4 presents the estimated effects of a primary balance shock on public debt and other fiscal and macroeconomic variables. Section 5 investigates the effects of austerity shocks in the form of positive revenue shocks and negative primary expenditure shocks. Section 6 shows the results of sensitivity and robustness analyses. Finally, Section 7 concludes.

2 Methodologies and empirical studies

The literature on the effects of fiscal policy shocks is extensive, but most studies focus on the effects on GDP, employment or unemployment, while fewer consider the impact on the dynamics of public debt. We here discuss briefly a number of the methodological choices in the literature and then present insights from studies on how public debt is affected by fiscal shocks including aggregate budget balance shocks and revenue and expenditure shocks.

2.1 Methodologies and empirical studies

The link from fiscal policy shocks to the dynamics of public debt is complex. This is easily seen from the debt accumulation equation (Cherif and Hasanov 2018):

$$d_t = \frac{1 + i_t}{(1 + \pi_t)(1 + g_t)} d_{t-1} + pb_t \tag{1}$$

The variable d_t denotes the debt stock as a share of GDP in period t. The variable i_t represents the nominal interest rate paid on government debt, π_t is the growth rate of the GDP deflator, and g_t is the real GDP growth rate. Finally, pb_t denotes the primary balance as a percentage of GDP. A fiscal policy measure affects interest rates, inflation, and economic growth. These variables, in turn, influence the evolution of the debt stock, with the magnitude of the effect depending on the initial level of debt. Equally important, the ultimate change in the primary balance will differ from that implied by the initial policy shock. This is because changes in the macroeconomic environment, as well as the fiscal responses they induce, will further affect the primary balance. The debt accumulation equation thus illustrates that fiscal policy measures influence public debt dynamics through multiple transmission channels.

Identifying the fiscal policy shocks is vital. Most studies use one of four approaches. i) Shocks can be identified in structural vector-autoregressive models (SVAR) using various theory assumptions (Blanchard and Perotti 2002, Mountford and Uhlig 2009). ii) Fiscal shocks can be extracted using narrative exploration with data sourced from historical records of fiscal policy measures or debates (Favero and Giavazzi 2012). iii) Some studies have sought to instrument the fiscal policy variables (Auerbach and Gorodnichenko 2012, Attinasi and Metelli 2017). iv) Fiscal shocks can under some assumptions be equated with the forecast errors of fiscal variables under certain assumptions (Auerbach and Gorodnichenko 2013, Cho and Rhee 2024).

Most studies seek to uncover the effects of fiscal shocks over time, and so they report impulse response functions. The impulse responses are typically derived in SVAR models. Since the 2000s however, local projection (LP) has increasingly been used to compute the dynamic responses to fiscal shocks because of its flexibility and ease of use. The LP methodology yields impulse responses that are identical to those of VARs in infinite samples or when the VAR has a sufficient number of lags. In short samples like ours, impulse responses from LPs have a smaller bias than those of VARs, at the expense of being less precisely estimated (Jordà 2005, Plagborg-Møller and Wolf 2021, Jordà and Taylor 2025).

2.2 Fiscal balance shocks

A number of studies consider aggregate fiscal balance shocks, typically primary balance shocks, and how they affect the path of public debt. Positive balance shocks indicate austerity measures being taken, while negative ones indicate expansionary policies. The studies typically find that the debt stock moves in the direction expected, but the timing and sizes of the moves are heterogeneous across studies.

Cherif and Hasanov (2018) run SVAR models on US data and find that the results are sensitive to the specification of the VAR model, the time sample, and the methods used to identify the primary balance shock. In most specifications the debt reacts notably to an austerity shock, but there are specifications where the debt ratio eventually returns to its pre-shock path, an outcome that the authors label as self-defeating austerity.

Georgantas et al. (2023) use a panel of 24 OECD countries with annual data running from 1990 to 2019. They use LPs to analyse the effects of fiscal consolidation, where the fiscal shock is the change in the cyclically adjusted primary balance as a percentage of potential GDP. They consider a positive fiscal shock of 1 per cent of GDP and find that it gradually reduces the public debt-to-GDP ratio by around 2 per cent of GDP after five years. There might be state dependences and non-linearities in the effects. Tkačevs and Staehr (2026) consider a sample of 11 euro area countries and find the effect on the debt-to-GDP ratio to be somewhat smaller though the dynamics are broadly similar. Di Serio (2024) uses a Bayesian Interacted Panel VAR model on data for the euro area countries and finds that an austerity shock leads to a durable reduction in debt of 1 to 1.5 per cent of GDP, though most of the adjustment occurs in the first year.

Some studies find that the effect on public debt is quite immediate but then fades relatively fast. Patel and Peralta-Alva (2025) estimate SVAR models on annual data for 1981–2019 for 17 advanced economies and use two different identification methods. They find that austerity or primary balance shocks of 1 per cent of GDP lower the ratio of public debt by less than 0.2 percentage point in the short term, and that the effect dies out within a year or two. Ando et al. (2025), who use data for a sample of advanced and emerging economies, also find that the average fiscal consolidation shocks have very small effects, though there is some state dependence.

2.3 Revenues and expenditures

Alesina and Perotti (1995) is an early study which concludes that the composition of the fiscal adjustments is of key importance for the outcomes. The key distinction is between revenue measures and expenditure measures. The study finds that fiscal expansions typically result from increases in government expenditure, particularly on transfer programmes, while contractions are typically due to tax increases.

Alesina et al. (2019) discuss why expenditure-based austerity policies may have different effects to tax-based policies.[3] The macroeconomic outcomes may be different because the two types of policy affect demand and supply differently, or because they have different effects on confidence and expectations. The outcomes may also differ because the persistence of the policies varies depending on whether they target revenues or expenditures.

A result found in most studies is that tax-based consolidations are more harmful for macroeconomic performance than expenditure-based plans are. This finding appears across various identification methods (e.g., Alesina and Ardagna 1998, Alesina and Ardagna 2010, Guajardo et al. 2014; Alesina et al. 2019, Beetsma et al. 2021), implying that the dynamics of growth and, ultimately, debt can vary depending on the composition of fiscal policy. Some studies using European data find that improved fiscal sustainability is associated with lower long-term yields, which can help reduce debt further when the primary balance improves (e.g., Ardagna et al. 2007, Ardagna 2009).

Attinasi and Metelli (2017) find that austerity increases the debt-to-GDP ratio in the short term whatever instrument is chosen. They use quarterly data for 11 euro area countries and estimate a small panel VAR model that uses sign restrictions to identify the shocks, including the assumption that tax rises lower GDP. Although austerity increases the debt-to-GDP ratio in the short term, the ratio declines markedly in the longer term if the austerity is based on government expenditures, while this is not the case if austerity is based on revenues.

Arguably contrary to the results above, House et al. (2020) find that austerity in the form of cuts in public expenditure had a substantial negative effect on GDP in 2010–2014, especially for the European crisis countries labelled GIIPS. The severe contractionary effect on economic activity caused debt-to-GDP ratios in several countries to increase.

[3] Glomm et al. (2018) provide a theoretical model that can be used to simulate the effects of various fiscal policy measures, and they find that the dynamics of output and debt differ even over very long horizons.

3 Data and methodology

3.1 Data

Our panel data are annual data sourced from AMECO, the official annual macro-economic database of the Directorate General for Economic and Financial Affairs of the European Commission. The database is updated twice a year following the publication of the official forecasts of the European Commission. It contains various macroeconomic and fiscal variables that are mainly sourced from Eurostat, though many of the variables also come from the official spring and autumn forecasts of the European Commission.[4]

The dataset covers all the countries that are or have been members of the European Union, but only for the years in which they are members of the Union. The panel dataset is unbalanced because the years of membership of the EU differ from country to country and because the availability of the data varies by series. We use the fiscal and macroeconomic forecasts of the European Commission to identify the fiscal shocks. The forecasts for the 15 West European countries that were members of the EU in 1995 are generally available from 2001 or 2002. For the countries that joined the EU starting in 2004, the forecasts are generally available from the year they joined. The data in all cases end in 2024.

A primary issue in defining forecast errors when using forecast data is whether to use the data that are currently available (current data) or the data that were available around the time the forecasts were made (real-time data). The main argument for basing forecast errors on real-time data is that calculating the errors from the currently available data might artificially inflate those errors and mean that definition changes are incorrectly attributed as shocks (Hall and Thapar 2023). This problem of data vintage is particularly acute in the European context, where fiscal data often undergo large ex-post revisions and reclassifications some years after the event. As Cimadomo (2016) notes, using revised current-vintage data can yield incorrect signs for fiscal reaction functions, as those data capture statistical redefinitions rather than the genuine economic information that was available to policymakers at the time. To address this measurement error and ensure that the shocks we identify reflect genuine economic surprises rather than accounting updates, we use real-time data to calculate the forecast errors.

[4]The forecasts are also published under the title *European Economic Forecast* in the Institutional Papers series of the European Commission. The Spring 2025 forecast is available at: https://economy-finance.ec.europa.eu/publications/european-economic-forecast-spring-2025_en

Table A.1 in Appendix A provides details on the definitions of the various variables. The macroeconomic variables are real GDP, the GDP deflator, and the 10-year interest rate in per cent per year, where the 10-year interest rate is the yield on government debt with a residual maturity of around 10 years. For the orthogonalisation, we also use the growth rate of GDP, computed as the log difference of real GDP, and the growth rate of the GDP deflator, computed as the log difference of the GDP deflator and casually referred to as GDP inflation. Both real GDP growth and GDP inflation are expressed in per cent per year.

The fiscal variables are the stock of public debt, the implicit interest rate paid on government debt, and various variables for fiscal flows. The debt variable is the stock of public debt at the end of the year, in per cent of GDP. The implicit interest is the average interest rate paid on government debt during the year, and it is computed as the interest payments during the year in per cent of the debt stock at the end of the preceding year. The fiscal flow variables are the primary budget balance, total revenues, and primary expenditure, all in per cent of GDP. All flow variables are in per cent of GDP.

Our baseline estimations use the European Commission forecasts published in the *autumn before the year* covered by the forecast. This means for instance that the forecasts for 2024 are taken from the autumn 2023 forecast of the European Commission. Some robustness analyses also use the spring forecasts.

3.2 Methodologies

We consider how various fiscal policy shocks affect the six macroeconomic and fiscal variables discussed above, i.e. GDP, the GDP deflator, the 10-year interest rate, government debt, the primary balance, and the implicit interest rate. We produce impulse response functions using the local projections methodology developed in Jordà (2005). The methodology has been widely used in analysing macroeconomic dynamics, as it produces the same impulse responses as SVAR models (Montiel Olea and Plagborg-Møller 2021, Jordà and Taylor 2025). The single-regression techniques are straightforward to implement and more robust to potential misspecification than SVAR models (Jordà 2005, Plagborg-Møller and Wolf 2021). The main challenge is that LP estimations need the structural shocks to be identified outside the model.

3.2.1 Identification of fiscal shocks

The LP methodology requires us to use information from outside the LP specification. Our strategy uses fiscal shocks or fiscal surprises that are computed as the difference between the realised fiscal outcome and the forecast or expectation in the previous year. Any information that was available in the previous year will have been built into the forecast, so the forecast error, or the difference between the forecast and the realisation, represents unexpected developments, i.e. a fiscal shock.[5] Auerbach and Gorodnichenko (2013), Fukunaga et al. (2022) and Beirne and Renzhi (2024) similarly use forecast errors to identify economic shocks. However, we advance the methodology by orthogonalising the fiscal forecast error by removing the part of the forecast errors that can be attributed to macroeconomic developments that were forecast, so that the resulting fiscal forecast errors pruned for macroeconomic forecasts can be attributed to unexpected fiscal policy measures.

The starting point is the European Commission forecast of the various fiscal or macroeconomic variables that we consider. The variable in year t for country i is called by $X_{i,t}$, and the Commission forecast made in the autumn of the previous year is $X^F_{i,t}$. The forecast error $X^{FE}_{i,t}$ is then found as:

$$X^{FE}_{i,t} = X_{i,t} - X^F_{i,t} \tag{2}$$

The variable $X^{FE}_{i,t}$ is the forecast error and may be seen as a surprise or shock that can be treated as exogeneous in local projection estimations (Auerbach and Gorodnichenko 2013, Beirne and Renzhi 2024). The challenge here, however, is that this surprise may be associated with other forecast surprises that directly or indirectly affect the dependent variable in the local projection estimations. This is a particular concern in this case, as we express the fiscal variables in per cent of GDP.

An example may be useful. Suppose that the forecast error of the primary balance for country i in year t is positive and substantial. This positive forecast error may have been caused by discretionary tightening and so represent a primary balance shock, but it could also have come from economic developments being unexpectedly positive and causing GDP growth or GDP inflation to be higher than forecast. If that is the case, then the positive forecast error of the primary balance could partly

[5] It is important to identify a shock that is not only exogenous to the state of the economy but is also unanticipated (Ramey and Zubairy 2018). The identification strategy based on forecast errors resolves in part the well-known issues of fiscal foresight. While unanticipated tax cuts have expansionary effects on output for example, phased-in tax cuts depress output during the phase-in period because firms and consumers delay their activity until the tax rates are lower (Ramey 2019). Shocks based on forecast errors explicitly use the public information set at $t-1$ and so help guard against fiscal foresight where agents anticipate policy before the observed aggregates are affected, which would otherwise induce biases.

be ascribed to the large positive forecast errors for GDP growth or GDP inflation.

We seek to isolate or identify fiscal policy shocks, which are the fiscal forecast errors that cannot be predicted by forecast errors for GDP growth and GDP inflation and other available fiscal and macroeconomic variables. We do this by running panel data estimations where we regress the forecast error of the fiscal variable being considered on the forecast errors for GDP growth and GDP inflation. Comparable approaches have previously been used by An and Jalles (2021), Cronin and McQuinn (2023), Cronin and McInerney (2023) and others to evaluate the performance of fiscal forecasts and disentangle the course of fiscal forecast errors.

The dependent variable, i.e. the forecast error for the fiscal variable $G_{i,t}^{FE}$, is regressed on the lagged dependent variable ($G_{i,t-1}^{FE}$), the forecast errors for GDP growth ($y_{i,t}^{FE}$) and GDP inflation ($\pi_{i,t}^{FE}$), as well as lagged GDP growth ($y_{i,t-1}$) and lagged GDP inflation ($\pi_{i,t-1}$), a constant (α_0), and country fixed effects (μ_i). The parameters α_0–α_5 are estimated. The residual is labelled $\varepsilon_{i,t}^{G}$ and represents the fiscal shock, i.e. the part of the forecast error of the fiscal variable that cannot be explained by the variables in the model.

$$G_{i,t}^{FE} = \alpha_0 + \alpha_1 G_{i,t-1}^{FE} + \alpha_2 y_{i,t}^{FE} + \alpha_3 \pi_{i,t}^{FE} + \alpha_4 y_{i,t-1} + \alpha_5 \pi_{i,t-1} + \mu_i + \varepsilon_{i,t}^{G} \tag{3}$$

The lagged dependent variable is included because preliminary estimations revealed that there is typically some positive persistence in the forecast errors so that a positive forecast error is followed by another one the following year even when there are multiple control variables. The forecast errors for GDP growth and GDP inflation are included because the forecasts for the fiscal variable in per cent of GDP may be shaped by the forecasts for these two variables. Lagged GDP growth and lagged inflation are included to mop up possible persistence effects. The fixed effects account for errors in the forecasts that are country-specific but time-invariant.

We estimate Equation 3 for each of the fiscal forecast errors used in the analysis and use the residuals $\epsilon_{i,t}^{G}$ as our preferred measure of fiscal shocks. We estimate Equation 3 using panel ordinary least squares with country fixed effects. The panel specification includes the lagged dependent variable, so there is a risk that the coefficients of the lagged dependent variable and the other covariates will be affected by the Nickell bias (Nickell 1981). However, this problem is probably minor given that the time dimension of the panel is relatively large. Bun and Kiviet (2001) and Judson and Owen (1999) find that in this kind of macroeconomic panel, the fixed effect estimator generally performs as well as or better than the GMM estimators, which are typically very sensitive to the instrument specification.

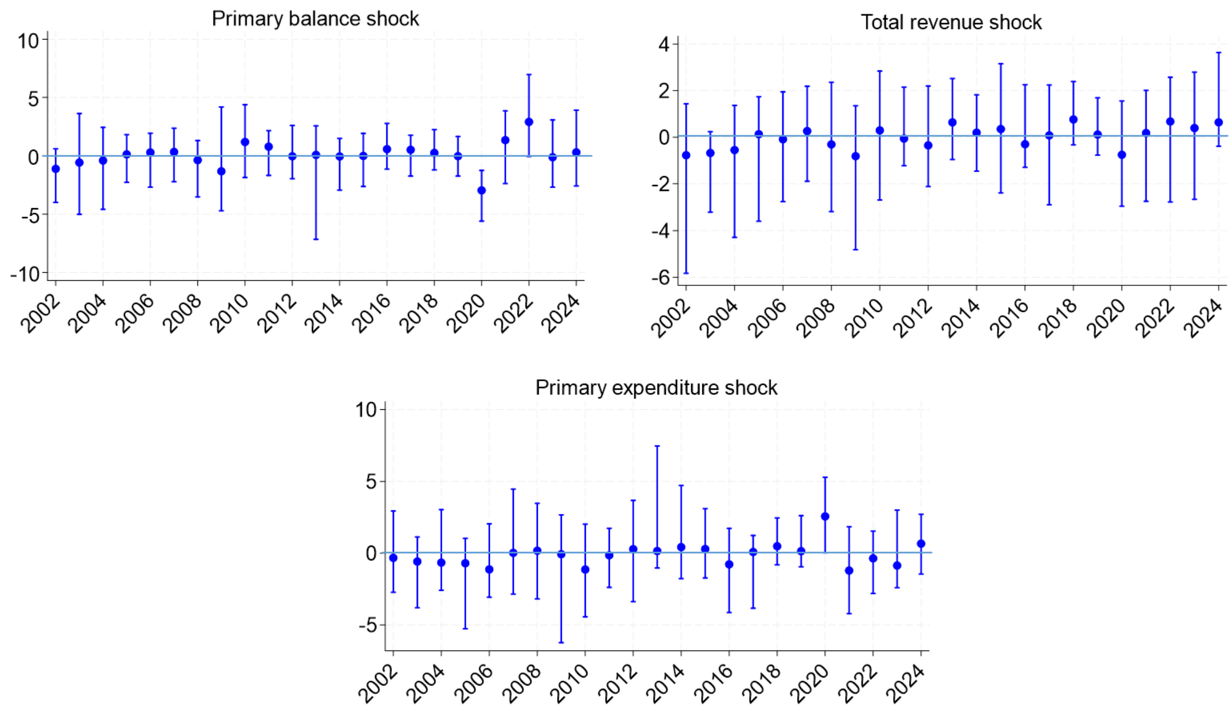
Table B.1 in Appendix B provides the baseline fixed effects estimations for the forecast errors of the primary balance, total revenues and primary expenditures. There is noticeable persistence in the forecast errors, as the estimates of the lagged dependent variable are statistically significant for all of the fiscal variables considered. Interestingly, the forecast errors for the macroeconomic variables GDP growth and GDP inflation only appear to be important for the forecast errors of the primary balance and primary expenditures, but not for the errors of total revenue. The estimated coefficients of lagged GDP growth and lagged GDP inflation are small and mostly statistically insignificant.

The fiscal shocks, or the orthogonalised forecast errors, are the residuals $\epsilon_{i,t}^{G}$ in Equation 3, and these are used as regressors in local projections that seek to determine the causal effect of fiscal policy shocks on macroeconomic and fiscal outcomes. Figure 1 shows the median and the 5th and 95th percentiles of the orthogonalised forecast errors computed over the panel of 28 EU countries for all the fiscal variables considered, i.e. the primary balance, total revenues, and primary expenditures.

The median for the primary balance shock hovers around 0 except in 2009 during the global financial crisis and in 2020 at the start of the Covid pandemic. There is substantial variation in the 5th and 95th percentiles over the 23 years considered, particularly during the two global crises but also during the years of the European debt crisis, when 2013 stands out. For the total revenue shock, the median and the 5th and 95th percentiles of the orthogonalised forecast errors exhibit substantial variation over time. The median is negative in the early 2000s after the introduction of the euro, in the aftermath of the global financial crisis and again in 2020 as the Covid pandemic hit the EU countries. The median for the primary expenditure shock is around 0 except during the Covid pandemic, while the 5th and 95th percentiles vary more over time.

The substantial variation in the various fiscal policy shocks or orthogonalised forecast errors over time and across the EU countries suggests that including these shocks in local projections may provide valuable insights. Crucially, while there is a great deal of variability over time, our baseline local projection specification (Equation 4) includes time fixed effects to absorb the common component of these global shocks. Furthermore, the sensitivity and robustness analysis in Section 6 demonstrates that explicitly cleaning the shocks of this common volatility by adding time fixed effects to Equation 3 yields results that are qualitatively identical. The sensitivity and robustness

Figure 1: Orthogonalised forecast errors as fiscal shocks, % of GDP



Note: The figures show the median and the 5th and 95th percentiles of the various fiscal shocks or orthogonalised forecast errors over the 28 EU countries in the sample.

analysis in Section 6 discusses the consequences of using various alternative identification schemes for the fiscal shocks, including changes to the specification in Equation 3 and changes to the estimation methodology.

3.2.2 Local projection

The orthogonalised fiscal shocks found from Equation 3 above are used in the local projection estimations to find the resulting dynamics of various macroeconomic and fiscal variables (Jordà and Taylor 2016, Jordà and Taylor 2025). We estimate the following specification:

$$W_{i,t+h} - W_{i,t-1} = \theta_h \varepsilon^G_{i,t} + \gamma_h \Delta W_{i,t-1} + \delta_h \Delta G_{i,t-1} + \rho_h y_{i,t-1} + \varphi_h \pi_{i,t-i} + u_{i,h} + \tau_{t+h} + \omega_{i,t+h} \quad (4)$$

The index h indicates the forecast horizon, and so $h = 0$ indicates the impact year in which the fiscal shock takes place, while $h > 0$ indicates the following years. The variable $W_{i,t}$ is the dependent variable and so $W_{i,t+h} - W_{i,t-1}$ is the "long difference", which depicts the difference between the dependent variable in the year before the shock and the dependent variable after h years. The term

$\epsilon_{i,t}^{G}$ is the fiscal shock found from Equation 3. We include a number of control variables to reduce the risk of omitted variables bias: $\Delta W_{i,t-1}$ is the lagged first difference of the dependent variable, $\Delta G_{i,t-1}$ is the lagged first difference of the fiscal variable used to construct the shock, $\epsilon_{i,t}^{G}$, $y_{i,t-1}$ is lagged GDP growth, $\pi_{i,t-i}$ is lagged GDP inflation, $u_{i,h}$ is the country fixed effect, and τ_{t+h} is the time fixed effect. Finally, $\omega_{i,t+h}$ is the error term of the panel data regression. We multiply the expenditure shocks by -1 before running the LP equation, so that both revenue and expenditure shocks correspond to fiscal tightening or austerity, as this makes the estimated impulse responses more comparable.

In principle, any variable can be used as a dependent variable. In the baseline specifications, the dependent variables are the logarithm of real GDP, the logarithm of the GDP deflator, the 10-year interest rate, the primary balance in per cent of GDP, the implicit interest rate on government debt, and public debt in per cent of GDP. Further specifications run the LP estimations for revenues and expenditures separately.

With small sample sizes, the high degree of persistence in most macroeconomic data means that the impulse responses estimated by LPs can be severely biased. The long difference specification works to reduce this small-sample bias substantially across horizons. Estimating in long differences reduces persistence in the regressors and effectively suppresses the problematic covariance term, and so the bias is almost washed out at all horizons when the process is stationary (Jordà and Taylor 2025). This mitigation disappears in the unit root case, but there is still improved bias performance from the long-differenced specification, as it correctly enforces the restrictions imposed by the integration properties of the DGP (Piger and Stockwell 2025). Given the persistence of fiscal and debt variables and the unit-root-like behaviour of public debt, long-difference LPs reduce finite-sample bias and give better coverage than LPs for levels. These considerations are particularly relevant for our application, which motivates our choice of long-difference LPs.

The impulse responses for each of the dependent variables are then the coefficients $\{\theta_h\}_{h=0}^{H}$ that are recouped from estimations of Equation 4, where the forecast horizon h is varied from year 0, the year of the shock, to a maximum of H, which we take to be year 4. The confidence interval is constructed using the estimated standard errors of its impulse responses for $\{\theta_h\}_{h=0}^{H}$. We use robust Driscoll and Kraay (1998) standard errors to correct for potential heteroskedasticity, autocorrelation in the lags, and cross-sectional dependence across panels. The Driscoll-Kraay standard errors are relatively large because the shocks are correlated across countries and the regressions include both country and time fixed effects.

A final consideration given that we are using the residual from Equation 3 as a regressor is that there may be a generated regressor issue (Pagan 1984). Ignoring the sampling uncertainty of the first step means that the standard errors estimated in the LP specification in Equation 4 might be inaccurate and possibly biased. In Section 6 we run a two-step bootstrap procedure as a robustness check in order to to account explicitly for the generated-regressor issue. Given that the data have a panel structure and there is within-country dependence, we use a cluster bootstrap at the country level. We resample countries with replacement in each replication, and re-estimate both the shock-identification equation and the local projection regressions. We perform 999 bootstrap replications. This approach preserves the within-country dependence structure and is standard in settings with clustered data (Cameron et al. 2008, Cameron and Miller 2015).

4 Primary balance shocks

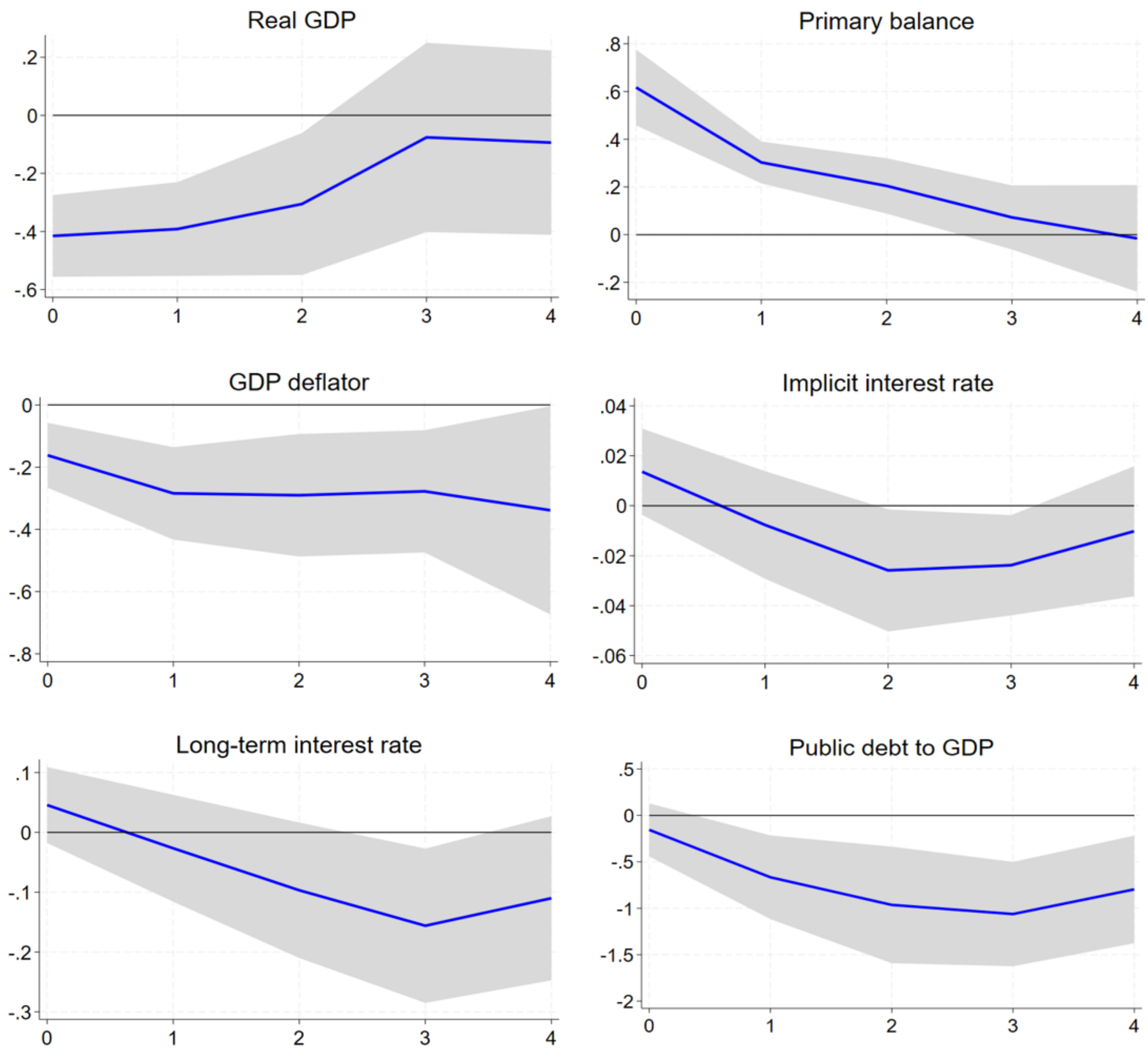
We start the empirical analysis by considering the effects of an austerity shock modelled as a positive primary balance shock, where the shock is orthogonalised or "pruned" as discussed in Section 3. The resulting impulse response functions (IRFs) are shown in Figure 2.

The IRF for real GDP depicts the logarithm of real GDP multiplied by 100, and thus shows the deviation of real GDP from its level before the shock in per cent. Real GDP declines by around 0.4 percentage point relative to that pre-shock level on impact and in the next two years, but recovers over time, so the effect of the austerity shock vanishes over time. The contractionary effects of austerity that we find for the panel of EU countries are close to those found in Leigh et al. (2010), who report that a fiscal consolidation of 1 per cent of GDP reduces GDP by 0.43 per cent. Our results are also in line with those in Diniz (2018) and Banerjee and Zampolli (2019). Tkačevs and Staehr (2026) consider 11 euro area countries and also find an initial negative response from GDP followed by a subsequent recovery.[6]

The IRF for the GDP deflator shows the deviation of the deflator from the baseline in per cent. The deflator declines following the decline in real GDP, which is consistent with a Phillips curve relationship between economic activity and inflation. The deflationary effects of contractionary fiscal shocks are also reported in other studies (Ben Zeev and Pappa 2017, Ferrara et al. 2021),

[6] Some studies find that fiscal consolidations can have expansionary effects on economic activity in the short term and thus lead to "expansionary fiscal contractions" (Alesina and Perotti 1995, Alesina and Ardagna 1998, Alesina and Ardagna 2010). Our results do not support this proposition.

Figure 2: Impulse responses to a primary balance shock of 1% of GDP



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

though some studies find more muted effects (Mountford and Uhlig 2009, d'Alessandro et al. 2019, Jørgensen and Ravn 2022).

The effect of the primary balance shock on the long-term interest rate is a very small and statistically insignificant increase on impact.[7] The interest rate declines from the first year after the shock, and the decline reaches about 0.15 percentage point and attains statistical significance in the third year, which may reflect confidence effects in financial markets and the decline in economic activity. Leigh et al. (2010) find that government bond yields decline by about 14 basis points after two years in response to a fiscal consolidation of 1 per cent of GDP, and this result is very close to our result.[8]

The response of the implicit interest rate shows the changes in the financing costs of the existing government debt stock. The implicit interest rate declines from the first year after the austerity shock, but the effect is very small and reaches a maximum of around 0.02 percentage point in the second and third years after the shock. The modest decline is consistent with the moderate effect on the long-term interest rate and the slow rollover of government debt in the EU countries.

The austerity shock improves the primary balance by around 0.6 percentage point of GDP on impact. The effect on the budget balance on impact being less than one-to-one reflects general equilibrium effects, as the declines in real GDP and the GDP deflator cause the fiscal balance to deteriorate (Plödt and Reicher 2015, Staehr et al. 2024). There is some persistence in the effect on the primary balance, as the improvement is around 0.3 percentage point in the first year after the shock and 0.2 percentage point in the second year. The effects are small and statistically insignificant from the third year.

The austerity shock and the associated effects on the macroeconomic and fiscal variables lead the public debt-to-GDP ratio to decline until the third year after the shock. The reduction is relatively modest at around 0.2 percentage point on impact, which is explained partly by the resulting improvement in the primary balance being only 0.6 percentage point of GDP, but also by real GDP and the GDP deflator declining. The maximum decline of around 1 percentage point in the stock of debt appears in the third year after the austerity shock, then the public debt ratio declines further by around 0.8 percentage point in the fourth year.

The key finding is that austerity shocks lead to a substantial decline in the public debt-to-GDP

[7] Banerjee and Zampolli (2019) similarly find a small increase in the 10-year bond yield on impact after an austerity shock.

[8] Broadly in line with our results, the findings of Dai and Philippon (2005) and Ardagna et al. (2007) are that the effect on long-term interest rates is muted in the short term, but larger in the longer term.

ratio, but the decline is gradual and is at its largest in the third year. These same dynamics are also found by Georgantas et al. (2023) even though the two studies use very different identification methods. The results are also related to those in Tkačevs and Staehr (2026), who find a gradual decline in the public debt ratio after an austerity shock. Both these studies, however, find the effect on the debt stock to be larger than we do. The results are also broadly in line with those in Cherif and Hasanov (2018) and Di Serio (2024), though the decline in debt in these studies happens earlier than in ours.

5 Revenue and expenditure shocks

The previous section showed that primary balance shocks lead to a substantial decline in the public debt-to-GDP ratio, but that the decline is gradual and plateaus in the third year. We now consider the components of the primary balance shock and how they affect public debt and other variables. Subsection 5.1 considers total revenue shocks, Subsection 5.2 considers primary expenditure shocks, and Subsection 5.3 discusses and compares the results. We estimate IRFs for each shock using the same specification and horizon, which lets us assess which measures drive the aggregate responses and whether their effects differ in their timing or magnitude.

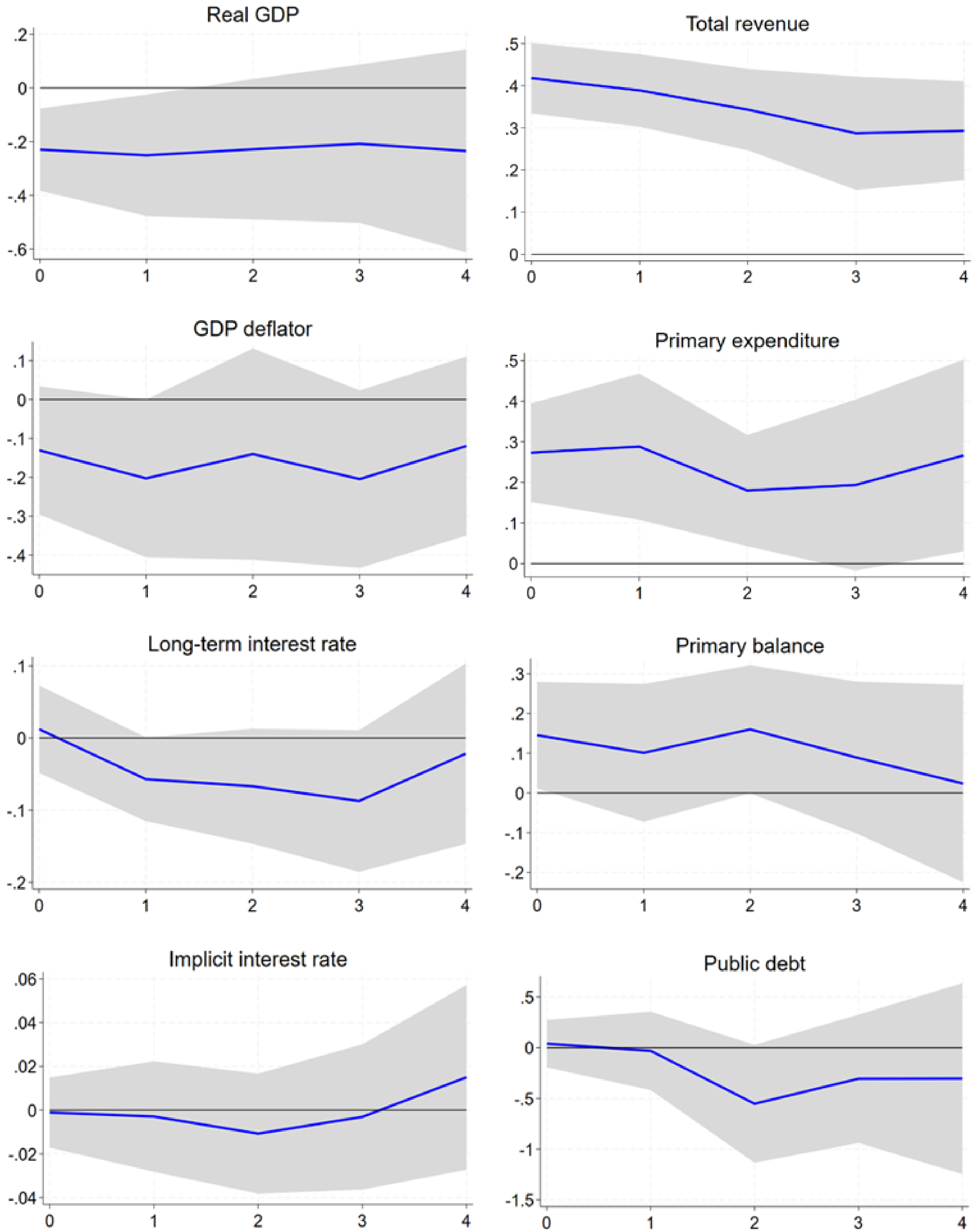
5.1 Revenue shocks

Figure 3 shows the IRFs of an aggregate revenue shock equal to 1 per cent of GDP. We find that GDP declines by marginally more than 0.2 per cent on impact and that the decline remains broadly at that level for the rest of the forecast horizon, though the effect is statistically insignificant beyond the impact year and the first year. Other studies have also shown that revenue-based austerity is contractionary, though the size of the effect differs across studies (Leigh et al. 2010, Alesina and Ardagna 2013).

The GDP deflator declines after the revenue shock, which is consistent with inflation being held down by fiscal tightening and the negative output gap. The point estimate is fairly stable at around 0.10 – 0.20 percentage point, but is imprecisely estimated throughout the forecast horizon.

The long-term interest rate is broadly unchanged on impact, but then declines by 5 to 10 basis points from the first year to the third. The implicit interest rate is negative except in the fourth year, but the effects are marginal and statistically insignificant, which suggests that the average

Figure 3: Impulse responses to a revenue shock of 1% of GDP



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

interest costs of outstanding debt change very little after a revenue shock.

A revenue shock of 1 per cent of GDP only increases total revenues by around 0.4 per cent of GDP on impact and by slightly less in the following years. GDP and prices being lower helps explain why the effect on total revenues is relatively small. Interestingly, the effect on expenditures is substantial at slightly below 0.3 per cent of GDP on impact and less in the following years. The dynamics of total revenues and primary expenditures help explain why the effect on the primary fiscal balance is relatively small. The primary balance improves by around 0.15 percentage point of GDP on impact and by less in the following years, but the effects are imprecisely estimated.

The public debt ratio does not change on impact or in the following year, but it declines by 0.5 percentage point in the second year and by less in the following years. The effect on the public debt-to-GDP ratio being delayed, relatively small and imprecisely estimated is consistent with the effects on the primary balance and the implicit interest rate being modest. The resulting debt dynamics support the view that relying on higher taxes tends to produce small or imprecisely estimated reductions in the debt-to-GDP ratio, especially in the short to medium term. Attinasi and Metelli (2017) and Beetsma et al. (2021) are among other studies which find that revenue-led consolidations have no effect or only modest ones on the public debt-to-GDP ratio.

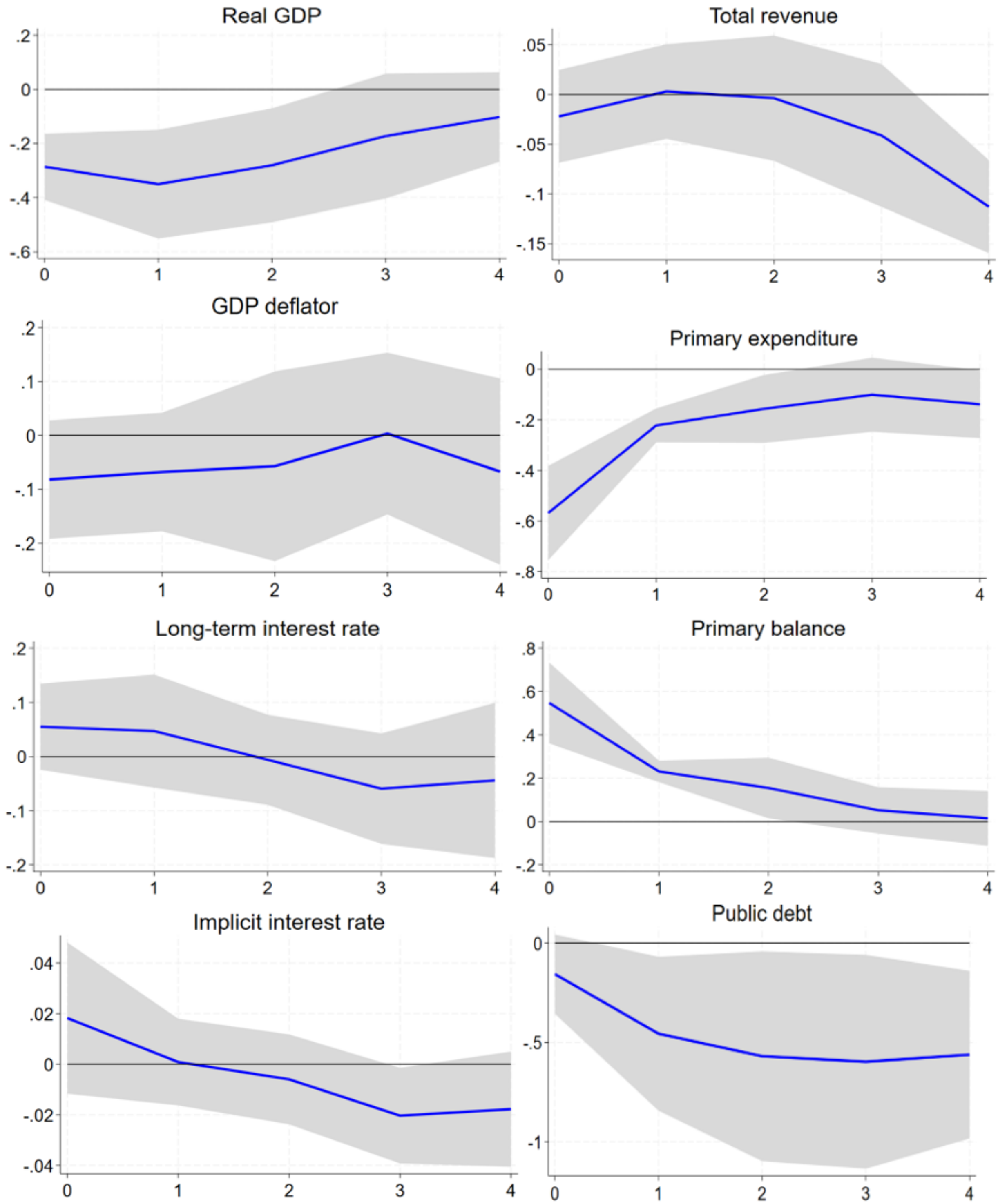
5.2 Primary expenditure shocks

We compute a primary expenditure shock as the forecast error for total spending net of interest payments and orthogonalised as discussed in Section 3. To make the shock represent austerity, we multiply the residual by -1 so that a positive value corresponds to an unanticipated reduction in primary expenditure. The resulting impulse responses are reported in Figure 4.

The negative expenditure shock leads to a decline in real GDP of around 0.3 per cent on impact and somewhat less in the following years. The decline is statistically significant in the first part of the forecast horizon. It is noticeable that the declines in GDP after the revenue shock and the negative expenditure shock are fairly similar at around 0.2 per cent throughout the forecast horizon; cf. the IRFs in Figure 3 and Figure 4.

The GDP deflator also declines in the first years of the forecast horizon, and the magnitudes are again comparable with those found for the revenue shocks. The IRFs for the long-term interest rate and the implicit interest rate reveal small and imprecisely estimated effects, suggesting again that the effect of revenue and expenditure shocks on interest rates is modest and fairly similar across

Figure 4: Impulse responses to a negative primary spending shock of 1% of GDP



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

the two fiscal shocks.

The negative expenditure shock has no discernible effect on total revenues in the first years of the forecast horizon, though there is a relatively small but still statistically significant decline in the fourth year. The negative effect on primary expenditure is large on impact at around 0.6 percentage point, but the negative effect diminishes over time. The effect on the primary balance reflects the developments of total revenues and primary expenditure. The primary balance improves by slightly less than 0.6 percentage point on impact, but only slightly above 0.2 percentage point in the first year and even less in the following years.

The negative primary expenditure shock reduces the public debt-to-GDP ratio, but the effect is initially small at around 0.2 percentage point. This outcome is the result of two counteracting effects, as the improved primary balance brings the debt ratio down, but lower GDP and a lower GDP deflator push it up through the denominator effect; the ratio of existing nominal debt to nominal GDP increases as nominal GDP declines ceteris paribus.

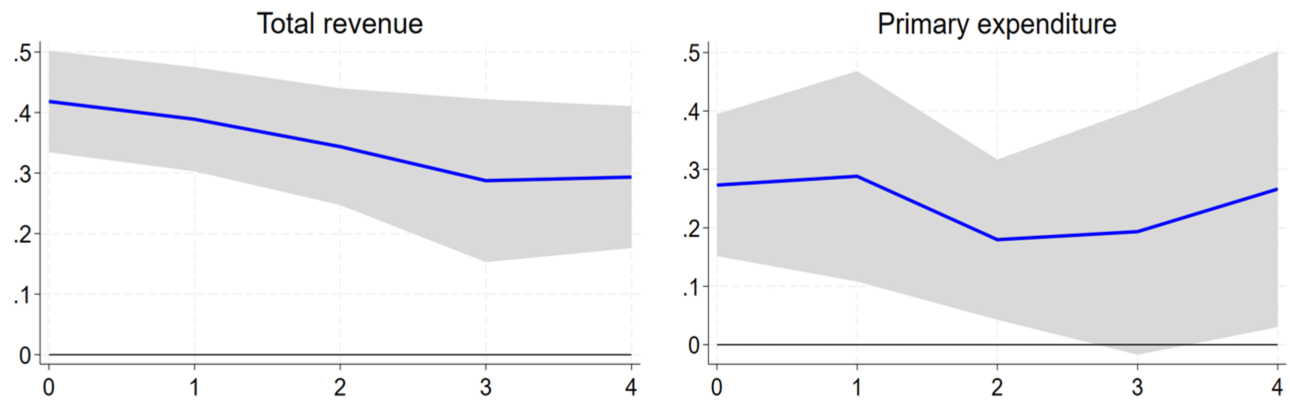
The decline in the public debt-to-GDP ratio increases over time and reaches 0.5 percentage point in the first year after the shock and slightly more in the following years. The debt ratio continues to decline to some extent because of the positive effect on the primary balance, but also because of the denominator effect as the initial declines in real GDP and the GDP deflator are reversed.

5.3 Comparing revenue and expenditure shocks

We found in our panel of EU countries that fiscal austerity in the form of positive revenue shocks has a small and statistically insignificant effect on the public debt-to-GDP ratio, while negative expenditure shocks have a noticeable, though somewhat sluggish, effect on the debt ratio. Studies such as Alesina and Ardagna (2010), Alesina et al. (2019) and Beetsma et al. (2021) have similarly found that the debt-to-GDP ratio reacts differently to tax-based and spending-based consolidations.

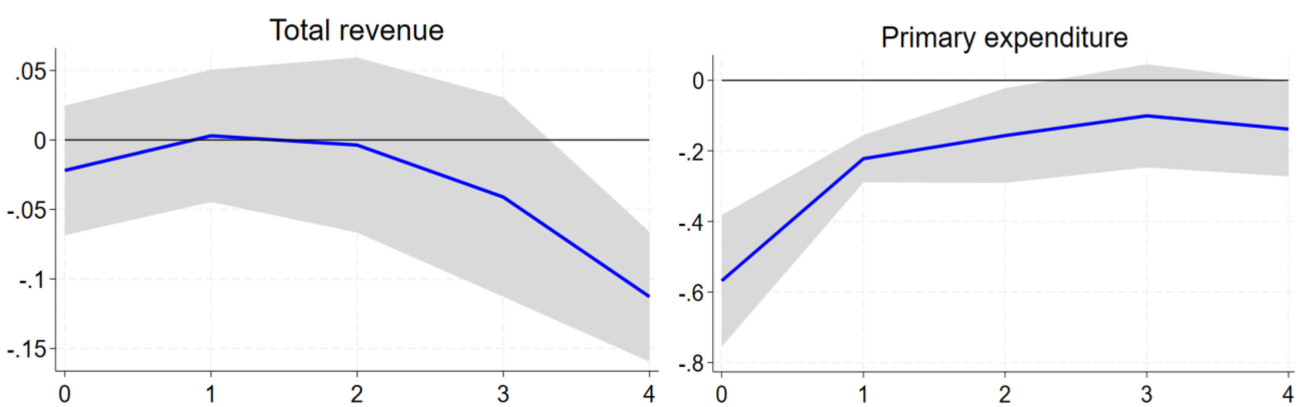
This subsection discusses these differences further, as the different effects do not stem from differences in the macroeconomic effects of the austerity shocks. Figures 3 and 4 illustrate that the impulse responses for GDP, the GDP deflator and the long-term interest rate are broadly similar for the two shocks, meaning that the different debt paths do not stem from different macroeconomic developments in our study, unlikely the hypothesis in Alesina et al. (2019). The differences in the debt dynamics can instead be ascribed to government revenues and expenditure reacting differently as shown in Figures 5 and 6, which duplicate the IRFs from Figures 3 and 4, respectively.

Figure 5: Revenue and primary spending IRFs to a revenue shock of 1% of GDP



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Figure 6: Revenue and primary spending IRFs to a negative primary spending shock of 1% of GDP



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Figure 5 shows the impulse responses of total revenue and primary expenditure after a revenue shock of 1 per cent of GDP. Revenues increase initially by 0.4 percentage point and over time by around 0.3 percentage point. It is noticeable that the revenue shock is followed by an increase in primary expenditure of around 0.3 percentage point of GDP in the first year and slightly less in the following years. The increase in total revenues is consequently partly offset by higher spending, which means that the resulting increase in the primary balance is small and eventually the debt-to-GDP ratio declines a very little. The counteracting reaction of primary expenditure to a total revenue shock may arise because the additional revenues provide the fiscal space for additional expenditure.

Expenditure cuts are effective at improving budgetary aggregates. Figure 6 shows that a negative primary expenditure shock reduces primary expenditure by approximately 0.6 percentage point on impact and somewhat less in the following year. Importantly, the negative primary spending shock has no discernible effect on total revenues in per cent of GDP except in the fourth year after the shock. The upshot is that the primary balance in per cent of GDP improves substantially on impact and by less in the following years, and so the debt-to-GDP ratio improves.

In conclusion, our estimations suggest that austerity is more effective at improving the fiscal balance and reducing public debt relative to GDP when it is in the form of a negative expenditure shock rather than a positive revenue shock. The main difference comes from the different fiscal reactions to the different shocks; we do not find any noticeable differences between the macroeconomic effects of the two different shocks.

The literature on public choice uses the term 'tax-and-spend' to indicate that higher tax revenues are followed by higher expenditures, while 'spend-and-tax' means that higher expenditures are followed by higher tax revenues. Von Furstenberg et al. (1986) and Payne (1998) investigate the two hypotheses using data for the USA, while Afonso and Rault (2009) use data from a number of European countries. The impulse responses in Figures 5 and 6 suggest that the EU countries in the panel have had a tax-and-spend reaction, which has limited the effect of revenue shocks on public debt, while there has been a very limited spend-and-tax reaction, so that expenditure shocks have had a substantial effect on public debt.

It is useful to emphasise key provisos concerning these results. The results are obtained on a sample of 28 EU countries over the years 2001 to 2024. The results reflect the average development of the countries in this time sample, and so the findings cannot be used to predict future developments.

Moreover, imposing a positive revenue shock allows expenditures to react and correspondingly, imposing a negative expenditure shock allows revenues to react. We believe that allowing and incorporating such fiscal reactions gives us IRFs that provide a reasonable description of the fiscal outcomes that are realised. An alternative might have been to compute IRFs for the revenue shock with expenditures remaining constant, and likewise to compute IRFs for expenditure shocks with revenues remaining unchanged.

6 Sensitivity and robustness

This section examines how robust the main empirical findings are to alternative identification schemes, estimation samples, and estimation specifications. The sensitivity checks illustrated in the figures below and in Appendix C confirm that the baseline results are reasonably robust to a wide range of modifications.

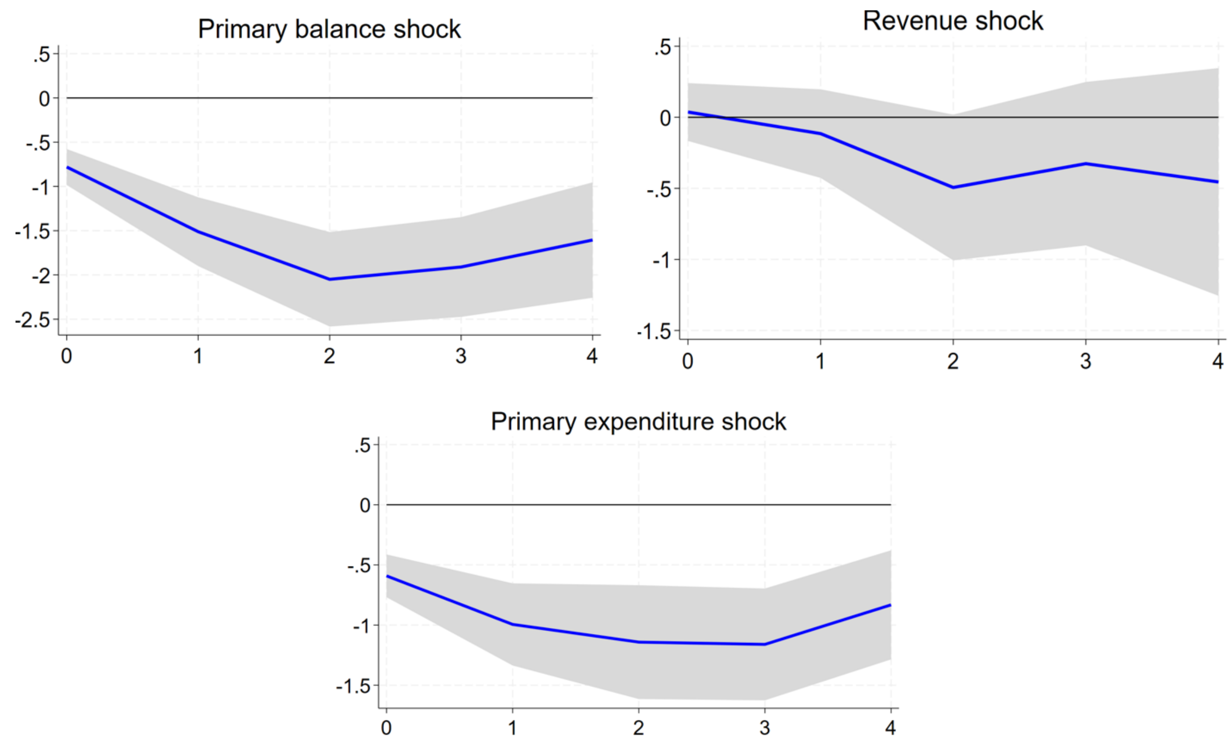
Taken together, the sensitivity exercises confirm the robustness of the main empirical results. The qualitative patterns of the impulse responses remain stable across all the identification schemes, country samples, and forecast vintages. Fiscal consolidation in the form of improvements in the primary balance made through expenditure cuts consistently generates gradual and statistically significant declines in the public-debt-to-GDP ratio, whereas revenue-based consolidation has weak and imprecisely estimated effects.

6.1 Identification of shocks

A key challenge in fiscal policy studies is identifying fiscal shocks. We use, like a few other studies, forecast errors for the fiscal variables that are computed as the realisation minus the forecast. A novel feature of our study is that we remove the effects from the fiscal forecast errors that arise from errors in the forecasts of key macroeconomic variables; see Subsection 3.2. The true fiscal shock is an unobservable variable and as such there will be some doubt about any identification scheme. This subsection presents analysis that sheds light on the properties of the fiscal shocks identified using our two-stage identification methodology.

Figure 7 shows the effect on the public debt-to-GDP ratio when the raw forecast errors for the primary balance, total revenues, and primary expenditure are used without orthogonalisation, meaning that Equation 3 is omitted. The public debt relative to GDP declines more in response to primary balance shocks and expenditure shocks when the shocks are not orthogonalised; compare Figure 7 with the responses of public debt in Figures 2–4. This would be consistent with the raw forecast errors containing information on the dynamics of macroeconomic and fiscal variables, including the forecast errors for the macroeconomic variables.[9] The responses of the debt-to-GDP ratio to the "raw" revenue shocks are generally small and statistically insignificant, as is the case for the orthogonalised revenue shocks.

Figure 7: Public debt impulse responses using the forecast errors without orthogonalisation

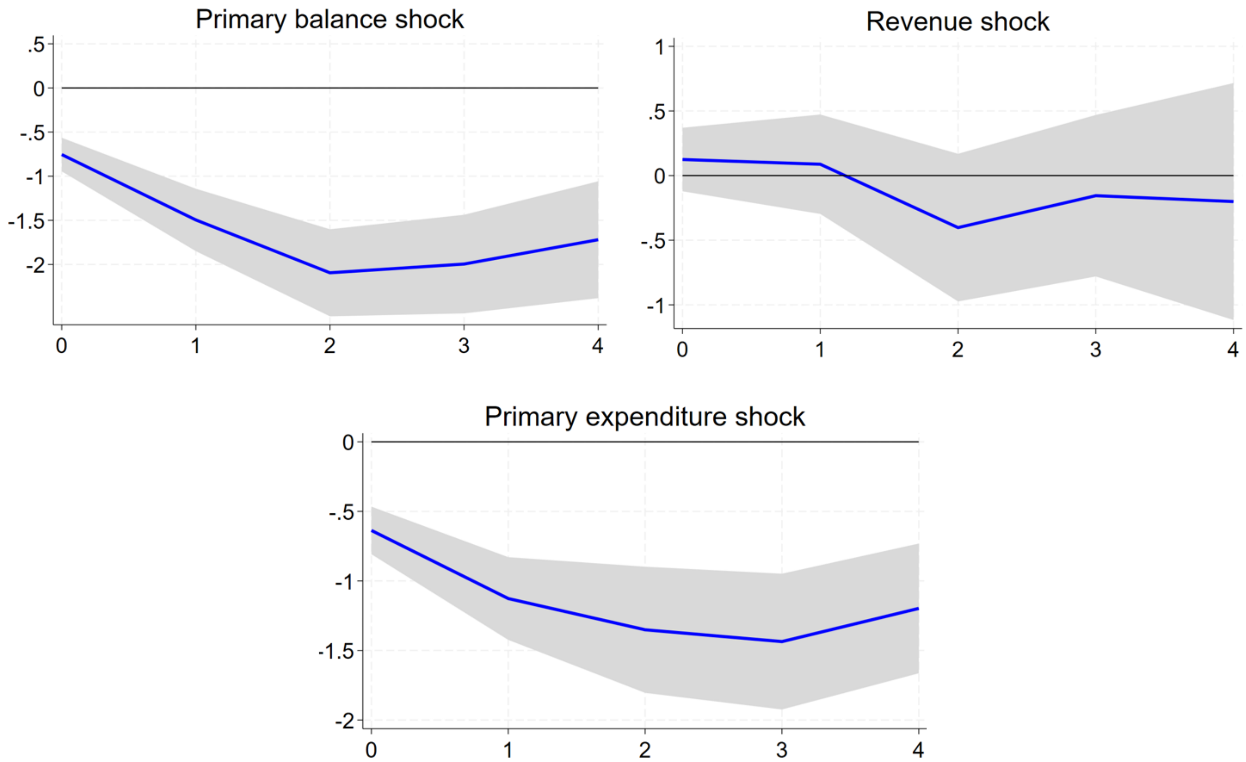


Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

To investigate the significance of the orthogonalisation further, we examine what happens when the orthogonalisation is retained but the forecast errors for the macroeconomic variables are omitted from Equation 3. Figure 8 shows that in this case the estimated impulse responses remain broadly similar to those obtained using the raw forecast errors, but are different from those in the baseline estimations in Sections 4 and 5. This underscores the importance of accounting for macroeconomic forecast errors in the orthogonalisation procedure.

[9]In specific terms, a positive "raw" primary balance shock may in part be caused by positive forecast errors for GDP growth or GDP inflation that themselves contribute to a reduction in the debt-to-GDP ratio. Orthogonalising the primary balance shock removes these macroeconomic effects on the debt-to-GDP ratio.

Figure 8: Public debt impulse responses using orthogonalised forecast errors without macroeconomic forecast errors



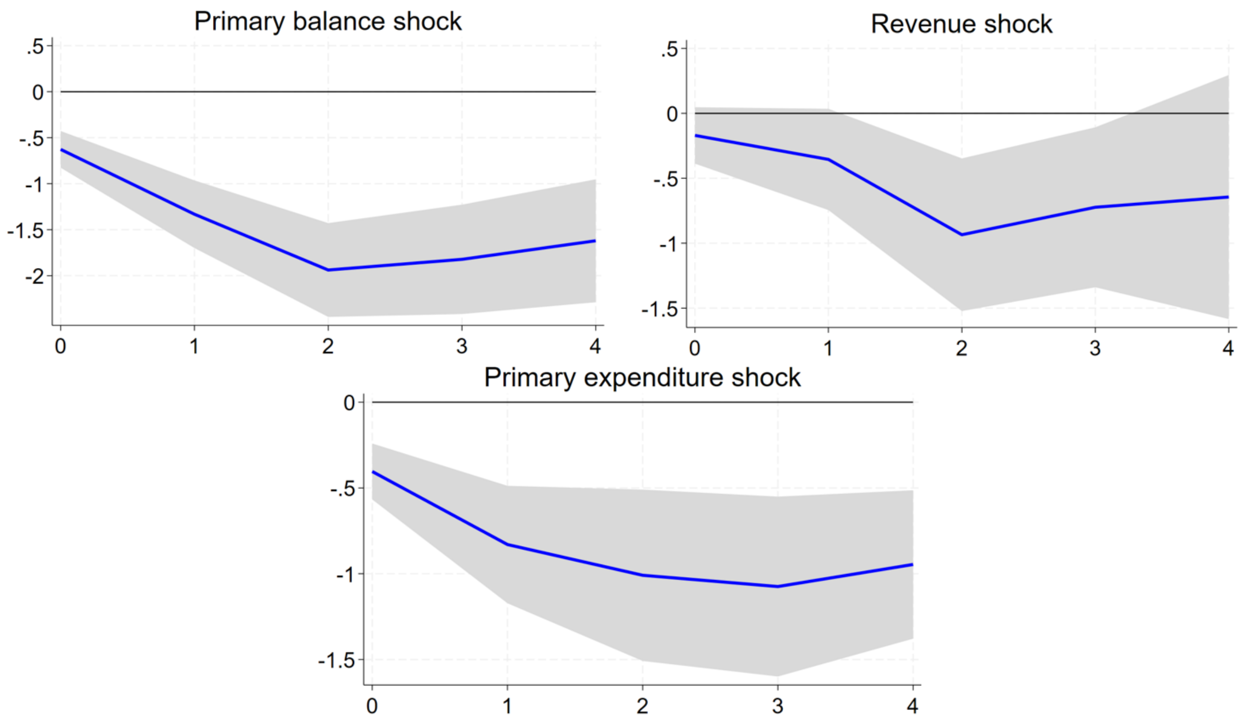
Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Including time fixed effects in the orthogonalisation step likewise increases the magnitude of the responses of public debt to balance and expenditure shocks, while the response to a revenue shock is only statistically significant in the second and third year after the shock (Figure 9).

We experimented with instrumenting macroeconomic forecast errors using their lagged values in case there might be any reverse causality from fiscal forecast errors to macroeconomic outcomes. The results for the instrumented variables were broadly in line with those found using fixed effects least squares, which suggests that the risk of reverse causality affecting the results is limited. It should be noted, however, that the lagged values are weak instruments and so the results should be interpreted with caution. Moreover, it is not straightforward to devise other instruments. We do not present the results here due to space constraints, but they are available upon request.

We also evaluated the robustness of the results to the choice of forecast vintages. All the estimations were originally done using the autumn forecasts from the previous year, but using instead the spring forecasts of the European Commission, which are produced in the spring of the same year as the realisation, results in slightly faster and somewhat larger responses to the primary

Figure 9: Public debt impulse responses using forecast errors where time fixed effects are included in the orthogonalisation



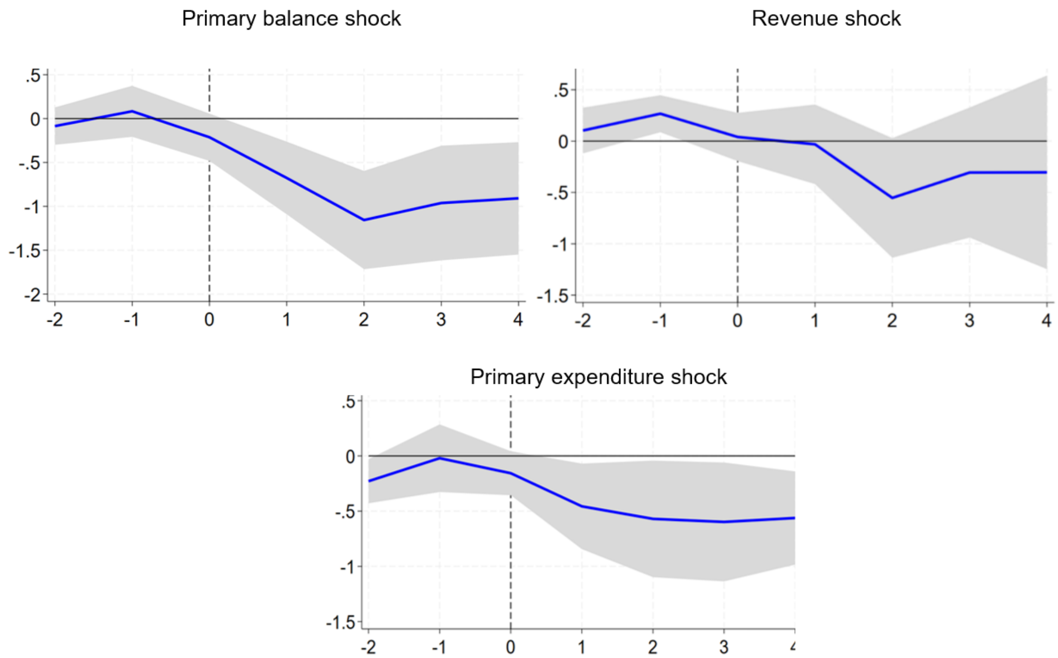
Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

balance and primary expenditure shocks, while the reactions to revenue shocks remain muted and statistically insignificant throughout the forecast horizon (Figure C.1 in Appendix C). Overall, the choice of the autumn or the spring forecast does not seem to affect the results markedly.

Finally, we apply lead placebo tests to verify that the estimated impulse response functions are driven by the shock $\epsilon_{i,t}^{G}$ that was identified and not by spurious correlation, specification errors or anticipation effects (Dube et al. 2025). This is done in the LP stage by replacing the forward projection in Equation 4 with the one-year and two-year backward projections. Under the assumption that there is no anticipation, future fiscal surprises $\epsilon_{i,t}^{G}$ should not affect the outcomes before the shock occurs, so the estimated coefficients of the backward projections should be small and statistically insignificant.

Figure 10 shows the debt impulse responses for the lead placebo tests, where the impulse responses for $h = -2$ and $h = -1$ depict the backward projections. It follows that the backward-looking impulse responses generally are numerically small and do not attain statistical significance with a partial exception $h = -1$ for the revenue shock. The conclusion is that the fiscal shocks do not affect public debt before the period in which the shock occurs. The results of the lead placebo lend some credibility to the validity of the fiscal shocks identified.

Figure 10: Results of the placebo test



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

6.2 Composition of the sample

The robustness of the findings to the composition of the country sample was also examined. Restricting the sample to the original twelve euro-area countries (EA12) reduces the number of observations and widens the confidence intervals. The impulse responses of debt to balance and expenditure shocks remain qualitatively similar, though they are less precisely estimated (Figure C.2 in Appendix C). Excluding countries one by one yields nearly identical results, with the only noticeable deviation arising for the revenue shock, where excluding Ireland alters the response slightly. The impact then becomes statistically significant at some more distant horizons. We do not present the numerous estimations, but the results are available upon request.

We were also concerned that individual episodes of macroeconomic instability such as the global financial crisis and the Covid pandemic could have affected the results unduly. Nevertheless, when we run the estimations excluding 2009 and 2020 separately, no substantial changes to the results were discerned (results available upon request).

6.3 Specifications of LP estimations

The role of model specification was examined as well. Omitting the time dummies from the local projection regressions (Equation 4) makes the adjustment of public debt more front-loaded, with stronger effects on impact and in the first year following both balance and expenditure shocks, but a very small or insignificant effect by the end of the horizon (Figure C.3 in Appendix C). The responses to revenue shocks remain small and statistically insignificant regardless of whether time effects are included.

6.4 Generated regressors and confidence intervals

The fiscal shocks are generated regressors given that they are obtained as residuals from a first-stage panel data estimation, so the second-stage standard errors may be inaccurate if they do not account for this uncertainty. To investigate the importance of the generated regressors issue, we use a country-cluster bootstrap that re-estimates both the shock identification equation and the local projection equation in each replication. The reported confidence intervals (Figure C.4 in Appendix C) are based on the empirical bootstrap distribution of the impulse responses.

The confidence intervals that result from the bootstrap are very close to those obtained in the baseline specification where we use Driscoll–Kraay standard errors. This suggests that the additional uncertainty associated with the estimation of the shocks is quantitatively small in our case. This may be because the first-stage orthogonalisation is estimated with relatively high precision in our dataset. The forecast-error regressions are linear, include a rich set of controls, and are estimated on a panel with a reasonably large time dimension, and so the residual-based shocks are relatively similar across the resamples. As a consequence the additional uncertainty introduced by treating these shocks as generated regressors is limited, and most of the sampling variation arises from the second-stage local projection estimation.

7 Final comments

The need to maintain fiscal sustainability and keep public debt under control has been on the agenda of the European Union since the European Economic and Monetary Union was formed in the early 1990s. Public debts in many EU countries have nevertheless increased markedly in the decades since, and several countries faced severe financing problems after the global financial crisis.

The pressures stemming from large budget deficits and increasing public debt stocks appear to be a fixture of economic policymaking in Europe.

This paper considers the effects of various fiscal policy shocks, including primary balance shocks, revenue shocks and expenditures shocks. The analysis is run on panel data for all the countries that were members of the European Union, and the unbalanced panel dataset covers the years from 2001 to 2024. The local projection methodology is used to produce impulse responses, and the fiscal policy shocks are orthogonalised forecast errors derived from European Commission forecasts, where the orthogonalisation is meant to remove the effects of macroeconomic forecast errors on fiscal forecast errors and thus reduce the risk of reverse causality.

Fiscal policy decisions are typically the outcome of a multi-stage process involving analysis, political negotiation, and legislative approval. This lengthy process means that a substantial portion of policy changes can be anticipated in advance, but the details of implementation, last-minute political compromises, and deviations in how policy is actually executed can all generate differences between the planned fiscal outcomes and those that are ultimately realised. These differences are precisely what the orthogonalised fiscal errors are intended to capture. At the same time though, this approach may not fully isolate purely discretionary policy actions, as forecast errors may still reflect some economic factors. Nevertheless, controlling for macroeconomic conditions and their dynamics allows the method to isolate a component of fiscal outcomes that is orthogonal to *systematic* economic developments and thus makes a useful proxy for unanticipated fiscal innovations.

The results on the panel data for 2001–2024 reveal that austerity in the form of positive primary balance shocks drags down real GDP and the GDP deflator, while the effect on the long-term interest rate is modest. The improvement in the primary budget balance is limited, and the improvement in the debt-to-GDP ratio is initially modest but then gradually strengthens.

The effects of revenue and expenditure measures differ. Positive revenue shocks have small and statistically insignificant effects on the debt stock, because the improvement in the primary balance is subdued and the macroeconomic situation deteriorates. Primary expenditure shocks have relatively fast and statistically significant effects on public debt. The results are different because the fiscal reactions differ, since higher revenues are followed by higher expenditure, while lower expenditure is not followed by lower taxes.

The findings in this paper offer important lessons for policymaking in EU countries that seek to use discretionary fiscal policy measures to reduce the ratio of public debt to GDP. One is that broad-based austerity measures can successfully reduce the debt-to-GDP ratio, but the effects on the budget balance and the debt stock are generally not very large and they are most pronounced in the longer term, so some patience is required. Another lesson emerges from the finding that discretionary spending cuts have on average had stronger effects on the primary budget balance and the debt stock than revenue increases have. The difference in the effects of the two austerity measures stems from the difference in their induced fiscal reactions. This suggests that revenue-based austerity may be more successful if it is supplemented by measures to ensure that the growth in public expenditure is restrained.

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Appendices

A Variables

Table A.1: List of variables, definitions and measurements

Variable name	Description	Unit	AMECO code
Debt	Public debt	% of GDP	UDGG
Primary balance	Primary balance	% of GDP	UBLGI
Total revenues	Total revenues	% of GDP	UTRG
Primary expenditure	Primary expenditure (Total expenditure minus interest payments)	% of GDP	UUTG, UYIG
Implicit interest rate	Interest payments in per cent of the average debt stock in the current and previous years	% per year	AYIGO
Long-term interest rate	Interest rate on government bonds with residual maturity of around 10 years	% per year	ILN
Real GDP	Real GDP	Index	OVGD
GDP growth	Real GDP, percentage change	% per year	
GDP deflator	GDP deflator	Index	PVGD
GDP inflation	GDP deflator	% per year	

B Estimations for orthogonalisation

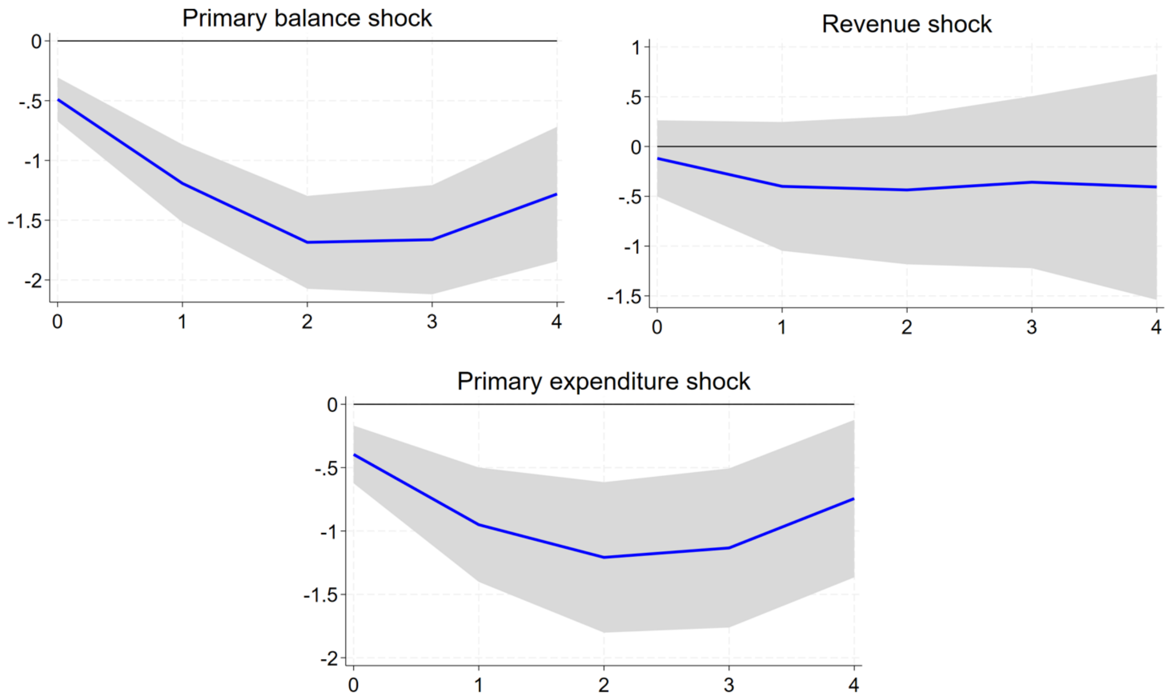
Table B.1: Fixed effect estimations of fiscal forecast errors

	Primary balance	Total revenues	Primary expenditure
Lagged dependent	0.191^{**} (0.073)	0.471^{***} (0.053)	0.243^{***} (0.046)
$y_{i,t}^{FE}$	0.409^{***} (0.110)	-0.057^{*} (0.031)	-0.475^{***} (0.083)
$\pi_{i,t}^{FE}$	0.145^{**} (0.064)	0.015 (0.040)	-0.093^{*} (0.051)
$y_{i,t-1}$	0.014 (0.061)	-0.055^{**} (0.024)	−0.029 (0.056)
$\pi_{i,t-1}$	0.008 (0.031)	−0.011 (0.031)	−0.035 (0.030)
Constant	−0.206 (0.212)	0.090 (0.132)	0.229 (0.266)
No. obs.	585	586	586
R^2	0.336	0.277	0.412

Note: The dependent variable is the forecast error of the fiscal variable indicated in the first row. Driscoll-Kraay standard errors are shown in brackets. Superscripts ***, **, * indicate statistical significance at the 1, 5 and 10 per cent levels respectively.

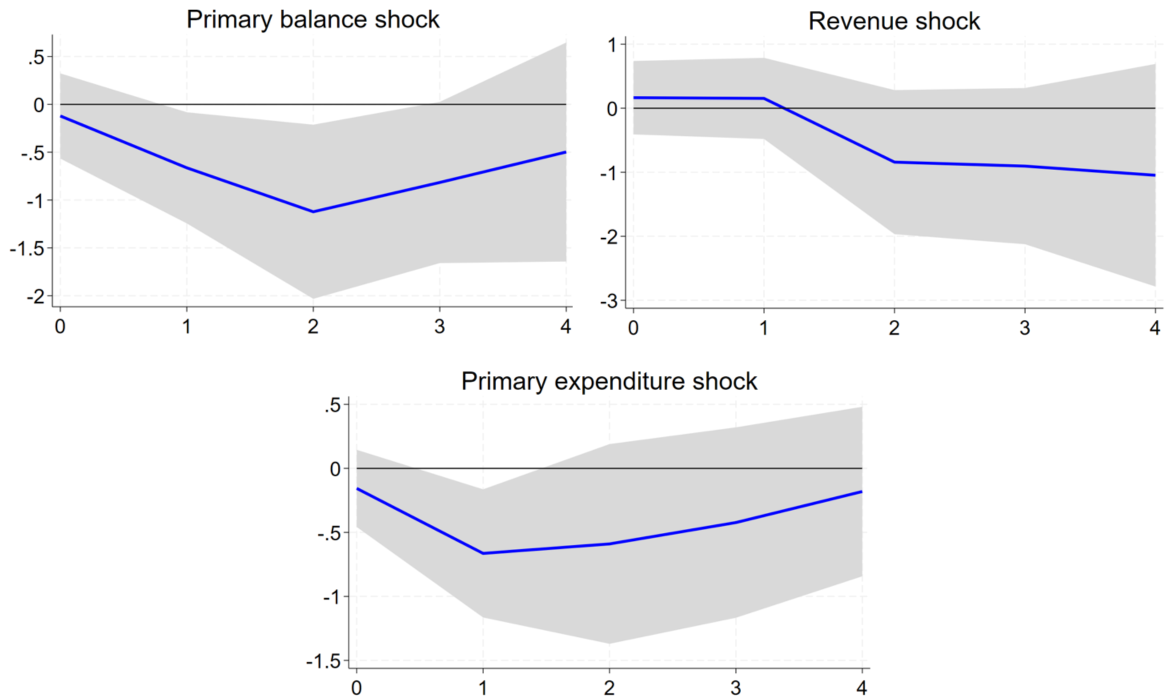
C Robustness

Figure C.1: Public debt impulse responses using the European Commission spring forecasts



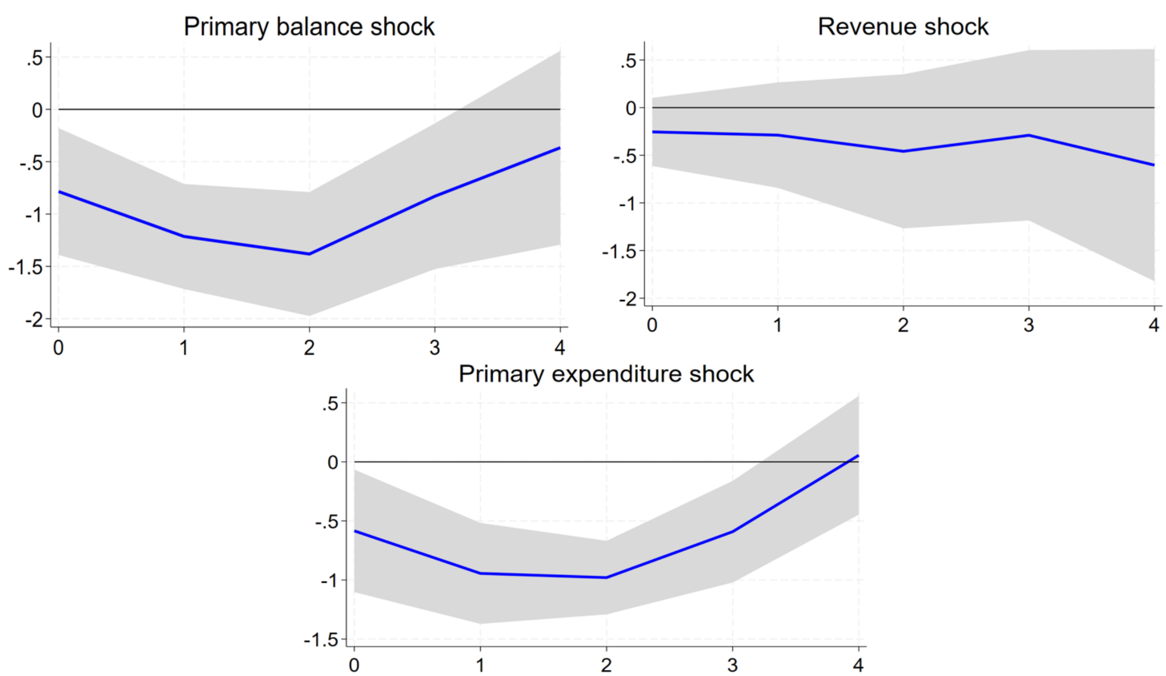
Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Figure C.2: Public debt impulse responses for the EA12 sample



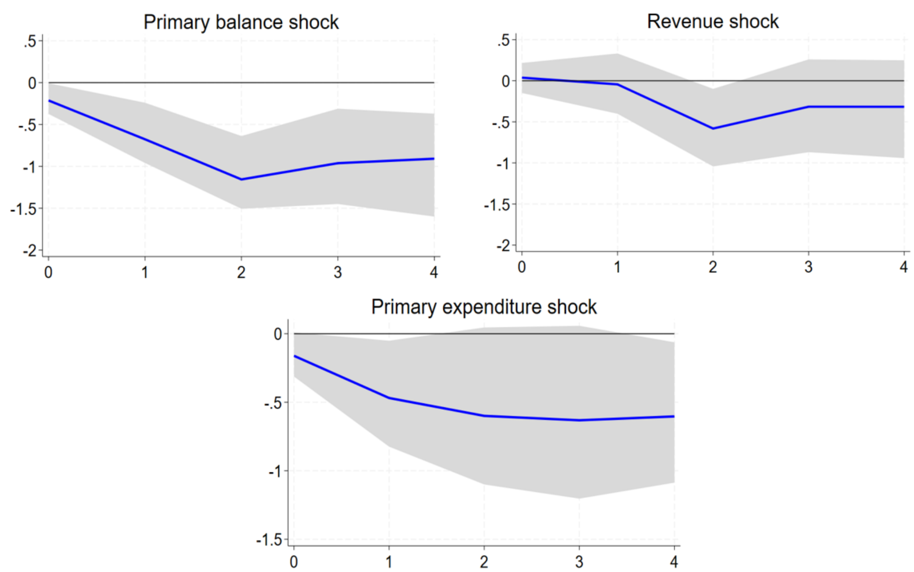
Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Figure C.3: Public debt impulse responses omitting the time dummies from the local projection regression



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors

Figure C.4: Public debt impulse responses with bootstrap-based confidence intervals



Note: The horizontal axis shows years. The vertical axis shows the deviation from the baseline in percentage points. The 90% confidence bands are constructed using Driscoll-Kraay standard errors