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What are the causal links between fiscal and external sustainability in the EU? New time-varying evidence

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ABSTRACT

We implement a two-step analysis of fiscal and external causality patterns using a data set for 27 EU countries in the period 2002Q1-2023Q4. In the first step, we compute fiscal and external sustainability time-varying coefficients, modelling the relationship between government revenues and government spending, and between exports and imports. In the second step, we use three recursive strategies, combined with Granger causality tests: forward expanding, rolling, and recursive window methods to capture causal relationships. Our results show that: (i) peripheral countries have lower sustainability coefficients, while non-Eurozone countries have higher sustainability coefficients, (ii) after the 2008 global financial crisis, there was an improvement in fiscal and external sustainability for most countries, (iii) during the Eurozone crisis in 2010–2012, in Austria, France, Greece, Ireland, Netherlands, Slovakia and Spain, improving fiscal sustainability lead to a better external sustainability, (iv) during that period, improvement of external sustainability lead to a better fiscal sustainability in EMU countries (Austria, Germany, Malta, Netherlands, Slovakia, Slovenia, Spain) and in non-EMU countries.

1. Introduction

Fiscal sustainability has been a topical issue in the last years, notably in the context of the European Union (EU), where a common fiscal framework is in place as guidance for the respective Member States' fiscal authorities. This framework, with some additional adjustments, dates back to the Stability and Growth Pact (SGP), and to the start of the 3rd phase of the Economic and Monetary Union, in January 1999. In the context of the SGP, specifically considering the preventive arm and of the corrective arm (notably the Excessive Deficit Procedure), fiscal sustainability has always been a main tenet, both to ensure sound fiscal policies and to provide a stable environment for the implementation of the common monetary policy in the Euro Area countries.[1]

After the Global Financial Crisis (GFC), which impacted adversely EU's public accounts and external positions, particularly prompting international financing programs, notably for Greece, Portugal, and Ireland, the EU put forward in 2011, in addition to the

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[1] To limit government deficit and debt, EU Member States have agreed reference fiscal thresholds, enshrined in the EU treaties: a 3% deficit ratio and a 60% debt ratio (calculated relative to a Member State's GDP).

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common fiscal surveillance, also a so-called Macroeconomic Imbalance Procedure (MIP). With this surveillance mechanism, Member States intend to identify, prevent and address the emergence of potentially harmful macroeconomic imbalances, and external sustainability issues, in a particular Member State, the Euro Area, or the EU. Hence. The MIP foresees the possibility of enhanced surveillance for countries identified with excessive imbalances, named the Excessive Imbalance Procedure.[2]

Therefore, the questions of fiscal sustainability and external sustainability are paramount, and can also be framed in the Twin Deficit Hypothesis (TDH) where fiscal deficits tend to translate into current account deficits. Indeed, the TDH relationship can be explained in the framework of the Mundell-Fleming Model, stemming from the macro accounting identity for aggregate demand, where the current account balance is defined as the sum of net private saving (net lending position of the private sector) and net public saving (general government balance). Hence, a fiscal shock could drive the current account in the same direction.[3] For instance, a government budget deficit can cause a current account deficit when the government budget is not fully financed by domestic private saving and needs foreign capital inflows as well. Nevertheless, a budget deficit can lead to an increase in the net lending position of the private sector, and then no effect on the current account balance occurs.

More specifically, we are then interested in assessing the relationship between fiscal sustainability and external sustainability for the EU countries. In other words, in this paper we check four possible scenarios: (i) whether fiscal sustainability Granger causes external sustainability; (ii) if external sustainability Granger causes fiscal sustainability; (iii) if there is bidirectional Granger causality; (iv) or if there is no relationship between fiscal and external sustainability. The answer to these queries is naturally extremely relevant, notably for policymakers and economic agents, given the financing options available for each country.

Therefore, we use a quarterly data set covering the 27 EU countries during the period 2002Q1-2023Q4, and we also contribute to the literature by implementing a novel two-step analysis of fiscal and external causality patterns. In the first step, and using Schlicht's (2021) method, we compute the fiscal and external sustainability time-varying coefficients, modelling, on the one hand, the relationship between government revenues and government spending, and on the other hand, the relationship between exports and imports. In the second step, we then use a lag-augmented vector autoregression with three recursive strategies, combined with Granger causality tests; the forward expanding window method; the rolling window method; and the recursive evolving window method to capture the potential causal relationships.

Our main results show that: (i) peripheral countries have lower sustainability coefficients, while non-Eurozone countries have higher sustainability coefficients, (ii) after the 2008 GFC, there was an improvement in fiscal and external sustainability for most countries, (iii) during the Eurozone crisis in 2010–2012, in Austria, France, Greece, Ireland, Netherlands, Slovakia and Spain, there was causality running from fiscal to external sustainability, (iv) during that period, causality was running from external to fiscal sustainability in EMU countries (Austria, Germany, Malta, Netherlands, Slovakia, Slovenia, Spain) and in non-EMU countries. Hence, the patterns of causality between fiscal and external sustainability have specificities in each country, and preemptive and ex-post policy measures are necessarily country finetuned, given notably the EU frameworks as the Stability and Growth Pact (SGP) and the Macroeconomic Imbalance Procedure (MIP).

Our study's novelty lies in its methodological and empirical scope. Unlike previous research that applies static cointegration or fixed-parameter VAR models to assess fiscal-external linkages (e.g., Afonso & Rault, 2010; Algieri, 2013), we adopt a dynamic perspective by estimating time-varying sustainability coefficients using Schlicht's (2021) approach and applying recursive Granger causality tests (Shi et al., 2020). This combination enables us to uncover evolving causal patterns across major economic shocks, including the Global Financial Crisis, the Eurozone crisis, and the COVID-19 pandemic. By doing so, we provide a richer understanding of the interdependence between fiscal and external sustainability and its implications for adaptive policy design in the European Union. The theoretical foundation of our analysis builds on the intertemporal budget constraint and the Mundell-Fleming model, which jointly explain the interaction between fiscal and external positions. In a monetary union, the inability to use exchange rate adjustments implies that fiscal policy becomes a primary instrument for external correction, reinforcing the potential bidirectional causality between fiscal and external sustainability. This dynamic is consistent with the Twin Deficit Hypothesis, which predicts that fiscal deficits translate into current account deficits, and with the Current Account Targeting Hypothesis, which suggests reverse causality under external shocks. By adopting a time-varying approach, we capture how these theoretical linkages materialize under changing regimes, such as the Global Financial Crisis and the Eurozone sovereign debt crisis, when fiscal constraints and external imbalances interact most strongly.

In a monetary union, fiscal and external sustainability are jointly constrained by two intertemporal restrictions: the government budget constraint and the external budget constraint. These restrictions generate three economically distinct and testable mechanisms that rationalize time-variation in the strength and direction of fiscal-external linkages. First, ***a demand/absorption channel, the twin-deficit logic***, which links a looser fiscal stance to stronger domestic absorption and imports; with no exchange-rate flexibility in a monetary union, adjustment operates more through quantities and financing, so fiscal impulses map more directly into external positions. Second, ***a risk-premium/financing channel, the sovereign–bank nexus***, which connects fiscal solvency to external funding conditions: shifts in sovereign spreads alter bank funding costs and thereby the external financing constraint. This channel is inherently state-dependent (calm vs. crisis). Third, ***a terms-of-trade/external-shock channel runs from external shocks (energy prices, global demand)*** to public finances via automatic stabilizers and discretionary measures. Our empirical design operationalizes these three mechanisms: the first step produces time-varying fiscal and external sustainability coefficients that proxy evolving solvency/

[2] One of the Scoreboard Indicators in the MIP is that the 3-year backward moving average of the current account balance as percent of GDP, should be within the thresholds of +6% and −4%.

[3] See Appendix A.

competitiveness; the second step uses time-varying Granger causality tests to detect when and in which direction one intertemporal constraint disciplines the other. In this sense, this two-step approach is a direct mapping from union-specific theoretical channel to measurement.

The organization of the paper is as follows. Section 2 provides the literature review. Section 3 explains the methodology. Section 4 presents the data, and section 5 carries out the empirical analysis. Section 6 concludes.

2. Literature review

2.1. Fiscal and external sustainability

The literature has addressed fiscal and external sustainability related issues in the past. Hamilton and Flavin (1986), for example, carry out stationarity tests on the budget balance and public debt in a pioneering study applied to the United States. The methodology for studying the properties of public debt became very popular based on this article. The analysis of the cointegration relationship between government revenues and expenditures (Hakkio and Rush, 1991) is another method to examine the sustainability of public finances. According to these authors, if government revenues and expenditures are non-stationary, the existence of cointegration between both variables is a necessary condition for the government to comply with the present value budget constraint (PVBC), and, therefore, to ensure fiscal solvency.

Furthermore, there is the perspective of Bohn (1998) who maintains that fiscal sustainability is ensured if the primary government balance responds positively to increases in the public debt-to-GDP ratio (backward-looking approach). This is consistent with a Ricardian fiscal (or monetary predominance) regime, in which the government has to attain primary government surpluses in order that its budget constraint is consistent with the repayment of the initial stock of real public debt. Canzoneri et al. (2001), along with Bohn (1998), are part of the literature on so-called fiscal reaction functions, being the perspective of Canzoneri et al. (2001) forward-looking. Hence, in a Ricardian regime, a budget surplus results in the reduction of public debt in the future.

On the other hand, Bohn (2007) critiques traditional sustainability tests based on stationarity or cointegration, arguing that these conditions are neither necessary nor sufficient for fiscal solvency. Instead, he advocates a model-based approach that focuses on the responsiveness of primary surpluses to changes in public debt. Our empirical design does not rely on cointegration and estimates time-varying sustainability coefficients from the reaction of government revenues and government expenditures, as well as from the reaction of exports to imports. Thus, the time-varying nature of our framework mitigates some of Bohn's concerns by capturing evolving fiscal and external behavior across different macroeconomic regimes. This flexibility is particularly relevant in the EU context, where crises and policy interventions have altered fiscal dynamics over time.

The empirical literature on fiscal sustainability initially focused on individual countries or small groups of countries and was based on unit root tests and the study of the causality and cointegration relationship between government revenues and expenditures (Haug, 1995; Getzner et al. 2001). Within the scope of the empirical literature on fiscal sustainability, later, studies emerged using a panel data structure from a relatively wide range of countries, employing standard panel techniques as well as examining panel cointegration relationships (Afonso, 2008; Afonso and Rault, 2010). The use of data with an annual frequency is a common view of analysis (Weichenrieder and Zimmer 2014; Lee et al., 2018), however, we can find studies that use quarterly data (Afonso and Jalles, 2017; Afonso and Coelho, 2023). In several articles, the empirical scope comprises the European Union or even Euro Area countries (Vanhorebeek and Van Rompuy 1995; Afonso, 2005; Brady and Magazzino, 2018; Afonso et al., 2021).

Regarding the topic of external sustainability, we can identify two complementary definitions of external accounts solvency, namely: (i) current net foreign assets must equal the sum of future net exports (the economy will have to achieve future net exports whose present value covers the current value of net foreign assets), and (ii) the present value of current net foreign assets is zero in infinity (to ensure a sustainable path for the external position).

The absence of Ponzi games is empirically tested by studying the stationarity of the stock of current net foreign assets in first differences. From a practical point of view, the stationarity of the current account balance is tested. In the same way as in the analysis of fiscal sustainability, the rejection of stationarity does not mean the absence of sustainability (according to Trehan and Walsh, 1991). In addition, external sustainability can also be tested through cointegration tests between exports and imports of goods and services. A current account balance would be sustainable if the series of exports and imports of goods and services are cointegrated (Husted, 1992; Wu et al., 1996). As concluded by Durdu et al. (2013), a sufficient condition for the intertemporal constraint to hold is that there is a negative relationship between net exports and net foreign assets. Indeed, these authors extend sustainability analysis to external accounts using complementary approaches – unit root and cointegration tests, VAR analysis, and a quantitative model of trade and debt dynamics – while allowing for structural breaks and non-linearities. Their emphasis on country-specific factors and regime shifts underscores the limitations of static tests. Our time-varying framework aligns with this perspective by capturing evolving fiscal-external linkages across crises and policy interventions, thereby providing a richer understanding of sustainability dynamics in the EU context.

Empirically, external sustainability can be analyzed from two perspectives, both of which are related to the intertemporal current account constraint. The first perspective considers the macroeconomic determinants of this restriction to compute the required adjustments (see, for instance, Afonso et al., 2019, based on Milesi-Ferretti and Razin, 1996). The second perspective performs time-series and panel data tests to ascertain the behavior of the current account balance, exports and imports of goods and services over time.

More specifically, Afonso et al. (2019) analyze external sustainability for 22 European Union countries between 1970Q1 and 2015Q4 according to two perspectives. In particular, the authors found evidence of sustainability of the current account balance and cointegration between exports and imports of goods and services in just a few countries. In turn, Afonso et al. (2020) examine external

sustainability considering the same sample and conclude that the current account balance is non-stationary, although there is a stable long-term relationship between exports and imports of goods and services.

Within the scope of the second perspective of the empirical analysis of the external sustainability, unit root tests of the current account balance are carried out (Raybaudi et al., 2004; Chen, 2011), with cointegration tests between exports and imports (Husted, 1992; Camarero et al., 2013) or both (Wu et al., 1996; Holmes, 2013). Moreover, there are also nonlinear approaches, which admit structural breaks, regime shifts and threshold values (Apergis et al., 2000; Chen, 2014; Lanzafame, 2014; Camarero et al., 2015; Andre et al., 2018), and the use of error correction models to assess reaction functions of net exports to net foreign assets (Durdu et al., 2013; Bajo-Rubio et al., 2014). These analyses are applied to individual countries (Raybaudi et al., 2004; Camarero et al., 2013) as well as to panels of countries, namely developed and emerging, OECD and Euro Area (Holmes, 2006; Camarero et al., 2015). Although there are studies that use a quarterly data frequency (Chen, 2011, 2014), the use of annual data is more usual (Husted, 1992; Bajo-Rubio et al., 2014).

2.2. Interplay between fiscal and external accounts

The literature advances five perspectives to explain the relationship between the government balance and the external balance, namely: (i) the Twin Deficit Hypothesis; (ii) the Ricardian Equivalence Hypothesis; (iii) the Current Account Targeting Hypothesis; (iv) the feedback linkage; and (v) the Twin Divergence Hypothesis.

The ***Twin Deficit Hypothesis (TDH)*** states that the fiscal deficit tends to result in a current account deficit. This relationship can be explained in the framework of two perspectives: the Mundell-Fleming Model (Mundell, 1960; Fleming, 1962) and the Keynesian Absorption Theory. From the first perspective, in an economy with a flexible exchange rate regime, a fiscal deficit leads to higher domestic real interest rates, which in turn attracts foreign capital flows and results in an appreciation of exchange rates. A stronger national currency reduces net exports and translates into a loss of the economy's external competitiveness, which in turn creates an external accounts deficit. In a fixed exchange rate regime, an increase in government deficit results in an increase in prices and income, which consequently leads to a real appreciation of the currency, which it turns negatively affects the current account balance. The second perspective suggests that an increasing government deficit can translate in upward pressure on domestic absorption, which results in increased domestic spending, and thus contributes to increased imports, leading to a deterioration in the current account balance.

(Abell 1990) and Rosenweig and Tallman (1993), using Vector Auto-Regressive (VAR) models and impulse response functions, corroborate this perspective for the United States. More recently, McFarlane et al. (2020) and Kim (2024) confirm this result. Also using quarterly data, Makin and Narayan (2013) for Australia and Janko (2020) for Canada obtain evidence from the TDH, using cointegration tests and an Autoregressive Distributed Lag (ARDL) model. Furthermore, Vamvoukas (1999) for Greece, Daly and Siddiki (2009) for OECD countries, and Trachanas and Katrakilidis (2013) for Greece, Ireland, Italy, Portugal, and Spain conclude by verifying the causality between the fiscal balance and the external balance.

The Twin Deficits Hypothesis, in addition to being corroborated by time series studies, which are generally applied to individual countries or to a group of countries with similar characteristics, is also confirmed by studies using panel data. These studies, which are less frequent than the first type, apply the usual econometric panel estimation techniques (e.g., for large panels, Altayligil and Çetrez, 2020; for OECD countries, Piersanti, 2000; for European Union countries, Afonso and Coelho, 2022).

According to the ***Ricardian Equivalence Hypothesis (REH)*** (Barro, 1974; 1989), the fiscal balance and the external balance are unrelated, as fiscal changes induce an intertemporal reallocation of savings (with intertemporal substitution between taxes and government deficits), whereas the intertemporal fiscal constraints of private agents, the real interest rate, investment, and the current account balance all remain unchanged. Therefore, fiscal deficits do not result in changes in interest and exchange rates and the effects on the current account are null, and there is no relationship between the budget balance and the external balance. Algieri (2013) reports empirical support for the REH for Greece, Ireland, Italy, Portugal, and Spain, through causality tests and using data with a quarterly frequency.

An inverse relationship could also exist, which moves in the direction of the external accounts to the public accounts. The underlying idea is that the external position of an economy can deteriorate because of factors that are exogenous to its fiscal position. In this scenario, a government deficit can respond to this deterioration and adjust to stabilize the economy. Adjustment can be made by using automatic stabilizers and/or discretionary fiscal policies. Summers (1988) referred to this inverse relationship as "Current Account Targeting". In this context, there is an inverse and positive relationship running from the current account balance to the government balance. The ***Current Account Targeting Hypothesis (CATH)*** has empirical support in Kalou and Paleologou (2012) and Nikiforos et al. (2015) for Greece, through cointegration and causality tests and a Vector Error-Correction (VEC) model.

Feldstein and Horioka (1980), for 21 OECD countries, between 1960 and 1974, and using a Simultaneous Equations Model (SEM), point that savings and investment are highly correlated and thus this ***feedback linkage*** translates into bidirectional relationship between the fiscal balance and the current account balance, with both variables moving together. As the relationship between variables occurs in both directions, this result may support both the TDH and CATH. Using quarterly data between 1960 and 1984 for the United States, Darrat (1988) concludes that there is a bidirectional relationship between the budget balance and the trade balance.

Lastly, Kim and Roubini (2008) assess the existence of endogenous movements of the fiscal deficit and the current account deficit, for the United States. They suggest that "***twin divergence***" is also likely, i.e., the current account deficit can improve when the government deficit worsens. This result, induced by an increase in the real interest rate (due to an expansionary fiscal policy), is attributed to two factors, namely, a partial Ricardian movement of private savings and a crowding out effect on investment.

These theoretical perspectives acquire particular significance in monetary unions, where the absence of exchange rate flexibility

constrains external adjustment mechanisms. Consequently, fiscal policy assumes a central role in stabilizing external accounts, while external shocks can feed back into fiscal positions through automatic stabilizers and discretionary measures. This interdependence underpins our empirical strategy and motivates the use of time-varying causality tests to capture evolving linkages across different macroeconomic regimes.

Our approach can be contrasted with two prominent alternatives. First, recall that Bohn (2007) argues that stationarity and cointegration are neither necessary nor sufficient for fiscal sustainability and proposes a model-based test that examines whether primary surpluses respond positively to debt accumulation. Second, Durdu et al. (2013) extend sustainability analysis to external accounts using a combination of time-series tests, VAR models, and structural simulations that allow for non-linearities and structural breaks. Since we take fiscal and external linkages to estimate time-varying sustainability coefficients, this dynamic specification addresses Bohn's critique by capturing evolving fiscal behaviour across regimes. Likewise, our recursive causality framework aligns with Durdu et al.'s (2013) emphasis on regime-dependent dynamics and country-specific heterogeneity, offering a unified perspective on fiscal and external sustainability within a monetary union.[4]

3. Methodology

3.1. Time-varying fiscal and external sustainability

In the first step, and in order to measure fiscal and external sustainability, we follow notably Afonso (2005) and Afonso et al. (2019) approaches, respectively. Specifically, and regarding the fiscal sustainability, we rely on the relationship between government revenues (R) and government expenditures (G), while for the external sustainability we look for the linkage between exports (X) and imports (M). However, as we intend to use the time-varying sustainability coefficients and not an average value for a given time period, we rely on the Schlicht's (2021) method, we compute the fiscal and external sustainability coefficients through equations (1) and (2), respectively:

$$R_t = \alpha_{0,i,t} + \beta_{i,t}.G_{i,t} + u_t \tag{1}$$

$$X_t = \alpha_{0,i,t} + \gamma_{i,t}.M_{i,t} + \varepsilon_t \tag{2}$$

where $\beta_{i,t}$ and $\gamma_{i,t}$ are the fiscal and external sustainability coefficients to be estimated for each quarter t and for each country i, respectively The closer are β and γ to unity, the higher are the fiscal and external sustainability. As mentioned above, equations (1) and (2) are estimated resorting to Schlicht's (2021) methodology, which assumes that β and γ changes "slowly and unsystematically over time":

$$\beta_t = \beta_{t-1} + \nu_t \tag{3}$$

$$\gamma_t = \gamma_{t-1} + \epsilon_t \tag{4}$$

where $\nu_t\ N(0, r^2)$ and $\epsilon_t\ N(0, r^2)$.

Building on Schlicht (2021), equations (1) and (3), along with equations (2) and (4), should be estimated simultaneously. The authors propose a method that extends the linear model by allowing the independent variables to vary gradually over time, unlike the static assumption of the linear model. The expected value of the fiscal (external) response coefficient at time t is assumed to be the same as its value at the time $t-1$, following a random walk process. The variation in the coefficients, represented by ν_t (or ϵ_t, for external sustainability), is assumed to follow a normal distribution with a mean of zero and a variance of r^2. These variances r^2 are estimated using a method of moments estimator, which coincides with the maximum-likelihood estimator for large samples but is more efficient and transparent for small samples. Thus, the standard regression model is a special case where r^2 approaches zero, resulting in $\beta_t = \beta_{t-1}$ (or $\gamma_t = \gamma_{t-1}$, for external sustainability). By allowing r^2 to be small but non-zero, the coefficients are permitted to evolve slowly over time, starting from the previous year's coefficients and incorporating any changes or deviations that occurred during that year.

Furthermore, we have assessed the presence of unit roots in each series for each country, as presented in Table B1, in Appendix B, concluding that most of the series are stationary at first differences. Therefore, and as previously allured, we have computed the time-varying fiscal, β, and external coefficients, γ, resorting to the Schlicht's (2021) approach, in order to assess the time-varying Granger causality between fiscal and external sustainability.[5]

[4] As mentioned by Afonso et al. (2024): "Investigating the time-varying nature of causal relationships is crucial, as causality is fundamentally time-varying and subject to structural breaks and regime changes. A theory and its causal interpretation may be valid during several quarters, or during specific recurring periods, and/or be no longer valid after a large-scale event that produces a regime change. To address such features, we rely on time-varying causality tests, which are particularly appropriate as they allow us to detect whether causal relationships between political and macroeconomic variables are absent, change through time, or remain stable. In other words, they do not require the rejection of causality over the entire period, which may be seen as a very restrictive assumption in economics and finance.".

[5] Other possible methodologies exist to estimate time-varying parameter coefficients. We can mention, for example, the contributions of Li et al. (2011) in the panel data context and Inoue et al. (2024) in the time-series context. This can be used for future work regarding the estimations of time-varying fiscal and external sustainability.

It is worth noting that our approach differs from Bohn's (2007) fiscal reaction function methodology and Durdu et al.'s (2009) structural modelling of external accounts. Whereas those frameworks focus on the responsiveness to debt or incorporate non-linear structural dynamics, our contribution lies in integrating time-varying sustainability coefficients with recursive causality tests to capture evolving linkages between fiscal and external positions.

3.2. Time-varying granger causality

Following Shi et al. (2020), we rely on the lag-augmented vector autoregression (LA-VAR) approach (Toda and Yamamoto, 1995; Dolado and Lütkepohl, 1996) for testing time-varying causality between fiscal sustainability (external sustainability coefficient series) and external sustainability (fiscal sustainability coefficient series). This approach does not require any choices concerning the detrending or differencing of the series. Besides, it explicitly allows for unknown changing points in the causal relationships. This approach relies on a series of non-Granger causality tests (i.e., the null is the absence of Granger-causality between the variables). These tests are robust to structural breaks, large-scale events that produces regime changes. The LA-VAR model is expressed as follows for an n-dimensional vector y_t,

$$y_t = \gamma_0 + \gamma_1 t + \sum_{i=1}^{k} J_i y_{t-i} + \sum_{j=k+1}^{k+d} J_j y_{t-j} + \varepsilon_t \tag{5}$$

where t is a time trend, k is the lag order of the original VAR model, d denotes the maximum order of integration of the variables in y_t, and ε_t is the error term. The regression can also be written as follows:

$$y_t = \Gamma \tau_t + \Phi x_t + \Psi z_t + \varepsilon_t, \tag{6}$$

where

$\Gamma = (\gamma_0, \gamma_1)_{n\times 2}$, $\tau_t = (1, t)'_{2\times 1}$, $x_t = \left(y'_{t-1}, \cdots, y'_{t-k}\right)'_{nk\times 1}$, $z_t = \left(y'_{t-k-1}, \cdots, y'_{t-k-d}\right)'_{nd\times 1}$, $\Phi = (J_1, \cdots, J_k)_{n\times nk}$, and $\Psi = (J_{k+1}, \cdots, J_{k+d})_{n\times nd}$.

The **null hypothesis of Granger non-causality** is given by the restrictions:

$$H_0 : \boldsymbol{R}\phi = 0 \tag{7}$$

where $\phi = vec(\Phi)$ using row vectorization, and $\boldsymbol{R}$ is a $m \times n^2k$ matrix. The elements of the coefficient matrix Ψ of the final d lagged vectors are taken to be zero. Then, equation (5) can be extended to a more compact form as:

$$Y = \tau\Gamma' + X\Phi' + Z\Psi' + \varepsilon \tag{8}$$

where $Y = (y_1, y_2 \cdots, y_T)'_{T\times n}$, $\tau = (\tau_1, \cdots, \tau_T)'_{T\times 2}$, $X = (x_1, \cdots, x_T)'_{T\times nk}$, $Z = (z_1, \cdots, z_T)'_{T\times nd}$, and $\varepsilon = (\varepsilon_1, \cdots, \varepsilon_T)'_{T\times n}$. Let $Q_\tau = I_T - \tau(\tau'\tau)^{-1}\tau'$ and $Q = Q_\tau - Q_\tau Z(Z'Q_\tau Z)^{-1}Z'Q_\tau$.

The OLS estimator is:

$$\widehat{\Phi} = Y'QX(X'QX)^{-1}. \tag{9}$$

The standard Wald statistic $\mathscr{W}$ to test the hypothesis H_0 is:

$$\mathscr{W} = (\boldsymbol{R}\widehat{\phi})'\left[\boldsymbol{R}\left\{\widehat{\Sigma}_\varepsilon \otimes (X'QX)^{-1}\right\}\boldsymbol{R}'\right]^{-1}\boldsymbol{R}\widehat{\phi}, \tag{10}$$

where $\widehat{\phi} = \mathrm{vec}(\widehat{\Phi})$, $\widehat{\Sigma}_\varepsilon = \frac{1}{T}\widehat{\varepsilon}'\widehat{\varepsilon}$, and $\otimes$ denotes the Kronecker product.

Three recursive strategies, combined with Granger causality tests, can be used: (i) the forward expanding (FE) window method; (ii) the rolling window (RW) method; and (iii) the recursive evolving (RE) window method. According to the simulations by Shi et al. (2020), the RE window algorithm provides the most reliable results, followed by the RW method.[6]

Specifically, the FE window method fixes the starting point at the first observation and moves the ending points from S_w to T (see Fig. 1). Next, the RW technique moves the starting and ending points together with a constant distance S_w. The window size is thus kept constant across the time variation. Regarding the RE window method, the ending point S_2 varies across the range $[S_w, T]$. However, the starting point changes from 1 to $(S_2 - S_w) + 1$. In particular, when S_w is equal to S_2, then S_1 is equal to 1 and the window size can expand until reaching S_2, as can be seen in the upper part of Fig. 1. When S_w is equal to $(1/2)S_2$, then S_1 is equal to $1/2$ and the window size can expand until reaching S_2, as can be seen in the lower part of Fig. 1.

Thanks to the aforementioned recursive strategies, we can obtain a series of Wald statistics[7] $\left\{\mathscr{W}_{S_1,S_2}\right\}_{S_2\geq S_w}^{S_1\in[1,(S_2-S_w)+1]}$. To test for the

[6] In their simulations, Shi et al. (2020) considered different cases for the order of integration in a bivariate VAR model: both variables are stationary (case 1), one variable is I(1) and the other one is stationary (cases 2 and 3), and both are non-stationary (case 4). All the tests are very close to the nominal size of 5 percent and the RE method shows power improvements when (a) the causal strength is moderate (0.8), (b) the sample size is large (T=200, T=300), and (c) the minimum window size is below 24% of the observations.

[7] When S_w is equal to S_2, then S_1 is equal to 1 and the window size can expand until reaching S_2, as can be seen in the upper part of Fig. 3. When S_w is equal to $(1/2)S_2$, then S_1 is equal to $1/2$ and the window size can expand until reaching S_2, as can be seen in the lower part of Fig. 3.

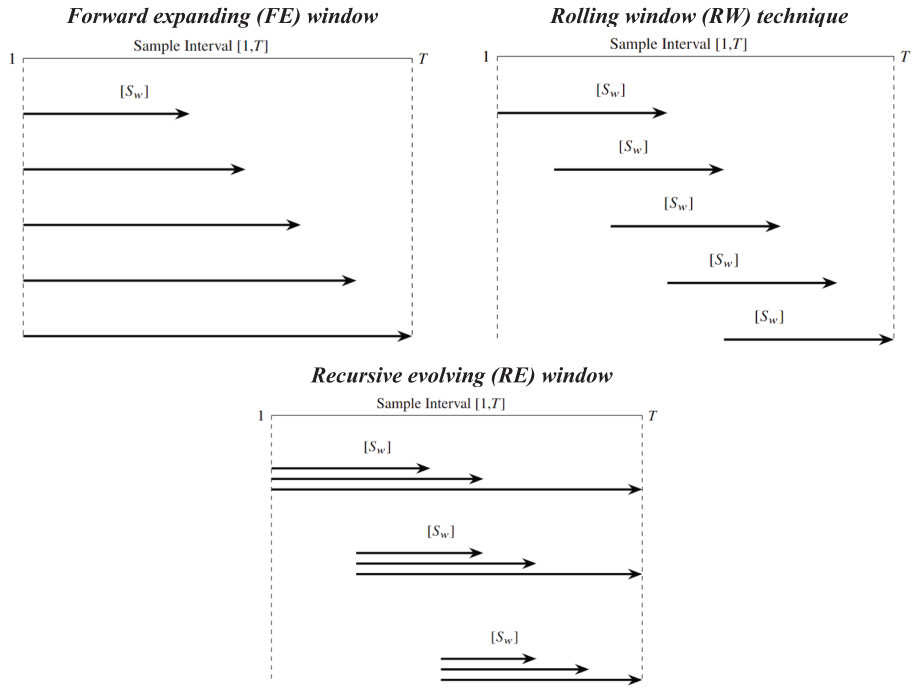

Fig. 1. Forward expanding, rolling, and recursive evolving windows schemes .
Source: Adapted from Baum et al. (2021, 2022)

Granger non-causality hypothesis, Shi et al. (2020) propose a sup-Wald statistic when recursive evolving window technique is utilized:

$$\mathscr{S}up - \mathscr{W}_{Sw} = \sup_{S_2 \geq S_w, S_1 \in [1,(S_2 - S_w)+1]} \left\{ \mathscr{W}_{S_1,S_2} \right\} \tag{11}$$

Alternatively, Shi et al. (2020) construct a sub-sample Wald test statistic with heteroskedastic errors:

$$\mathscr{W}^* = T_w(\mathbf{R}\widehat{\phi})' \left[\mathbf{R} \left\{ \widehat{V}^{-1} \widehat{\Sigma} \widehat{V}^{-1} \right\} \mathbf{R}' \right]^{-1} \mathbf{R}\widehat{\phi}, \tag{12}$$

where $\widehat{\phi} = \text{vec}(\widehat{\Phi})$ and $\widehat{\Phi}$ is the OLS estimate for the sub-sample running from S_1 to S_2. Besides:

$$\begin{aligned} &\widehat{V} = I_n \otimes \widehat{Q} \text{ with } \widehat{Q} = \frac{1}{T_w} \sum x_t x_t', \\ &\widehat{\sum} = \frac{1}{T_w} \sum \widehat{\xi}_t \widehat{\xi}_t' \text{ with } \widehat{\xi}_t = \widehat{\varepsilon}_t \otimes x_t. \end{aligned} \tag{13}$$

Therefore, the heteroskedastic-consistent sup-Wald test statistic can be expressed as:

$$\mathscr{S}up - \mathscr{W}^*_{Sw} = \sup_{S_2 \geq S_w, S_1 \in [1,(S_2 - S_w)+1]} \left\{ \mathscr{W}^*_{S_1,S_2} \right\} \tag{14}$$

The main advantage of this methodology, fully described in Shi et al. (2020), is that the null of absence of causality is not constrained to be fulfilled over the whole sample. In this sense, the approach that we use in the paper is more general. Thus, these tests are more dependable and have more economic underpinnings than standard Granger causality tests. Three outcomes are possible with these tests: (i) absence of causality over the full period; (ii) causality over specific periods; and (iii) causality over the whole sample. In the first case, the causality between fiscal and external sustainability is absent. In the second case, the causality between fiscal and external sustainability is observed over specific subperiods and can support the "twin deficit" channel and/or the "international spillover" channel. In the third case, the causality is observed over the full sample period as in the standard Granger causality tests.

It is worth acknowledging that Granger causality tests identify temporal predictive relationships rather than structural causation in a strict economic sense, and the LA-VAR framework employed here does not formally address potential endogeneity arising from omitted common drivers, simultaneous policy responses, or measurement error in the underlying fiscal and external accounts. The recursive evolving window approach mitigates concerns related to structural breaks and parameter instability, while the inclusion of the GSCPI and oil-price shocks as robustness controls absorbs part of the joint cyclical variation. Nevertheless, a fully structural identification of the fiscal–external nexus would require a different econometric design, such as a proxy SVAR or local projections with external instruments. Accordingly, we interpret our findings as time-varying predictive evidence consistent with the theoretical

channels outlined in the Introduction, rather than as estimates of structural causal effects.

4. Data

Our study comprises 27 European countries, namely, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden, covering the 2002Q1-2023Q4 period. To maintain a complete quarterly panel through 2023Q4, we include forecasted observations for 2023Q2-2023Q4 from Eurostat projections. While this ensures temporal consistency, it introduces some uncertainty because forecasts may not fully reflect unforeseen shocks or policy changes. Accordingly, results for these quarters should be interpreted as indicative trends. Nevertheless, robustness checks excluding these observations confirm that our main findings remain qualitatively unchanged.

The quarterly data on government revenues and expenditures to compute the time-varying fiscal sustainability as well as the data on exports and imports to obtain the time-varying external sustainability coefficients were retrieved from the Eurostat database.

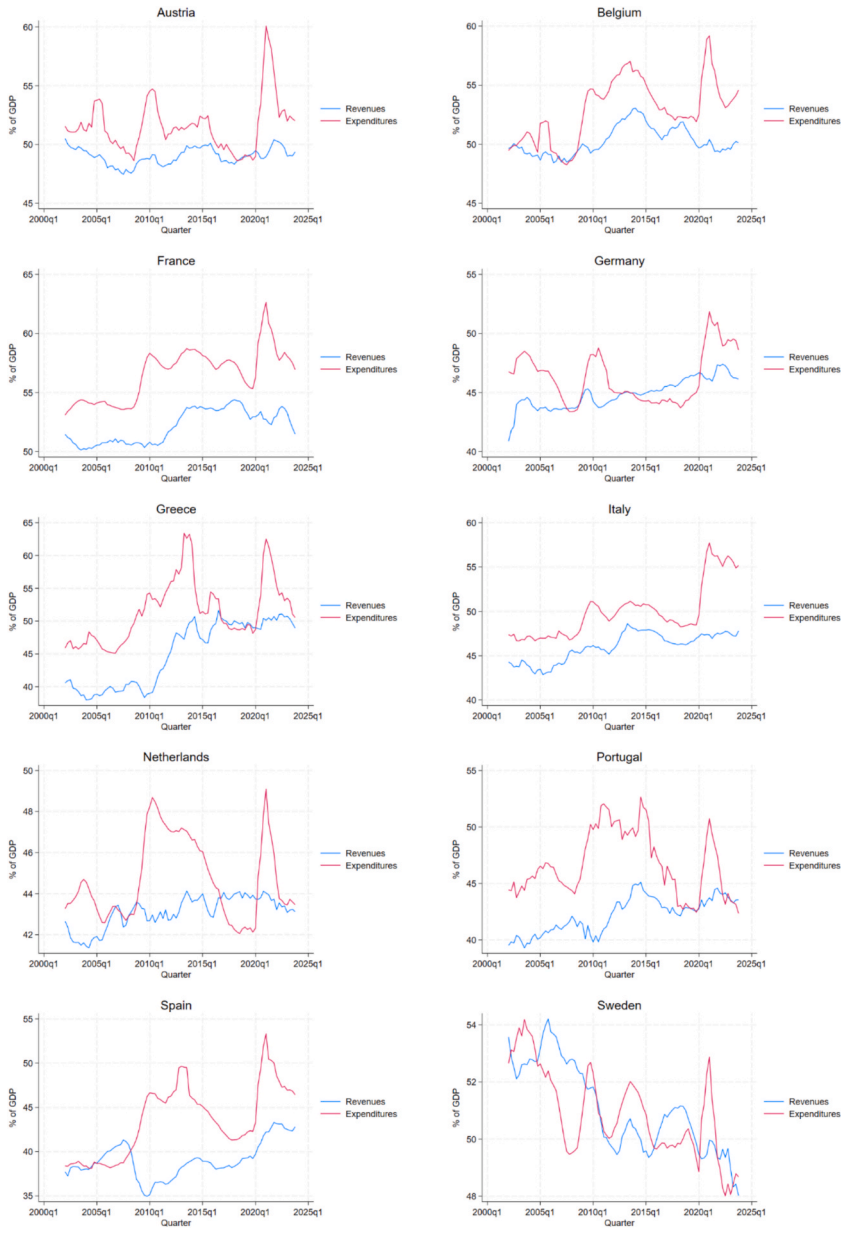

Fig. 2. Relationship between government revenues and government expenditures for selected countries, 2002Q1-2023Q4 .
Source: EUROSTAT database

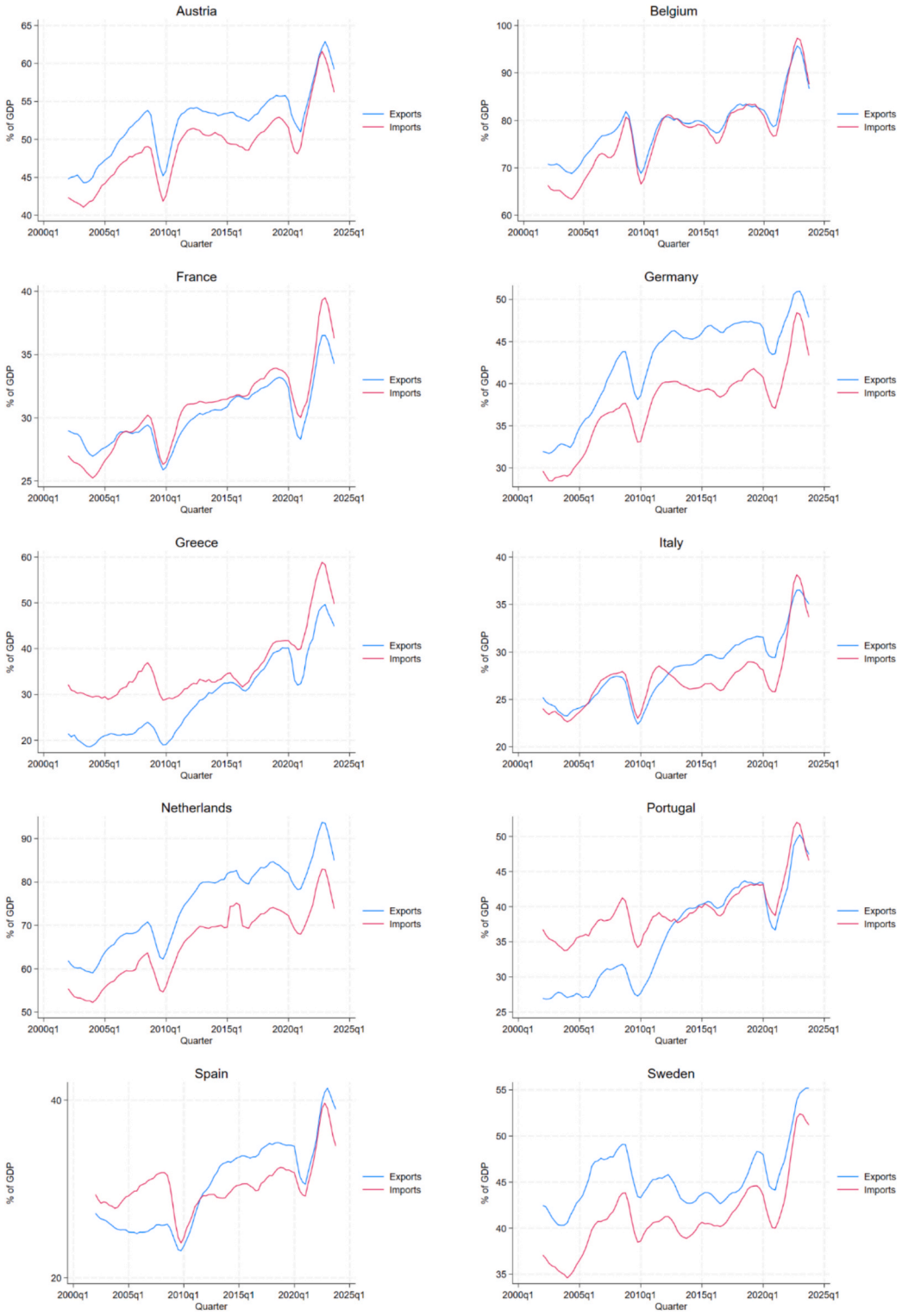

Fig. 3. Relationship between exports and imports for selected countries, 2002Q1-2023Q4 .
Source: EUROSTAT database

Table 1
Descriptive Statistics, full sample.

Variable	*Mean*	*Std. Dev.*	*Max.*	*Min.*	*Obs.*
Revenues	42.475	6.436	56.362	21.939	2376
Expenditures	45.101	6.816	64.894	21.198	2376
Exports	63.001	35.710	213.501	18.545	2376
Imports	60.732	30.011	181.690	22.651	2376
β	0.140	0.124	0.502	−0.154	2376
γ	0.744	0.222	1.065	−0.393	2376

Source: Authors' calculations.

Regarding the government revenues and expenditures dynamics as well as exports and imports evolution though time, in Figs. 2 and 3, we have highlighted such dynamics for some selected countries. Generally, while there is an overall co-movement between exports and imports, translating a more balanced external sector, the dynamics between government revenues and expenditures follow sometimes opposite directions, emphasizing some periods of fiscal imbalances.

These perceptions are somehow corroborated by the descriptive statistics for the full sample, presented in Table 1. As can be observed, the average time-varying external sustainability coefficient ($\gamma = 0.744$) is five times larger than the average time-varying fiscal sustainability coefficient ($\beta = 0.140$), highlighting, to some extent, the dissociation between the two sustainability coefficients. Moreover, in Table 2, we present the average time-varying fiscal and external sustainability per country, further illustration the higher magnitude of the external sustainability estimated coefficients. Fig. 4 depicts a temporal dynamic of these coefficients for some selected EU economies where some co-movement is visible.

In addition, Table 3 reports the averages of the time-varying coefficients of fiscal and external sustainability for several groups of EU countries: core, periphery, Baltic, Central and Eastern, Euro Area and non-Euro Area.[8] We consider this distinction between Euro Area and non-Euro Area since the loss of the exchange rate policy may lead some economies to suffer from recurrent external imbalances that forced some financial and fiscal international program interventions, namely the peripheral Euro Area economies. The distinction between Euro Area and non-Euro Area countries may further elucidate the impact of monetary union on fiscal and external sustainability. In particular, Table 3 shows that the average of the time-varying coefficients of fiscal sustainability for the core countries is lower when considering all the countries. However, the average time-varying coefficients of external sustainability are higher. In turn, peripheral countries exhibit lower averages in relation to core countries and the full sample for both fiscal and external sustainability coefficients. For the Baltic countries, the average fiscal sustainability coefficients are higher compared to the full sample; in the case of external sustainability coefficients, the average is lower. Central and Eastern countries exhibit higher averages relative to the full sample. Comparing countries that belong to the Eurozone and those that do not belong to the Eurozone, the average values of the time-varying coefficients of fiscal and external sustainability are lower for countries that are part of the Eurozone.

To structure the reading of the European heterogeneity, we overlay three features on our country groupings (core, periphery, Baltics, CEEC; euro vs. non–euro): (i) energy import dependence/terms–of–trade losses in 2022; (ii) external balance–sheet positions (NFA) and financial openness; and (iii) institutional capacity, proxied by pre–2020 fiscal–rule compliance and the presence of market backstops. These features help rationalise why non–euro and CEEC members exhibit higher average sustainability coefficients (diversified markets, positive integration effects), why periphery members show lower average coefficients (financing constraints and narrower bases), and why euro–area membership interacts with the risk–premium channel in crisis windows. We use this framework when reading the causal windows below.

Given the effects of the 2008 GFC on EU countries, and the subsequent Eurozone crisis in 2010–2012, we distinguish between the periods prior and after the GFC, i.e., the pre-GFC and the post-GFC periods refer to the time span before and after 2009 (inclusive), respectively. Thus, based on Table 4, we can see that after the 2008 GFC, there was an improvement in fiscal and external sustainability for most European Union countries as well as for the European Union as a whole, especially regarding external sustainability. This evidence is due to the fiscal and external adjustments that occurred in these countries after 2009 and also following the Eurozone crisis in 2010–2012, which resulted in the correction of the fiscal and external imbalances that had accumulated until then.

Furthermore, Table 5 points out that the fiscal/external sustainability and external/fiscal sustainability causal relationships became stronger after the outbreak of the 2008 GFC for the several groups of countries included in the analysis.

Nonetheless, despite the descriptive statistics and the average time-varying fiscal and external coefficients per country and groups of countries, we compute the correlation between such variables, as illustrated in the heatmap of Fig. 5. We can clearly see a higher correlation between expenditures and revenues, suggesting that there may be higher fiscal sustainability levels, which is contradicted by the average value of the time-varying fiscal sustainability coefficients, presented in Table 1. At the same time, we find low correlation values between fiscal and external time-varying sustainability coefficients. Moreover, considering the different time-varying

[8] The core EU countries' group is composed by Austria, Belgium, Denmark, Finland, France, Germany, Luxembourg, the Netherlands, and Sweden. In the peripheral EU countries' group, we consider Cyprus, Greece, Ireland, Italy, Malta, Portugal and Spain. Estonia, Latvia and Lithuania belong to the Baltic EU countries' group. The Central and Eastern EU countries' group integrates Bulgaria, Croatia, Czechia, Hungary, Poland, Romania, Slovakia, and Slovenia. The Euro Area countries are: Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. In turn, the non-Euro Area countries are: Bulgaria, Czechia, Denmark, Hungary, Poland, Romania, and Sweden.

Table 2
Average time-varying fiscal and external sustainability coefficients, 2002Q1-2023Q4.

	Fiscal	*External*		*Fiscal*	*External*
Austria	0.016	0.928	**Italy**	0.125	0.664
Belgium	0.063	0.815	**Latvia**	0.157	0.528
Bulgaria	0.199	0.722	**Lithuania**	0.097	0.713
Croatia	0.133	0.684	**Luxembourg**	0.282	0.954
Cyprus	−0.008	0.391	**Netherlands**	0.189	0.840
Czechia	0.300	0.975	**Malta**	0.027	0.792
Denmark	0.441	0.975	**Poland**	0.165	0.706
Estonia	0.239	0.692	**Portugal**	0.019	0.781
Finland	−0.046	0.813	**Romania**	0.209	0.636
France	0.030	0.858	**Slovakia**	0.032	0.801
Germany	0.113	0.828	**Slovenia**	0.386	0.849
Greece	0.121	0.737	**Spain**	0.037	0.729
Hungary	0.159	0.820	**Sweden**	0.132	0.881
Ireland	0.154	−0.033			

Source: Authors' calculations.

sustainability coefficients of each economy, and given the different development patterns and features of the EU economies that we are considering in this study, we calculated the correlation matrix along different country groups, presented in Table 6.

Hence, from Table 6, we can conclude that in core EU countries, the correlation between fiscal and external sustainability coefficients is moderate (0.626), indicating a nuanced relationship where fiscal policies and external balances influence each other being relatively interdependent. This suggests that core countries may possess more robust mechanisms to manage fiscal and external imbalances independently. Conversely, in peripheral EU countries, the correlation is negative and close to zero, highlighting a weaker interdependence between fiscal and external sustainability. This could imply that peripheral countries are more vulnerable to external shocks, which can significantly impact their fiscal stability.

Euro Area countries exhibit a lower correlation between fiscal and external variables, particularly pre-GFC, suggesting that the shared fiscal and monetary policy framework may not amplify the interdependence between these two aspects of sustainability. Non-Euro Area countries, on the other hand, show a more varied pattern, with some exhibiting strong correlations while others do not, reflecting the diverse fiscal and external dynamics outside the Eurozone.

The temporal analysis, comparing pre- and post-GFC periods, reveals significant shifts in the relationships between fiscal and external sustainability. In the pre-GFC period, the correlations are generally lower, indicating a more stable and less interdependent relationship. However, post-GFC, the correlations increase, particularly in Euro Area countries, suggesting that the crisis has heightened the sensitivity of fiscal sustainability to external factors. This shift underscores the importance of external balances in maintaining fiscal health in the aftermath of economic shocks.

The study also highlights regional variations within the Euro Area, distinguishing between peripheral and non-peripheral countries. Peripheral Euro Area countries exhibit higher correlations and interdependency between fiscal and external sustainability post-crisis, indicating a heightened vulnerability to external shocks. Non-peripheral Euro Area countries, while also showing increased correlations post-crisis, maintain a relatively lower level of interdependence compared to their peripheral counterparts. This suggests that non-peripheral countries may have more resilient fiscal frameworks that can better absorb external shocks.

In summary, the correlation matrices underscore the complex and dynamic relationship between fiscal and external sustainability across different EU regions and time periods. The findings highlight the varying degrees of interdependence between fiscal policies and external balances, influenced by regional characteristics, monetary union membership, and economic shocks. These insights are crucial for policymakers aiming to enhance fiscal and external sustainability, particularly in the context of economic integration and global financial volatility.

5. Empirical analysis

5.1. Does fiscal sustainability cause external sustainability?

In this subsection, we now use the time-varying sustainability coefficients obtained in the first step analysis, to compute the causality patterns between fiscal sustainability and external sustainability.

Based on Fig. C.1 (Online Appendix C), where we plot the recursive time-varying granger causality tests, the null hypothesis of non-causality is rejected in several cases (forward expanding window and rolling window results are reported in the Online Appendix E). Hence, we can draw some conclusions about the evidence of causality between fiscal sustainability coefficients and external sustainability coefficients for the 27 European Union countries in the period between 2006Q4 and 2023Q4.

When the 2008 GFC occurred, in some countries that fiscal sustainability Granger causes external sustainability, namely in Austria, Croatia, Czechia, Germany, Ireland, Netherlands, Slovakia, Spain, and Sweden (where the null hypothesis of no-Granger causality is rejected, and with the test statistic surpassing the confidence bands).

During the period of the Eurozone crisis in 2010–2012, in Austria, France, Greece, Ireland, Netherlands, Slovakia and Spain, there was a causality between fiscal sustainability and external sustainability. In some countries that are not part of the Euro Area, this

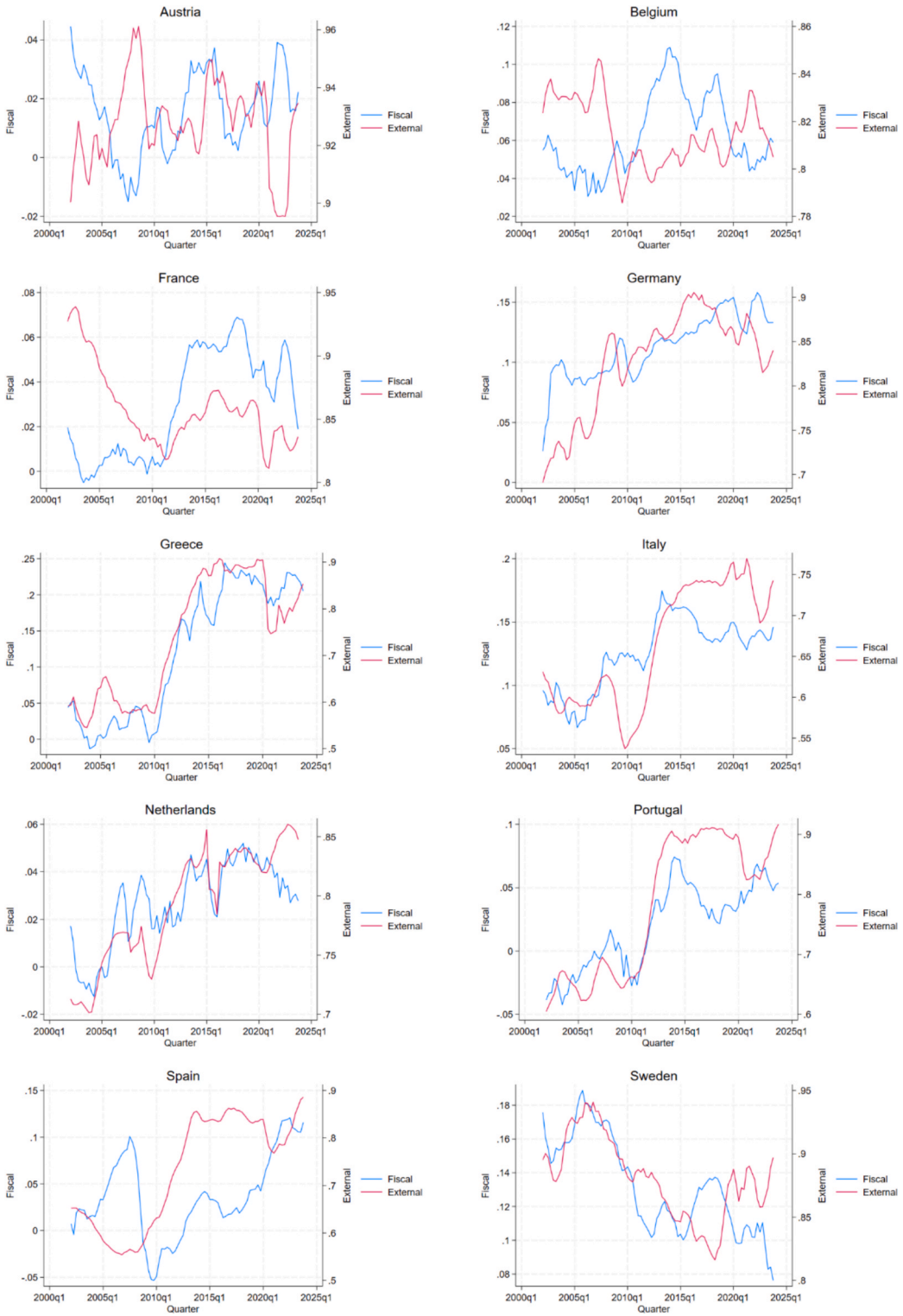

Fig. 4. Time-varying fiscal and external sustainability coefficients, 2002Q1-2023Q4 .
Source: Authors' calculations

Table 3
Average time-varying fiscal and external sustainability coefficients by country groups, 2002Q1-2023Q4.

Sample	*Fiscal*	*External*
Full Sample	0.140	0.744
Core countries	0.135	0.877
Periphery countries	0.068	0.580
Baltic countries	0.164	0.644
Central and Eastern countries	0.198	0.774
Euro Area countries	0.105	0.719
Non Euro Area countries	0.229	0.816

Source: Authors' calculations.

Table 4
Average time-varying fiscal and external sustainability coefficients by countries, pre- and post-GFC, 2002Q1-2023Q4.

	Fiscal		*External*	
	PRE-GFC	**POST-GFC**	**PRE-GFC**	**POST-GFC**
Austria	0.011	0.018	0.928	0.927
Belgium	0.045	0.071	0.830	0.808
Bulgaria	0.238	0.180	0.545	0.805
Croatia	0.132	0.133	0.581	0.733
Cyprus	−0.047	0.011	0.317	0.426
Czechia	0.281	0.309	0.924	0.999
Denmark	0.464	0.430	0.950	0.986
Estonia	0.201	0.257	0.574	0.746
Finland	−0.063	−0.038	0.919	0.763
France	0.005	0.041	0.888	0.844
Germany	0.085	0.126	0.760	0.859
Greece	0.020	0.169	0.593	0.804
Hungary	0.127	0.173	0.738	0.859
Ireland	0.284	0.094	−0.331	0.106
Italy	0.092	0.141	0.603	0.692
Latvia	0.106	0.181	0.334	0.619
Lithuania	0.074	0.107	0.575	0.777
Luxembourg	0.280	0.283	0.912	0.974
Netherlands	0.190	0.188	0.735	0.890
Malta	0.009	0.035	0.740	0.817
Poland	0.167	0.165	0.583	0.763
Portugal	−0.015	0.035	0.652	0.841
Romania	0.232	0.198	0.482	0.707
Slovakia	0.030	0.032	0.711	0.843
Slovenia	0.355	0.401	0.794	0.875
Spain	0.043	0.034	0.594	0.793
Sweden	0.166	0.116	0.915	0.865
Mean	0.130	0.144	0.661	0.782

Source: Authors' calculations.

Table 5
Normalized means of test statistics of causality tests by groups of countries, pre- and post-GFC, 2006Q4-2023Q4.

Sample	Fiscal causes External	External causes Fiscal
Core	0.300	0.189
Peripheral	0.205	0.322
Baltic	0.299	0.275
CEEC	0.245	0.218
pre-GFC	0.134	0.169
post-GFC	0.278	0.252
Core pre-GFC	0.195	0.161
Peripheral pre-GFC	0.072	0.162
Baltic pre-GFC	0.100	0.150
CEEC pre-GFC	0.132	0.193
Core post-GFC	0.316	0.193
Peripheral post-GFC	0.224	0.346
Baltic post-GFC	0.328	0.294
CEEC post-GFC	0.262	0.221

Source: Authors' calculations.

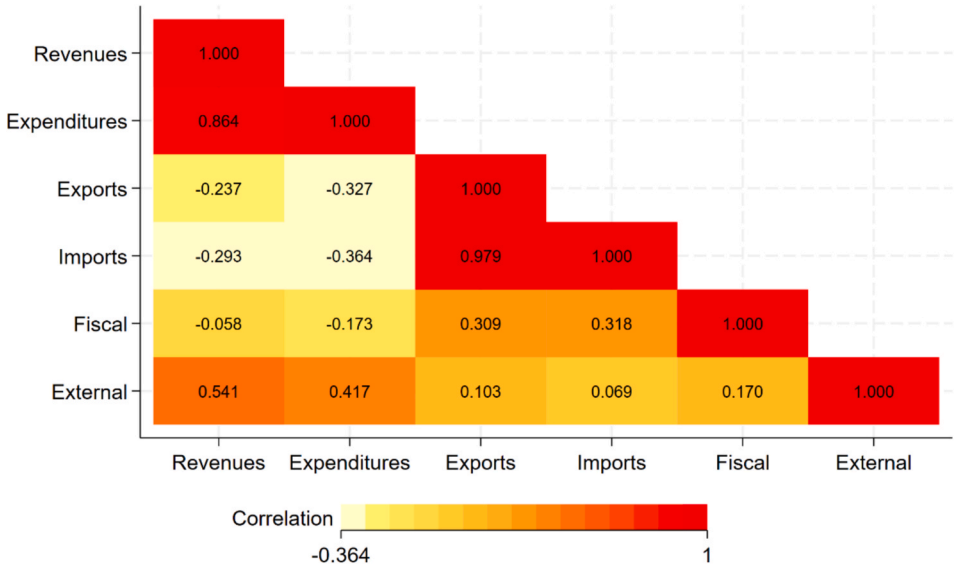

Fig. 5. Heatmap of correlation matrix, full sample .
Source: Authors' calculations

pattern of causality is also observed, namely Croatia, Romania and Sweden.

Throughout the great confinement crisis associated with the SARS-CoV-2 pandemic (2020–2022), we obtained empirical support for the causality between fiscal sustainability and external sustainability in countries such as Croatia, Cyprus, Czechia, Denmark, Finland, Germany, Greece, Ireland, Italy, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain.

Furthermore, for Bulgaria, there is a pattern of causality between fiscal sustainability and external sustainability as of 2010Q2; for Cyprus, from 2020Q3; Czechia, from 2021Q3; Malta, from 2020Q2; Portugal, from 2018Q4; Slovakia, from 2021Q1; and Spain, from 2014Q2. In Latvia, there is no causality between the fiscal and external sustainability coefficients in the period under analysis.

5.2. Does external sustainability cause fiscal sustainability?

Moreover, we now use the time-varying sustainability coefficients obtained in the first step analysis, to compute the causality patterns between external sustainability and fiscal sustainability.

Analyzing Fig. C.2 (Online Appendix C), we can conclude that, during the occurrence of the 2008 GFC, the pattern of causality between external sustainability and external sustainability was not significant in the European Union countries, with the exceptions of Czechia, Poland, Romania and Slovakia.

During the Euro Area crisis, causality was observed between the external and fiscal sustainability coefficients in countries that are part of the Economic and Monetary Union – Austria, Germany, Malta, Netherlands, Slovakia, Slovenia and Spain – as well as in countries that did not adopt the single currency – Bulgaria, Denmark, Hungary and Poland.

In countries such as Bulgaria, Croatia, Denmark, Finland, France, Germany, Hungary, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, Slovenia and Sweden, during the great confinement crisis, we may observe this pattern of causality.

In Italy, from 2013Q4, and in Romania, from 2012Q4, external sustainability Granger causes fiscal sustainability. In Lithuania, this causality pattern between 2015Q2 and 2022Q2 is observed. In Cyprus and Portugal, there was no causality between the external and fiscal sustainability coefficients for the majority of the period under analysis.

Interpreting Figures C.1 and C.2 (Online Appendix C) through the lens mentioned in Section 4, "fiscal-to-external" episodes in stressed EMU members around 2010–2012 align with the risk premium channel: improvements in fiscal sustainability coincided with restored market access and lower rollover risk, which eased external funding constraints. By contrast, during 2020–2022 the combination of monetary backstops and common fiscal capacity reduced sovereign risk salience, so "external-to-fiscal" effects strengthened as export rebounds and the services reopening boosted revenue bases and compressed premia. The 2022–2023 energy shock then reintroduced asymmetry: net energy importing countries with large price shield packages display weaker "fiscal-to-external" transmission, while more diversified exporters or less energy dependent economies show a faster external correction with attendant fiscal improvement. This event conditioned reading is consistent with the mechanisms set out in the Introduction and explains why directionality differs by group.

The cross-country patterns we document align closely with the major economic, social, and policy events that reshaped Europe over our sample. First, the 2004–2013 waves of EU enlargement and deepening supply-chain integration of Central and Eastern European countries (CEECs) into the production networks of the "core" are consistent with the higher average sustainability coefficients and tighter fiscal-external comovements we observe for that group. Evidence shows that accession catalysed value-chain

Table 6
Correlation Matrix by countries' groups and periods.

	Core European Countries					***Peripheral European Countries***				
	Revenues	*Expenditures*	*Exports*	*Imports*	*Fiscal*	*Revenues*	*Expenditures*	*Exports*	*Imports*	*Fiscal*
Expenditures	0.841					0.808				
Exports	−0.576	−0.616				−0.589	−0.574			
Imports	−0.546	−0.570	0.995			−0.519	−0.513	0.981		
Fiscal	0.062	−0.188	0.385	0.352		0.252	0.109	0.357	0.355	
External	0.106	−0.152	0.344	0.301	0.626	0.562	0.452	−0.134	−0.068	−0.088
	Euro area countries					***Non-Euro area countries***				
Expenditures	0.851					0.896				
Exports	−0.385	−0.486				0.185	0.218			
Imports	−0.383	−0.470	0.986			−0.053	0.001	0.937		
Fiscal	−0.274	−0.319	0.517	0.531		0.403	0.219	0.113	0.001	
External	0.537	0.380	0.050	0.060	−0.012	0.607	0.525	0.616	0.341	0.473
	Baltic countries					***CEEC countries***				
Expenditures	0.613					0.830				
Exports	0.498	0.198				0.391	0.274			
Imports	0.370	0.020	0.916			0.334	0.217	0.969		
Fiscal	0.947	0.405	0.477	0.412		−0.337	−0.402	0.298	0.349	
External	0.407	0.252	0.917	0.722	0.308	0.271	0.168	0.791	0.661	0.330
	Pre-GFC					***Post-GFC***				
Expenditures	0.874					0.863				
Exports	−0.102	−0.195				−0.308	−0.421			
Imports	−0.261	−0.316	0.958			−0.326	−0.423	0.985		
Fiscal	−0.096	−0.214	0.341	0.353		−0.046	−0.171	0.296	0.303	
External	0.644	0.628	0.075	0.004	−0.037	0.495	0.276	0.052	0.048	0.308
	Pre-GFC & Euro area					***Post-GFC & Euro area***				
Expenditures	0.835					0.861				
Exports	−0.153	−0.395				−0.434	−0.531			
Imports	−0.199	−0.396	0.984			−0.421	−0.513	0.986		
Fiscal	−0.516	−0.622	0.706	0.682		−0.215	−0.276	0.450	0.475	
External	0.746	0.699	−0.018	−0.027	−0.524	0.511	0.286	0.038	0.052	0.180
	Pre-GFC & non-Euro area					***Post-GFC & non-Euro area***				
Expenditures	0.883					0.890				
Exports	−0.081	0.015				0.104	0.027			
Imports	−0.295	−0.206	0.945			−0.090	−0.113	0.961		
Fiscal	0.364	0.208	0.038	−0.023		0.428	0.257	0.234	0.092	
External	0.669	0.651	0.324	0.086	0.598	0.570	0.345	0.529	0.312	0.646
	Pre-GFC & Euro area & Peripheral					***Post-GFC & Euro area & Peripheral***				
Expenditures	0.809					0.814				
Exports	−0.644	−0.638				−0.639	−0.664			
Imports	−0.570	−0.520	0.967			−0.562	−0.601	0.984		
Fiscal	−0.526	−0.666	0.797	0.665		0.410	0.284	0.254	0.277	
External	0.750	0.780	−0.667	−0.519	−0.861	0.597	0.347	−0.181	−0.118	0.201
	Pre-GFC & Euro area & non-Peripheral					***Post-GFC & Euro area & non-Peripheral***				
Expenditures	0.811					0.924				
Exports	−0.535	−0.701				−0.375	−0.453			
Imports	−0.527	−0.678	0.995			−0.411	−0.470	0.990		
Fiscal	−0.606	−0.590	0.844	0.827		−0.643	−0.624	0.566	0.608	
External	0.531	0.237	0.183	0.145	0.080	0.153	0.063	0.486	0.419	0.173

Source: Authors' calculations. We have also considered the Euro Area group combining all the countries that have introduced the euro as currency. We set a country that belongs to the Euro Area when the euro currency begins to circulate in a respective period.

trade and reallocation effects that raised productivity and employment in the entrants, thereby supporting external adjustment through export upgrading and diversified market access (Kaplan et al., 2018; see also the broader post-enlargement assessments in Lane and Milesi-Ferretti, 2012). These structural forces matter for our time-varying causality results: integration into German-centered value chains and stronger institutions likely dampened the volatility of the external sustainability coefficient in CEECs, while easing the fiscal costs of adjustment via stronger revenue bases during expansions.

Furthermore, the Global Financial Crisis (GFC) and the subsequent euro–area sovereign debt crisis generated sharp capital–flow reversals and demand compression in deficit countries, with external adjustment operating more through expenditure reduction than through expenditure switching. This macro environment helps explain why the post–GFC strengthening in external sustainability that we find is most pronounced exactly where pre–crisis "excess deficits" were largest (Lane and Milesi-Ferretti 2012). The crisis phase also featured powerful policy regime shifts. The ECB's Outright Monetary Transactions (OMT) commitment in mid–2012 durably reduced sovereign spreads in stressed members, loosening fiscal financing constraints and – via the bank-sovereign nexus – supporting the restoration of external funding conditions (Altavilla, et al., 2016). In our framework, these interventions are consistent with episodes in which improvements in fiscal sustainability Granger–cause improvements in external sustainability for peripheral EMU economies during 2010–2012, reflecting the mechanism by which lower rollover risk and cheaper funding permit more orderly current–account

adjustment.

Additionally, the pandemic shock (2020–2022) again altered the mapping between fiscal and external dynamics but in ways that differed across country groups. At the monetary level, the Pandemic Emergency Purchase Programme (PEPP) compressed sovereign and corporate spreads – particularly in peripheral markets – thereby stabilizing both fiscal trajectories and external financing conditions (Pinto and Costa, 2023). At the fiscal-institutional level, the activation of the SGP general escape clause and the launch of NextGenerationEU (NGEU) relaxed near–term fiscal constraints and promised medium–term growth–enhancing investment, with model–based assessments pointing to sizable level effects on output in the main beneficiaries and positive spillovers to the rest of the euro area (Bańkowski et al., 2022). This combination of monetary backstops and common fiscal capacity helps rationalize our finding that time–varying causality from external to fiscal sustainability strengthened in several EMU members during the pandemic: once market stress was quelled, external rebounds driven by goods exports and the services reopening fed back into revenue bases and lower risk premia, improving the fiscal sustainability coefficient.

Finally, the 2021–2023 energy–price and terms–of–trade shock – amplified by Russia's invasion of Ukraine – introduced a new, asymmetric layer of heterogeneity. For net energy importers, the terms–of–trade loss eroded real incomes, weighed on private absorption, and, in some cases, widened external imbalances even when headline current accounts temporarily improved via import compression. Where governments deployed large energy price shields or tax relief, the short–run effect was to support disposable income and smooth external adjustment, at the cost of higher gross financing needs that temporarily weakened the fiscal sustainability coefficient (Dullien and Tober, 2024). In our time–varying tests, these forces help to explain why some core economies exhibit weaker fiscal–to–external causality during 2022–2023, even as peripheral economies with narrower export bases and higher energy dependence display the opposite pattern when fiscal measures and regained market access stabilized domestic demand while external balances adjusted more gradually.

Together, these event–conditioned mechanisms underscore that the heterogeneity we detect – between core and periphery, EMU and non–EMU, and across enlargement cohorts – is not merely statistical. It reflects the evolving interaction among financial conditions (crisis backstops, QE), common fiscal capacity (NGEU), structural integration (value chains, trade specialization), and relative price shocks (energy terms of trade). This reading is consistent with pre– and post–crisis narratives that emphasize demand–driven external adjustment under tight financing constraints (Lane and Milesi-Ferretti 2012), the potency of OMT and, later, PEPP in compressing sovereign risk (Altavilla et al., 2016; Pinto and Costa, 2023), and the role of NGEU in mitigating divergence during the pandemic (Bańkowski et al., 2022), while the energy shock reintroduces asymmetric pressures whose fiscal and external footprints differ by exposure and policy response (Dullien and Tober, 2023).

5.3. Robustness checks

In order to conduct robustness checks, we introduced the Global Supply Chain Pressure Index (GSCPI) crafted by the Federal Reserve Bank of New York (York, 2025), and the global oil price as control variables in the LA-VAR model with alternative econometric specifications. These variables allow for a better understanding of the strength of the terms-of-trade/external-shock channel and to capture heterogeneous responses of European countries to global supply chain pressures and oil price shocks. More specifically, European countries are characterized by varying degrees of exposure to external trade and global value chains. Furthermore, the intensity of oil imports – defined as the share of oil imports in total imports – may also influence the transmission of shocks through the terms-of-trade / external-shock channel, particularly in light of the surge in post-COVID inflation.

With regard to the causal relationship between fiscal sustainability and external sustainability (see Fig. D.1 in Online Appendix D, which reports the recursive evolving window time-varying Granger causality from fiscal to external sustainability under the GSCPI and oil-price-shock control variables, country by country), when taking the standalone control variables, we note that:

(i) for some countries (Austria, Belgium, Cyprus, Greece, Hungary, Italy, Lithuania, and the Netherlands), the period during which evidence of causality is observed is longer, particularly when oil price shocks are considered;

(ii) conversely, in the cases of Estonia, Finland, and Slovenia, the period of evidence of causality is longer when the GSCPI is considered;

(iii) for Luxembourg, the period of evidence of causality is longer for both control variables;

(iv) there is a reduction in the period during which evidence of causality is observed for Bulgaria, Croatia, France, and Spain;

(v) for Czechia, Germany, and Slovakia, the causality pattern is similar when both controls are considered; when the GSCPI is used as a control, the pattern of causality is similar for Denmark, Italy, and Sweden; whereas when oil price shocks are considered, similarities in the causality pattern are observed in the cases of Ireland, Poland, and Portugal;

(vi) finally, in the case of Latvia, evidence of causality emerges, while for Malta and Romania, the causality pattern changes.

Furthermore, based on Fig. D.2 in Online Appendix D (which reports the corresponding recursive evolving window time-varying Granger causality from external to fiscal sustainability under the same control variables), we also identify certain similarities and differences in relation to the causality patterns between external sustainability and fiscal sustainability reported in Section 5.2, namely:

(i) the change in the causality pattern for Austria, Belgium, Cyprus, Czechia, the Netherlands, Romania, and Spain, with a more prolonged period of evidence when oil price shocks are considered; in the cases of Greece and Portugal, this evidence emerges under both controls;

(ii) a similar causality pattern when considering the GSCPI (Denmark and France); and a similar causality pattern when considering oil price shocks (Bulgaria, Finland, Latvia, Luxembourg, and Sweden); a similar causality pattern, with a more prolonged period of evidence for both controls (Germany and Poland); and a similar causality pattern under both controls (Malta and Slovakia);

(iii) for Croatia, there is a more prolonged period of evidence under both controls, whereas for Hungary, Italy, Lithuania, and

Slovenia, there is a reduction;

(iv) in the cases of Estonia and Ireland, changes in the causality pattern emerge.

6. Conclusion

In this paper, we have performed a novel two-step time-varying analysis in order to identify causality patterns between fiscal and external sustainability for 27 EU countries during the period 2002Q1-2023Q4.

The first step of the empirical analysis consists of computing the time-varying coefficients of fiscal and external sustainability, based on the relationships between government revenues and expenditures as well as between exports and imports, using Schlicht's (2021) method. Next, we follow three recursive strategies, namely forward expanding window, rolling window technique and recursive evolving window, to implement Granger causality tests, aiming to capture causal relationships between fiscal and external sustainability.

An important conclusion of our article is related to the existing heterogeneity of the so-called fiscal and external sustainability coefficients of EU countries taken individually as well as between groups of countries. More specifically, peripheral countries have lower sustainability coefficients, while Central and Eastern countries exhibit higher coefficients. In addition, the correlation between fiscal and external sustainability coefficients is moderate (0.626) for core countries who may possess more robust mechanisms to manage fiscal and external imbalances independently. Conversely, in peripheral EU countries, the correlation is close to zero, implying that peripheral countries are more vulnerable to external shocks, which can significantly impact their fiscal stability.

Furthermore, non-Eurozone countries have higher sustainability coefficients compared to Eurozone countries. After the 2008 GFC, there was an improvement in fiscal and external sustainability for most EU countries as well as for the EU as a whole, especially with regard to external sustainability. Moreover, during the Eurozone crisis in 2010–2012, causality was observed between external and fiscal sustainability in EMU countries (Austria, Germany, Malta, Netherlands, Slovakia, Slovenia, and Spain) and in non-EMU countries. Hence, preemptive and ex-post policy measures necessarily require country fine-tuned, given notably such EU fiscal and macro frameworks as the SGP and the MIP.

From a country-group perspective, our findings translate into differentiated policy priorities. Peripheral EMU members, given their lower fiscal sustainability coefficients and heightened sensitivity to the risk-premium channel documented above, should accumulate sufficient fiscal buffers in normal times in order to preserve market access when external financing conditions tighten and the sovereign–bank nexus tightens with them. Non-EMU members benefit from the absorption role of exchange-rate flexibility, yet remain exposed to terms-of-trade and capital-flow reversals; for these economies, prudent fiscal management should be complemented by macroprudential instruments that limit the build-up of external imbalances, and by adequate foreign-currency liquidity buffers. Central and Eastern European countries (CEECs), whose external sustainability is supported by their integration into core European value chains, should preserve the structural conditions that sustain export upgrading and diversified market access, while strengthening domestic fiscal institutions and revenue bases so as to insulate public finances from cyclical external shocks. These differentiated prescriptions are consistent with the heterogeneity captured by our time-varying coefficients and recursive causality tests, and they reinforce the case for country-fine-tuned implementation of the EU's common fiscal and macroeconomic surveillance frameworks.

In addition, the patterns of causality between fiscal and external sustainability of the several EU countries have specificities in each country. Nevertheless, the crises that occurred during the period under analysis, namely the 2008 GFC, the Eurozone crisis in 2010–2012 and the great confinement crisis in 2020–2022, provide a useful framework and explanations.

A possible caveat of our analysis is the reliance on forecasted data for the last three quarters of 2023, which may embed model assumptions rather than realized outcomes. Although this does not materially affect the core results, it underscores the need for future updates once actual data become available. Finally, following our work, one topic that could be studied in future research is the examination of the determinants of fiscal and external sustainability and the interdependence between both sustainability coefficients. This analysis could be conducted for a specific EU country and/or for the broad panel of EU countries. Several specific extensions appear especially promising: (i) embedding time-varying fiscal reaction functions – in the spirit of Bohn (1998), but with recursive coefficients—into the present framework, so as to characterize the response of primary surpluses to debt dynamics and to external positions across regimes; (ii) testing for threshold effects in the time-varying sustainability coefficients, which would allow the data to identify non-linear adjustments associated with specific debt-to-GDP or current-account thresholds and complement the recursive evidence reported here; and (iii) examining the role of financial market integration – proxied, for instance, by cross-border banking exposures, sovereign-bond spread comovement, or measures of capital-account openness – in mediating the strength of the fiscal-external linkages over time, with a view to disentangling the risk-premium channel from the demand/absorption channel discussed in this paper.

CRediT authorship contribution statement

António Afonso: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **José Alves:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **José Carlos Coelho:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jamel Saadaoui:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project

administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jimonfin.2026.103610.

Data availability

Data will be made available on request.

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