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The international dimension of an incomplete EMU

Abstract

This paper quantifies the economic influence that shocks to EMU cohesion, which in turn reflect the incomplete nature of the monetary union, have on the rest of the world. Disentangling euro area stress shocks and global risk aversion shocks based on a combination of sign, magnitude and narrative restrictions in a daily Structural Vector Autoregression (VAR) model with financial variables. We find that the effects of euro area stress shocks are significant not only for the euro area but also for the rest of the world. Notably, an increase in euro area stress entails a slowdown of economic activity in the rest of the world, as well as a fall in imports/exports of both the euro area and the rest of the world. A decrease in euro area stress has somewhat more widespread beneficial effects on both economic performance and global trade activity.

Keywords: Economic and Monetary Union, Bayesian SVAR, narrative sign restrictions, panel local projections

JEL Codes: C23, C32, F02, F33

Non-technical summary

Since the global financial crisis of 2007-08 and the ensuing crisis in the euro area of 2010-2012, the "completion" or deepening of the European Economic and Monetary Union (EMU) has been a matter of an extensive and sometimes controversial debate. Already during and soon after that crisis, European Union policy makers announced and then took some significant steps to deepen the EMU[1]. The ECB, for its part and in pursuit of its mandate, also took extraordinary steps during the crisis by implementing some non-standard measures, which have underlined its willingness to act as an appropriate lender of last resort.

Nevertheless, this process of EMU deepening has not been always smooth and remains incomplete. It has implied *de facto* variations in the degree of EMU cohesion over time. The process was also pursued largely with an inward looking perspective that mostly neglected, at least explicitly, the external, or international, dimension. For example, the euro area (and the European Union as a whole), has still to take notable steps with regard to its international representation or the international role of the euro. The premise has been that the completion of EMU, apart from making the euro area more resilient to global shocks, will also have benefits for the global economy.

While this is true overall according to our findings, the process of completing EMU has entailed both advances and setbacks, or negative and positive (euro area) stress shocks that impact the rest of the world, with differentiated effects on advanced economies on the one hand and emerging economies on the other. The effects of euro area shocks also seem to have slightly asymmetrical effects on the rest of the world, depending on whether they are positive or negative. At the same time, global (risk aversion) shocks as well significantly affect the euro area economy, thus implying the need for more EMU cohesion.

The identification of the various shocks, that is, their origin (euro area or global), the extent to which they are significant and for which part of the global economy, as well as the magnitude of their economic impact, has been a matter of debate in the literature. In this regard, three noteworthy aspects of this paper relate to i) constructing an appropriate, high-frequency measure of EMU cohesion, which we call EASTR (for euro area stress) which relies on government bond spreads; ii) making use of appropriate (sign, magnitude and narrative) restrictions in the

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[1]For example, in 2012 the decision was taken to create the banking union with single European supervision residing at the ECB, and advancing bank resolution arrangements at the European level through the Single Resolution Mechanism (SRM) and the Single Resolution Fund (SRF) of bank-based contributions. These steps went hand in hand with significant adoptions or adaptations of bank regulations pertaining to the bail-in of creditors such as the Bank Recovery and Resolution Directive (BRRD). Another step was the establishment of various regional safety net institutions such as the European Financial Stabilisation Mechanism (EFSM), the European Financial Stability Facility (EFSF), and ultimately the European Stability Mechanism (ESM), which apart from being intended to act as a fiscally neutral backstop to the SRF, provides the most substantial regional safety net globally.

framework of a Bayesian structural VAR model, in order to correctly and fully identify the relevant shocks and iii) thereby measure more precisely, through panel local projections, the economic impact of shocks in terms of economic activity, trade and inflation.

We find that shocks emanating in the euro area and based on the theoretical assumption of not being countered by policy measures, have sizeable effects: a one standard deviation increase in euro area stress entails a slowdown of economic activity in the rest of the world, with industrial production dropping by 0.8% on average in advanced economies and 0.3% in emerging economies over a 12-month horizon. The same shock also entails a significant fall in imports/exports of both the euro area and the rest of the world. By contrast, a release of euro area stress has more long-lasting effects on both economic performance and global trade activity, with an average yearly boost of industrial production by 0.73% in advanced economies and 0.45% in emerging markets over the first year.

Although our cut-off date for data is August 2019, our findings also speak to the renewed debate over EMU completion following the massive economic shock resulting from the outbreak of the corona virus pandemic. We believe our approach is well suited in delineating specific shocks during this crisis and identifying the magnitude of their impact.

1 Introduction

> *[...in this] world where challenges are global, we've got to be together to be truly sovereign, to be true masters of our destinies, because on our own we would have no way to cope with these global challenges. The evidence is in front of our eyes every day.* (Draghi (2019)).

Since the introduction of the euro, twenty years ago, both the global economy and the euro area (EA) economy have changed considerably as has the interaction between the two. On the one hand, the European Union (EU) has become not only the largest global trading block, handling 17.3% of world trade[2], but also a monetary union, whose currency has rapidly become the second most important in the international monetary system (see ECB IRE 2020). On the other hand, the international economy has experienced some dramatic changes, mainly driven by globalization and the rise of the so-called emerging market economies[3]. Moreover, these trends have been accompanied by a continued increase in financial integration, which has only slightly slowed down after the Great Financial Crisis (GFC), and a greater global correlation between real and financial macro-variables (see Ca' Zorzi et al. (2019)).

In light of these facts, the rich and controversial debate on EMU deepening[4] needs to take into account how such a process affects and is affected by rising global economic change and integration. Notably, the debate needs to consider the international impact that an increase in the depth of European integration and an improvement in its quality (henceforth "EMU cohesion") would likely exert on the rest of the world. From a policy perspective, this analysis can help clarify the potential effects stemming from progress, or alternatively, a slowdown in the enhancement of EMU functioning, the latter being defined by the further development of micro- and macroeconomic policy tools, as well as institutions, presented in the Four Presidents' Report (2012) and Five Presidents' Report (2015)[5]. Such an investigation becomes even more pressing in light of the risks stemming from the recent rise in protectionism and a potential reversal in the multilateral development of the international economic order[6].

However, providing an answer to this research question is not an easy task in that, beyond the incomplete nature of EMU, the two processes of European and international integration have been deeply intertwined, with the direction of causality often running both ways and, hence,

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[2]Excluding intra-EU trade, as reported by EC DG Trade 2019.

[3]According to IMF WEO 2019, the ratio between the world GDP share of advanced economies and that of emerging markets will be 36/63 by 2024.

[4]See Pisani-Ferry and Zettelmeyer (2019) for a collection of policy-oriented articles by academic observers.

[5]The two reports postulate that the completion of EMU should rely on four unions developed in parallel: financial (including banking and capital markets union (CMU)), fiscal, economic and political.

[6]As pointed out in Corsetti (2015): "The future of the Eurozone (EZ) therefore rests on developing an institutional framework that can credibly deliver stability at the EZ level."

being difficult to identify. Against this backdrop, and given the complexity of the process, this paper contributes to the ongoing debate by focusing on the effects that stress shocks in the EMU, arising from the degree of its completion, might exert on the rest of the world (RoW). In this sense, we refer here to the "international dimension of an incomplete EMU"[7]. While this international dimension is only one of many as regards EMU deepening,[8] an investigation of the channel of EMU shock transmission to the global economy can help inform the current policy discussions.

Conceptually, our paper builds on two main streams of research: i) the strand of literature aiming at quantifying the cross-border transmission of macroeconomic shocks[9] and, in particular, of monetary policy shocks[10]; ii) the papers focusing on crises periods to evaluate the international spillovers of the euro area crisis. Among the latter, Stracca (2015) shows that the global repercussions of the euro area crisis have mainly impacted the financial sector via a fall in equity returns, which has been more pronounced for countries with higher trade exposure to the euro area and a currency pegged to the euro, as well as for non-EA members of the EU[11]. In a similar vein, Aizenman et al. (2012) show that the effects of the euro area crisis in emerging economies are generally smaller than the responses to the global financial crisis. On the other hand, Ahmad et al. (2013) find that the transmission of shocks from the peripheral euro area economies to the emerging markets can feature either contagion (e.g. in the case of the BRICS) or interdependence (e.g. for Indonesia and South Korea)[12]. With a somewhat different focus, Claessens et al. (2011) analyse the behavior of firm-level stock returns of EU and non-EU companies and find that the effects of euro area crisis events ultimately depend on a series of country and firm-level characteristics.

Differently from these contributions, our empirical strategy firstly aims at quantifying the changes in the *cohesion* of the euro area economy as a whole, both in crisis and non-crisis periods. Specifically, we construct a Structural Vector Autoregressive model with euro area and global financial variables where shocks to EMU cohesion ("euro area stress shocks") are disentangled from "external" shocks, i.e. shocks originating outside of the euro area, by means of sign, magnitude and narrative restrictions. This approach, which is novel in the literature studying the effects of the euro area crisis, successfully teases out shocks that originate inside

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[7]This aspect can be put in perspective against the Four Presidents' Report and the Five Presidents' Report, as the two reports remain largely silent on the international dimension of EMU completion apart from a call for the consolidation of the euro area's external representation.

[8]In this regard, in Section 2.1 below we link our EMU stress variable also to a synthetic index of EMU institutional deepening, the EURII.

[9]See Dungey et al. (2011) and Forbes (2012) for a survey.

[10]See, among others, Forbes et al. (2017)) and Chen et al. (2017).

[11]Allegret et al. (2017) provide similar results using a Smooth Transition Regression (STR) framework.

[12]Similarly, Bird et al. (2017) disentangle between contagion and safe-haven effects, when evaluating the spillovers of the euro area sovereign debt crisis onto the non-EA neighbours.

the euro area from global risk aversion shocks, in spite of the fact that they are qualitatively very similar.

In a second step, we produce an assessment of the broader macroeconomic implications that these types of shocks can have. Notably, we show that euro area stress shocks negatively impact the economic activity of the RoW and entail a temporary slowdown in global trade whose magnitude can become substantial if no corrective action is undertaken. To the best of our knowledge, a quantification of EA cohesion spillovers on to extra-EA economies is an original contribution to the existing research[13].

The remainder of the paper is structured as follows: Section 2 introduces the methodology that we use to isolate "euro area stress shocks" and presents the main results; Section 3 quantifies the effects that these shocks have on the RoW from a macroeconomic perspective; Section 4 concludes.

2 Methodology

Our empirical approach consists of two main building blocks: i) we estimate a daily SVAR, with sign, magnitude and narrative restrictions, in order to tease out euro area stress shocks (Section 2.2) ; ii) we assess the effects that such shocks have on a set of macroeconomic variables for the RoW by means of panel local projections (Section 3). Before proceeding to i), however, we first construct a quantitative measure of EMU cohesion to be used to identify euro area stress shocks (Section 2.1).

2.1 The proxy for euro area financial cohesion (EASTR)

The proxy for EMU cohesion (EASTR henceforth) is given by the average 10-year government bond spread between Italy and Spain on the one hand and Germany on the other. This definition essentially relates the degree of cohesion among the euro area Member States to the stress of their sovereign bond markets relative to the benchmark (Germany)[14]. The choice of average sovereign spreads as stress indicators for euro area cohesion is supported by a series of stylized facts and empirical evidence provided by the relevant literature. While a non-zero bond yield spread may be seen as normal in a monetary union in the presence of country-specific macroeconomic conditions and policies, large and abrupt fluctuations of bond spreads may be interpreted as a demand for higher risk premia on the part of market participants because of

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[13]Most of the related literature, indeed, mainly focuses on the macroeconomic repercussions that the euro area crisis had on its Member States. In this regard, see Neri and Ropele (2015)

[14]The measure excludes countries that had temporarily lost market access during the financial crisis to control for idiosyncratic movements in sovereign spreads.

uncertainty arising from the incomplete nature of EMU. Such premia vis-à-vis the benchmark sovereign exhibiting safe haven status during peak stress moments, i.e. the German Bund, are not necessarily linked to the macroeconomic fundamentals of individual euro area Member States.

In this regard, Attinasi et al. (2009) show that the increase in euro area sovereign spreads over the period 2008-2009 was due to a reassessment on the part of investors of sovereign risk following the announcements of several bank rescue packages which initiated the bank-sovereign nexus. Di Cesare et al. (2012) find that the high levels of sovereign yields over the period 2011-2012 in several euro area countries were mainly due to an increase in the perceived risk of a break-up of the euro area, rather than to macroeconomic and fiscal developments[15]. Similarly, De Grauwe and Ji (2013) show that a significant part of the surge in the spreads of the peripheral euro area economies during 2010-2011 was not linked to the deterioration of the underlying fundamentals, but it was rather determined by strong negative self-fulfilling market sentiments as of the end of 2010 linked to "the fragility of the Eurozone". Afonso et al. (2018) find that the OMT announcement in August 2012 marked a regime shift in the pricing of sovereign bonds in the euro area, whereby the link between sovereign spreads and fundamentals has grown weaker, while spreads and re-denomination risk have become relatively higher compared to the pre-crisis period[16]. Born et al. (2020) get to fairly similar conclusions when assessing the transmission of spread shocks to a set of macroeconomic fundamentals both in advanced and emerging economies. However, they also provide evidence of a stronger link between the *volatility* of sovereign spreads and macroeconomic shocks in advanced economies after 2008. Finally, Bahaj (2020) deploys a narrative identification strategy based on a set of foreign events during the euro crisis to show that Eurozone sovereign spreads were driven not only by the domestic economic conditions.

On the other hand, some contributions seem to point in a different direction. Krishnamurthy et al. (2017), for instance, show that the ECB's SMP and OMT led to a fall in the sovereign bond yields of Italy, Spain and Portugal which was only partially due to redenomination risk, though focusing on shorter-term yields[17]. The structural relationship between government debt maturity and default vs. redenomination risk is extensively discussed in Bocola and Dovis (2019), where it is found that, in the presence of higher roll-over (redenomination) risks, government might find it optimal to issue longer-term debt, whereas the contrary holds true in case of a

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[15]De Santis (2012) also shows that a "regional risk factor" is one of the main drivers of the generalized increase in euro area sovereign spreads in 2008-2011.

[16]In this regard, see also von Hagen et al. (2011), Afonso et al. (2014, 2015) and Manganelli and Wolswijk (2014).

[17]This does not seem to have been the case for most recent programmes like the Pandemic Emergency Purchase Programme (PEPP) launched in March 2020.

worsening of fundamentals leading to an increase in default risk. Even if the authors show that most of the movements in Italian spreads between 2011 and 2012 were due to a deterioration of fiscal fundamentals, the results are highly influenced by the initial assumptions and the model is not able to account for a large share of movements in spreads at the height of the sovereign debt crisis. Moreover, in line with some of the above mentioned contributions, as of mid-2012 movements in the spreads of both Italy and Spain have been accompanied by a steady increase in the average debt maturity, which seems to suggest that redenomination risk has played an increasingly relevant role ever since (Figure 1).

Figure 1: Average debt maturity and 10-year spread against Germany for Italy and Spain
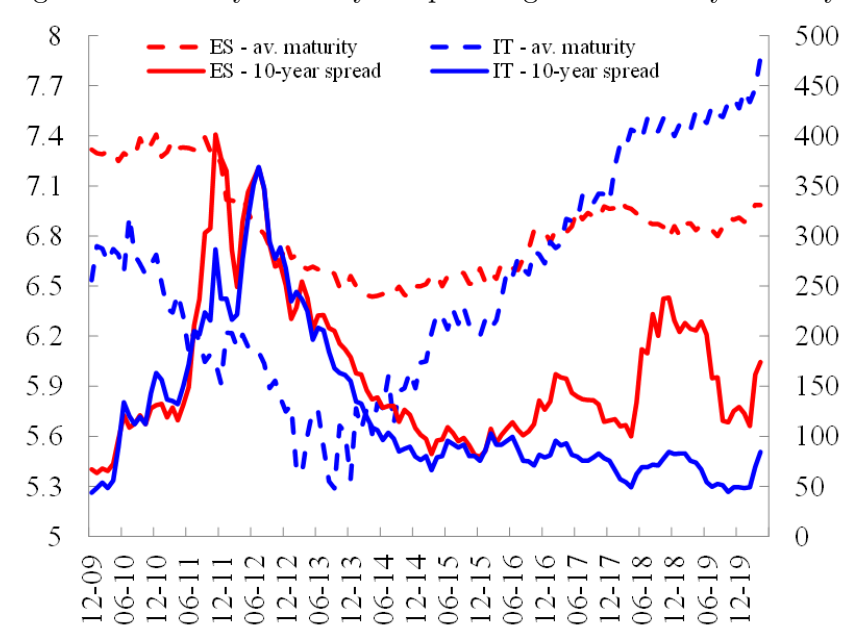
Notes: Debt duration is expressed in years and is plotted on the left-hand scale, while 10-year spreads against the German Bund are plotted on the right-hand scale and indexed with 2010 = 100.
*Sources:* ECB, Haver Analytics and authors' calculations.

Besides the support provided by a part of the existing literature, the EASTR measure is also found to be highly correlated with other commonly-used indicators of within-euro area stress, e.g. the sum of (absolute) TARGET2 balances (Figure 2a) and 5-year CDS premia (Figure 2b), with an estimated correlation coefficient swinging over time between 0.66 (peripheral) and 0.76 (core) for the former and ranging from 0.42 (core bank CDS premia) to 0.89 (peripheral bank CDS premia) for the latter[18]. Moreover, there is also a high degree of co-movement with the redenomination risk measure of De Santis (2019), which is based on 3-year quanto CDS spreads vis-à-vis Germany (Figure 2c)[19].

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[18]On the relationship between TARGET2 balances and macroeconomic adjustments in the euro area, see Fagan and McNelis (2014). On the use of CDS premia on sovereign and bank bonds as proxy for the sovereign-bank nexus, see De Bruyckere et al. (2013), Angelini et al. (2014), Acharya et al. (2014).
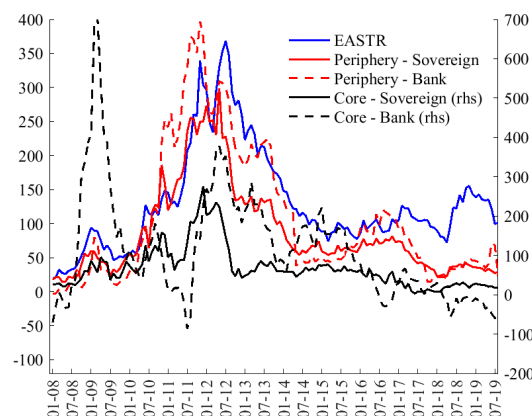
[19]We would like to thank Roberto De Santis for providing the estimated measure of redenomination risk for

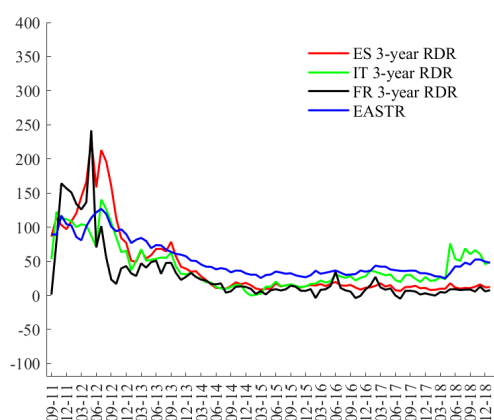Figure 2: Comparison between EASTR and other indicators.
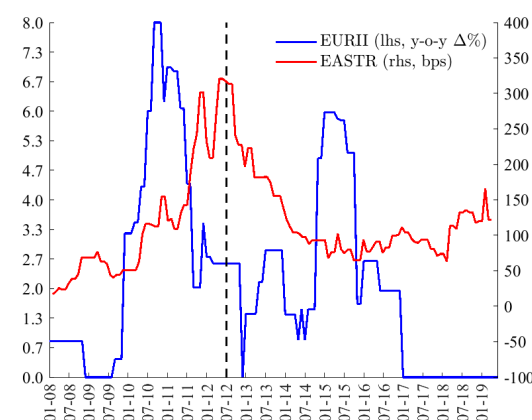
(a) EASTR vs TARGET2 balances
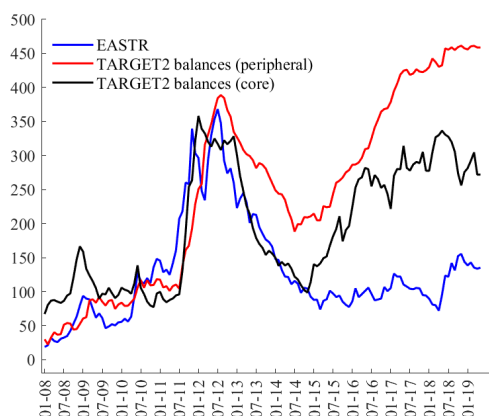
(b) EASTR vs 5-year CDS premia

(c) EASTR vs Redenomination Risk

(d) EASTR vs EURII

Notes: CDS premia are defined as the 5yr euro-denominated CDS spreads vis-à-vis Germany; redenomination risk is computed using 3-year CDS premia; TARGET2 balances are computed as the sum of absolute values; in Figures 2a and 2b, EASTR, CDS premia and TARGET2 balances are indexed with 2010 = 100; in Figure 2c series are indexed with 2011 = 100; in Figure 2d, EURII index is in annual percentage change and the dashed vertical line corresponds to the London speech.
Sources: ECB, Datastream, De Santis (2019) and authors' calculations.

The evolution of the EASTR measure is also consistent with the institutional response of the euro area authorities to the financial and the euro area debt crises, as quantified by the European Institutional Integration Index (EURII) which measures the steps of institutional and policy deepening along a comprehensive set of dimensions[20]. Figure 2d shows that periods of tension to EMU cohesion corresponding to increases in the EASTR variable (financial crisis of 2007-2009, euro area debt crisis of 2010-12) are followed by increases in the EURII index capturing the implementation of EMU deepening measures such as the establishment of the European Stability Mechanism (ESM) or the setup of the Banking Union through the creation of European banking supervision and resolution (2013-2016). Given all this, the EASTR measure can be interpreted as a high frequency quantitative measure of the completeness (and ultimately viability) of the euro area. It is in this sense, then, that "EMU cohesion" measured by the EASTR proxy needs

to be interpreted in this paper.

2.2 The SVAR model

The first step of our empirical exercise consists of disentangling between shocks to the deepening and cohesion of the euro area coming from inside the euro area itself on the one hand, and external shocks influencing in particular global financing conditions and risk aversion. One can think of singular events during the euro area sovereign debt crisis period 2010-2012 as an example of the former, and peak events during the global financial crisis such as the Lehman Brothers bankruptcy as an instance of the latter. With this aim, we estimate a *daily* Structural Vector Autoregression model (SVAR) of the following form:

$$A_0 Y_t = \mathbf{c} + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \varepsilon_t, \tag{2.1}$$

where ε_t is a vector of structural shocks which are assumed to be Gaussian with mean zero and variance I_N, conditional on past information and the initial conditions $(Y_0, \ldots, Y_{-p})$[21]. The vector Y_t includes seven financial variables, both euro area-based and global: our EASTR measure, the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), the world equity price index excluding the euro area ("RoW equity"), the equity price index for the euro area ("EA equity"), the nominal effective exchange rate of the euro (€NEER), the US 10-year benchmark government bond yield and the spread of JP Morgan's Emerging Market Bond Index Plus (EMBI+)[22]. Data cover the period from January 1999 to August 2019.

We aim at identifying two types of shocks within the SVAR, namely: i) a within-euro area (EA) stress shock influencing the market perception about the long term viability of the monetary union and ii) a more standard global risk shock. Teasing out the two shocks is challenging because within-euro area stress shocks can become global risk shocks for the rest of the world (Stracca (2015)). Following Antolín-Díaz and Rubio-Ramírez (2018), the identification strategy is based on a combination of sign, magnitude and narrative restrictions. The underlying intuition is that global shocks entail generalized fluctuations in the spreads across different regions, which

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Spain, Italy and France.

[20]Notably, the EURII includes the following sub-components: Free Trade Area and Customs Union, Supra-national institutions and decision-making, Financial Markets Union, Coordination of monetary and exchange rate policies, Democratic legitimacy and accountability, Internal Market, Economic Union, Fiscal Union and Monetary Union (see Dorrucci et al. (2015)).

[21]In what follows, p is set equal to 2, as indicated by the posterior marginal likelihood. This specification, though parsimonious, is well-suited to capture most of the relevant dynamics, as also indicated by the robustness checks in Section C.3 below.

[22]The VIX, the equity price indexes and the €NEER are included in log terms, while all the variables are demeaned and standardized. An increase in the €NEER means an appreciation of the euro against the main trading partners' currencies. See Appendix A for data sources.

should then move in a similar manner (both direction and magnitude-wise). Therefore, events of positive (negative) global risk aversion shocks on the one hand are partially identified by imposing the restrictions below:

i) there must be an increase (decrease) in the VIX;

ii) the EA stress variable and the EMBI+ spread must both increase (decrease);

iii) the EMBI+ spread must react more than the EA stress variable (*magnitude restriction*);

iv) the US 10-year government bond yield must decrease (increase).

On the other hand, positive (negative) EA stress shocks are identified as follows:

i) there must be a increase (decrease) in the EA stress variable;

ii) the EA stress variable must react more than the EMBI+ spread (*magnitude restriction*);

iii) the euro nominal effective exchange rate must depreciate (appreciate).

Table 1 compares the daily changes in the variables of interest around some well-known global and euro area events over the period 2010-2017. The preliminary evidence seems to support the proposed identification scheme.

2.2.1 Event study

In order to check that the changes in Table 1 are significant and, hence, that the restrictions to be imposed on the daily SVAR are supported by the data, we perform an event study around those events.

Table 1: Daily changes around selected events

	Date	EA stress	€NEER	VIX	EMBI	EA eq.	RoW eq.	US10Y
Global events								
Lehman Brothers default	*16/09/2008*	0.65	-0.46	4.06	10.67	-69.66	-4.19	-0.02
Taper tantrum	*22/05/2013*	9.60	-0.01	0.18	11.67	-58.23	-2.88	-0.02
Chinese stock market bubble burst[1]	*Jun-Aug 2015*	-3.45	0.30	-5.75	-23.67	64.760	1.320	0.108
EA events								
Greece requests for programme	*23/04/2010*	11.30	-0.16	0.67	-0.67	28.93	0.81	0.00
Ireland requests for programme	*22/11/2010*	14.50	-0.56	1.86	7.00	-72.06	-0.30	-0.03
Spain and Cyprus request for programme	*27/06/2012*	10.95	-0.27	0.25	4.00	-7.99	0.15	-0.04
London speech[+]	*26/07/2012*	-35.05	0.16	-0.75	-16.33	50.18	2.05	0.11
Greek bailout referendum	*06/07/2015*	3.50	-0.39	-0.65	4.33	-71.01	3.54	-0.03
EG* agrees on Greek third programme	*09/07/2015*	-24.30	0.66	-3.02	-11.33	108.78	-0.05	0.08
Brexit referendum	*23/06/2016*	24.65	-0.63	7.98	18.00	-261.77	-6.07	-0.19
Sintra speech[+]	*27/06/2017*	-2.35	0.77	-0.97	2.00	-2.62	-0.05	0.02

Notes: [1] This refers to the sum of daily changes around a series of salient events that have featured the Chinese stock market turbulence between mid-2015 and beginning of 2016; these events include two stock market crashes (on 27 July 2015 and 24 August 2015) and the devaluation of Renminbi on 11 August 2015; [2] by "programme" we refer to EU/IMF economic adjustment programmes;   [+] ECB President's speeches;   * EG = Eurogroup.

Notably, we assess the significance of daily changes in the endogenous variables by running the following regression:

$$\Delta x_t = \alpha_x + \mathbf{Event}_t \beta_x + \mathbf{D}_t \gamma_x + \varepsilon_{x,t}, \tag{2.2}$$

where $\Delta x_t = \{\Delta EASTR_t, \Delta EURNEER_t, \Delta VIX_t, \Delta EMBI_t, \Delta EAEQ_t, \Delta RoWEQ_t,$ $\Delta US10yr_t\}$ and $\mathbf{Event}_t$ is a $1 \times M$ vector of dummy variables that refer to the events in Table 1. Such dummies are set equal to 1 on the date of the event they are linked to and 0 otherwise. In addition, we include a $1 \times (K + P)$ matrix of control variables, $\mathbf{D}_t$, that is partitioned as:

$$\mathbf{D}_t = \left[\ \mathbf{R}_t \ \Big| \ \mathbf{P}_t \ \right],$$

where $\mathbf{R}_t$ is a $1 \times K$ matrix of dummy variables that are equal to 1 on the date of the release of European macroeconomic data and 0 otherwise, while $\mathbf{P}_t$ is a $1 \times P$ matrix including dummy variables that equal 1 on the dates of release of US macroeconomic data, and 0 otherwise. In our setting, we consider 6 macroeconomic releases for the euro area and the US: Consumer Price Index Estimate, Actual Consumer Price Index, Real Gross Domestic Product, Unemployment Rate, Industrial Production and Consumer Confidence Index. The inclusion of these regressors helps us control for possible omitted variable bias, as these events might trigger significant movements in the dependent variables at daily frequency[23].

The parameter of interest in Equation (2.2) is the $1 \times M$ vector β_x, whose i-th element represents the difference between the change in variable x on event day i, with $i = 1, \ldots, M$, and the average daily change of x on other dates, excluding the events and the release days of other macroeconomic data either in the euro area or US. Therefore, if the i-th element of $\hat{\beta}_x$ is statistically significant, then event i has a significant effect on x. In addition, we check for the joint significance of the elements of β_x by performing a Wald test with null $H_0 : \sum_{i=1}^{M} \hat{\beta}_{i,x} = 0$. This indicates whether the whole set of events in $\mathbf{Event}_t$ has a cumulative significant impact on x.

Regression results, reported in Table 2, show that changes around the majority of events are highly significant across all the endogenous variables. Moreover, they provide a clear indication on the restrictions to impose on the matrix of contemporaneous relations (A_0) as explained below.

2.2.2 Baseline identification

Based on the estimates in Table 2, Table 3 reports the baseline restrictions for A_0[24]. It is worth noticing how the magnitude restrictions on the EMBI+ spread are pivotal to pin the shocks

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[23]This approach draws from the rich literature using event studies to assess the effects of conventional and unconventional monetary policies (see, among others, Altavilla et al. (2016), Altavilla and Giannone (2017), Lloyd (2017)).

[24]The number of restrictions imposed is more than what would be required to identify the two shocks. However, part of the literature has underlined the importance of implementing all the theoretically plausible restrictions to pin down the shocks of interest (see, among others, Baumeister and Benati (2013)).

Table 2: Significance of daily changes around global and European events

	EA stress	€NEER	VIX	EMBI	EA eq.	RoW eq.	US10Y
Global events							
Lehman Brothers default	0.13	-1.282***	2.971***	1.246***	-1.470***	-2.537***	-0.273***
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Taper tantrum	1.257***	-0.057***	0.162***	1.336***	-1.328***	-1.764***	-0.406***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Chinese stock market bubble burst	-0.460***	0.692***	-4.083***	-2.684***	1.492***	0.743***	1.871***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
EA events							
Greece requests for programme	1.480***	-0.426***	0.520***	0.472***	0.664***	-0.061***	-0.070***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ireland requests for programme	1.900***	-1.443***	1.384***	-0.200***	-1.646***	-0.496***	0.805***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Spain and Cyprus request for programme	1.434***	-0.707***	0.215***	0.072***	-0.181***	-0.702***	0.462***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
London speech	-4.602***	0.381***	-0.511***	1.223***	1.150***	1.877***	-1.857***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Greek bailout referendum	0.457***	-1.027***	-0.439***	2.126***	-1.622***	-0.458***	0.500***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
EG* agrees on Greek third programme	-3.192***	1.664***	-2.160***	-0.049***	2.491***	1.318***	-1.287***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Brexit referendum	3.232***	-1.637***	5.829***	-3.697***	-5.986***	-3.204***	2.059***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sintra speech	-0.311***	1.927***	-0.671***	-0.049***	-0.058***	0.398***	0.234***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$, p-values in parentheses. t-statistics are computed using Newey and West standard errors. All figures are in standard deviation terms.
For clarifications on the events, see the footnote to Table 1 above.

of interest down. At this stage, it might be questioned whether a simpler framework based on just these restrictions would be sufficient to tease the two shocks out. In Section C.1 below we address this question by setting up a SVAR with just the EASTR variable, the EMBI+ spread and their difference. We then impose simple sign restrictions to identify the euro area stress and global risk aversion shocks. While the structural shocks series are very similar to the ones estimated in our baseline setup, however the IRFs are quite different and they show that the simplified identification scheme is not able to fully disentangle between the two shocks.

Table 3: Baseline sign restrictions

Variables \ Shocks	EA stress	Global
EASTR	> 0	≥ 0
€NEER	≤ 0	$<$ EA shock
VIX		> 0
EMBI+ spread	$<$ EASTR	$\geq$ EASTR
EA equity	≤ 0	
RoW equity	$<$ EA Equity	≤ 0
US10Y		< 0

In addition, we also impose narrative restrictions corresponding to some identified important events, along the methodology outlined in Antolín-Díaz and Rubio-Ramírez (2018). Complementing the baseline sign and narrative restrictions with additional ones corresponding to a restricted set of events is indeed instrumental to substantially sharpen the identification of the

shocks of interest, as also shown in Section C.2. Notably, we restrict the sign of the shocks taking place on the dates of five events:

  i) Lehman Brothers bankruptcy (15 September 2008): *positive* global shock;

  ii) FED's "Taper tantrum" (22 May 2013): *positive* global shock;

  iii) Request of financial assistance by Spain and Cyprus (27 June 2012): *positive* euro area shock;

  iv) ECB President's London Speech (26 July 2012): *negative* euro area shock;

  v) Approval of the 3rd economic adjustment programme for Greece (9 July 2015): *negative* euro area shock.

For some of these events, we also complement the sign restrictions on the structural shocks with additional restrictions on the magnitude of the contributions to either the EASTR variable or the VIX. Specifically, the default of Lehman Brothers is considered as a positive global risk aversion shock, which is also the most important contributor to the historical decomposition of the VIX. Similarly, the ECB President's London speech is classified as a negative EA stress shock, which is then the most important contributor to the historical decomposition of the EASTR variable. Table 4 summarizes all the narrative restrictions in the SVAR[25].

Table 4: Narrative restrictions

Date	Event	Shock	
		Type	Contribution
15-Sep-08	Lehman Brothers bankruptcy	Global+[*]	$\xrightarrow{+} VIX$[**]
22-May-13	FED "Taper tantrum"	Global+	
27-Jun-12	Spain and Cyprus request for programme	EA+	
26-Jul-12	London speech	EA-	$\xrightarrow{+} EASTR$
09-Jul-15	Eurogroup agrees on Greek 3rd programme	EA-	

Notes: [*] $z+$: positive z-shock, $z-$: negative z-shock;
[**] $\xrightarrow{+} x$: most important contributor in historical decomposition of variable x. For a formal definition of these types of restrictions, see Section B.4.

2.3   Results

Figure 3 displays the Impulse Response Functions (IRFs) for a 10-basis-point increase in the EASTR variable and a 0.63 percentage points (pps) increase in the VIX which, in our framework, correspond to a negative shock to euro area cohesion and a positive shock to global risk aversion. For comparison purposes, we impose a euro area shock that entails the same increase in the

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[25]The selection of events is done on the basis of an algorithm that considers different combinations from the list reported in Table 1. The final outcome consists of the subset of events, out of 254 different combinations, with the highest number of draws that satisfy the narrative restrictions. Refer to Appendix B for the technical details of the estimation.

VIX as a global risk aversion shock.

Generally speaking, the two shocks lead to different responses across the variables of interest. For instance, a euro area shock has a greater impact on euro area equity prices, the €NEER and the US 10-year yields, while the impact of global risk aversion shocks is more relevant for RoW equity prices as well as the EMBI+ spreads.

Specifically, an increase in the EASTR variable by 10 basis points (bps) affects EA equity prices and the €NEER, which both decrease on impact by 0.87 and 0.34 pps respectively. The same shock also leads to an increase in the US 10-year yield by 6 basis points, while leaving the EMBI+ spread unaffected over a one-month horizon. On the other hand, a global risk aversion shock given by a comparable increase in the VIX (+0.63 pps) entails an immediate drop in the equity prices for both the RoW (-0.42 pps) and the euro area (-0.30 pps). This also leads to a substantial decrease in the US 10-year yield (-3.17 bps) and an increase in the EMBI+ spread (+2.33 bps).

These results suggest that global shocks work their way through equity markets, while euro area stress shocks have more pervasive negative effects through the bond markets, as also confirmed by the estimated differences across IRFs to the two shocks (Figure 4).

2.3.1 Dynamic multipliers

The direct comparison of IRFs magnitudes is subject to an important caveat, namely that the functional form as well as the assumptions of our model are ad-hoc and might disregard other important relations across the endogenous variables (e.g., the EMBI+ is by construction a function of the US Treasury yield curve). Therefore, it looks more appropriate to evaluate the reaction of the variables of interest by means of conditional dynamic multipliers, which are computed as the ratio between the cumulative IRFs of two variables against a common shock of interest. Notably, the conditional dynamic multiplier of variable y vis-à-vis variable z is computed as follows:

$$\Phi_{yz}(k) \equiv \left| \frac{\sum_{k=0}^{K} \frac{\partial y_{t+k}}{\partial \varepsilon_t^x}}{\sum_{k=0}^{K} \frac{\partial z_{t+k}}{\partial \varepsilon_t^x}} \right| \tag{2.3}$$

where $\sum_{k=0}^{K} \frac{\partial y_{t+k}}{\partial \varepsilon_t^x}$ is the cumulative IRF of variable y to shock x at horizon K. These statistics are particularly useful in this context because they make it possible to study the relations across different variables without requiring any assumption on the form that such relations should take[26].

Table 5 reports the estimates of Equation (2.3) for the two different shocks, with y and z given

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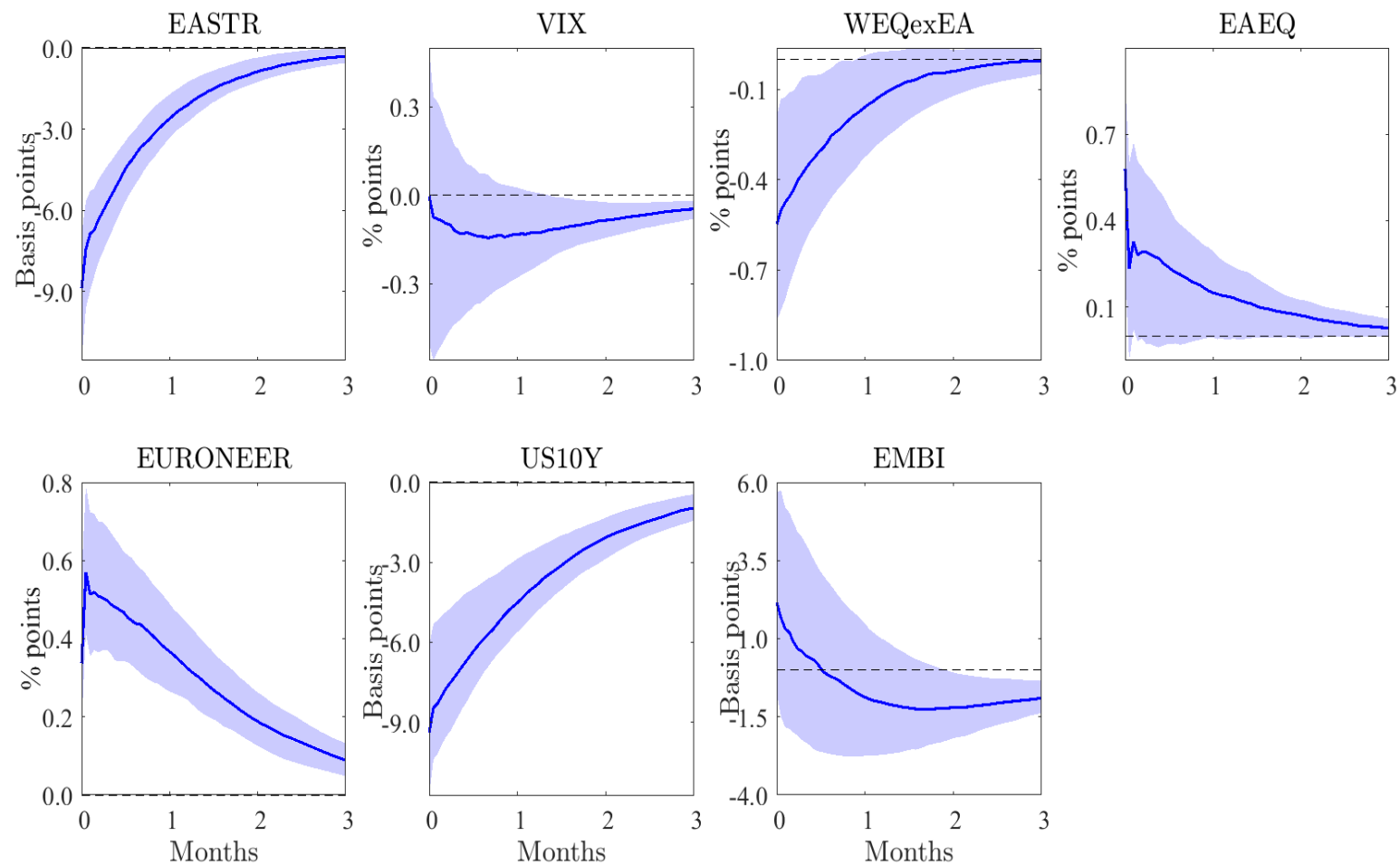[26]See Barnichon and Mesters (2019) and Galí and Gambetti (2019) for additional details.

Figure 3: IRFs - euro area stress (blue) and global risk aversion (red) shocks
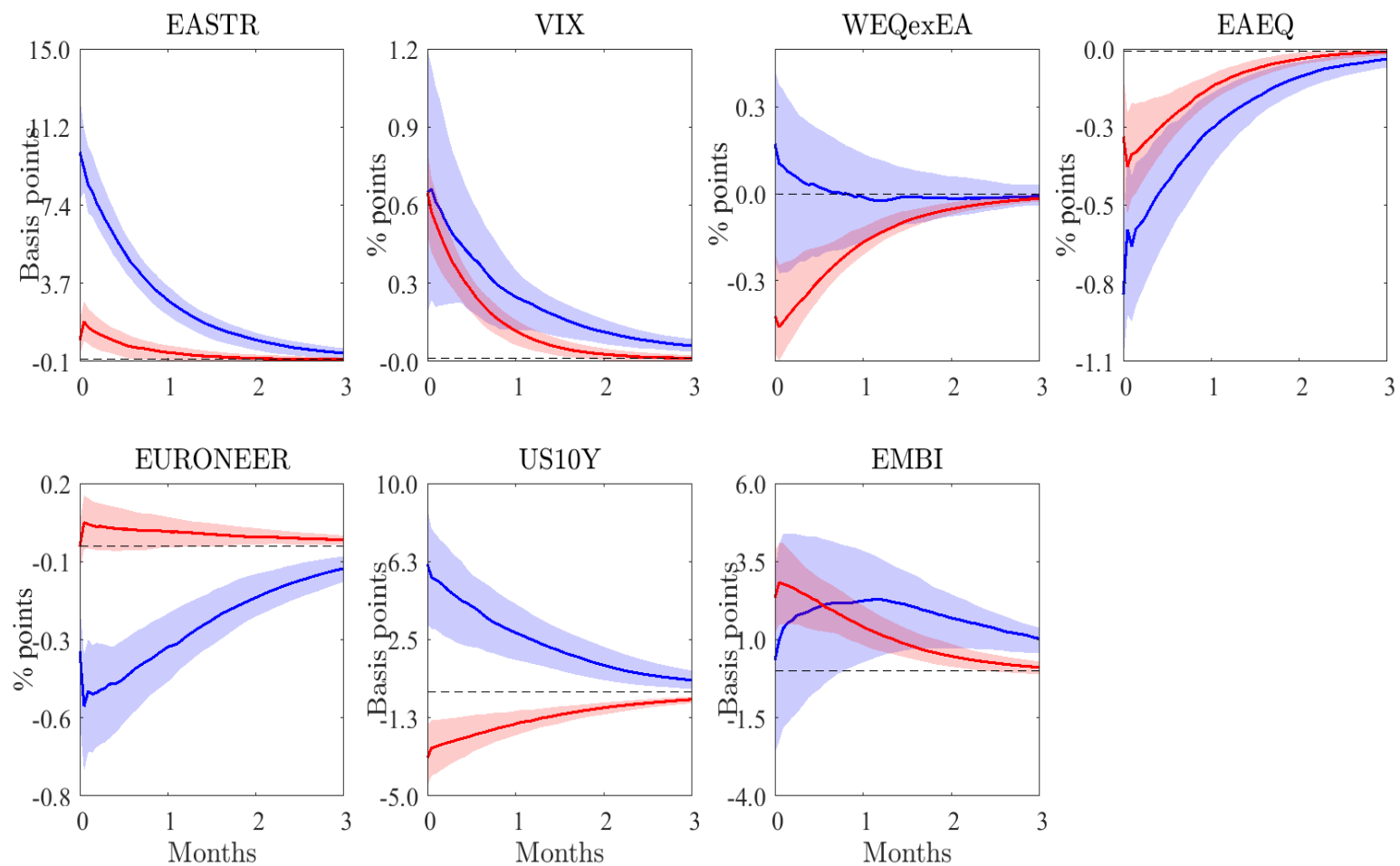
Figure 4: Differences between IRFs to euro area stress and global risk shocks.

Table 5: Maximum dynamic multipliers for EA stress and global risk aversion shocks

	16th percentile	Median	84th percentile
EMBI+/US10Y			
EA shock	0.22	0.87	2.37
Global shock	0.58	1.05	2.14
EASTR/EMBI+			
EA shock	2.38	4.96	14.91
Global shock	0.32	0.56	0.88
EA equity/World equity			
EA shock	1.52	3.38	15.74
Global shock	0.55	0.89	1.29
EASTR/US10Y			
EA shock	1.16	1.68	3.23
Global shock	0.26	0.54	0.99

Notes: Multipliers are computed as $\max_k \Phi_{yz}(k)$, where $\Phi_{yz}(k)$ is defined in Equation (2.3).

by: i) the EMBI+ spread and the US 10-year government bond yield; ii) the equity price indices for the euro area and the rest of the world; iii) the EASTR and the US 10-year government bond yield; iv) the EASTR and the EMBI+ spread. When comparing the US 10-year yield and the EMBI+, there is no statistically significant difference between the effects of the two shocks in that the confidence bands for the estimated multipliers both include 1. Moving to the pair EASTR variable/US 10-year yield, on the other hand, the median values show that the US yield is more impacted by a global shock than the EASTR variable, while the contrary holds true after a euro area stress shock, with estimates of the dynamic multiplier being significantly above 1. According to the results, EASTR also reacts much more to euro area stress shocks than the EMBI+, while global shocks are more impactful for the latter. Finally, effects of global shocks on world equity prices are not statistically different from the effects on European prices, while the latter react much more than the former in the case of a euro area stress shock.

In line with part of the existing literature, these findings suggest that both euro area and global shocks provoke relevant portfolio re-balancing effects deriving from a shift in the sentiment of investors. However, the nature of such shift appears to be different between the two instances, as euro area stress shocks have generalized negative repercussions on extra-European bond markets as signalled by the increase in the US 10-year yield. Global risk aversion shocks, on the other hand, imply a more typical flight-to-safety reaction as indicated by the decrease in US yields and the increase in EMBI+ spreads.

Additional evidence around the findings discussed so far can be provided by the historical decomposition analysis (Figure 5). Generally speaking, while historical decompositions display higher volatility since the onset of the GFC (2007-2008) and until mid-2012 (London speech), contributions of both global risk aversion and euro area stress shocks have followed a stabler path thereafter, between 2012 and the end of 2017. Moreover, Figure 5f unveil interesting dynamics for the US 10-year government bond yield, in that the contribution of euro area stress shocks has closely tracked, both level- and volatility-wise, that of global risk aversion shocks until the ECB President's London speech in July 2012 and the ECB's announcement of OMT. For the EMBI+ spread, on the other hand, global risk aversion shocks seems to have been consistently predominant throughout the time span considered (Figure 5g).

In the second half of 2017, the fall in economic tension in the euro area led to a slight appreciation of the euro (Figure 5e) and a small drop in the EASTR variable (Figure 5a). This trend was, however, more than offset at the beginning of 2018 after the ECB announced the stop of net purchases under the Public Sector Purchase Programme (PSPP). In the first half of 2019, which corresponds to the last part of the sample, global shocks returned to play a major role compared to euro area stress shocks, not only in bond, but also in equity markets (Figure 5d).

3   The impact of EMU stress shocks

In this section, we evaluate to what extent euro area stress shocks, as identified in Section 2.2, have affected the euro area economy and the rest of the world.

We consider in particular the impact exerted on a set of *monthly* macroeconomic indicators for the euro area and a group of Advanced Economies (AEs) as well as Emerging Market Economies (EMs)[27]. With this aim, we first aggregate the daily shocks at the monthly level (Figure 6)[28] and, then, we quantify the intra-EA and cross-border effects by means of impulse response functions (IRFs) computed with Jordà's local projections approach. This methodology is particularly suitable in this case, given its appealing property of being both more robust to misspecifications and very easily adaptable to non-linear frameworks.

 Notably, we set the following panel regression model up:

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[27]See Appendix A for a complete list of countries.

[28]Following Gertler and Karadi (2015) and Jarociński and Karadi (2020), the aggregation is done by summing up the daily shocks on a monthly basis. As a robustness check, we have also used an aggregation method based on monthly averages. Results, available upon request, are very similar to what shown in the paper.

Figure 5: Historical decomposition - euro area stress (blue) and global risk aversion (red) shocks
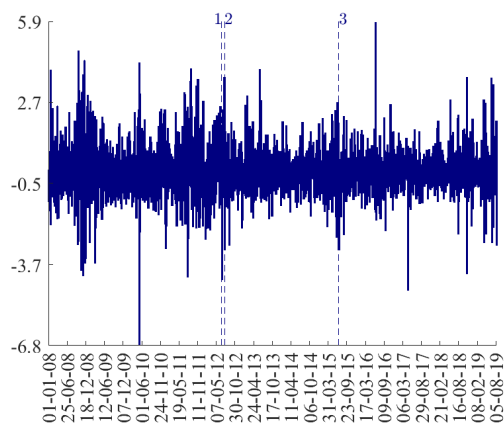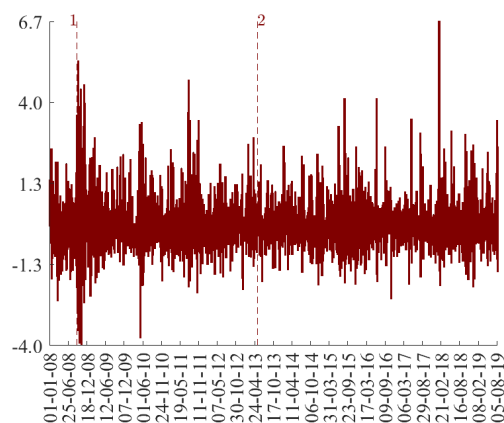
(a) EASTR
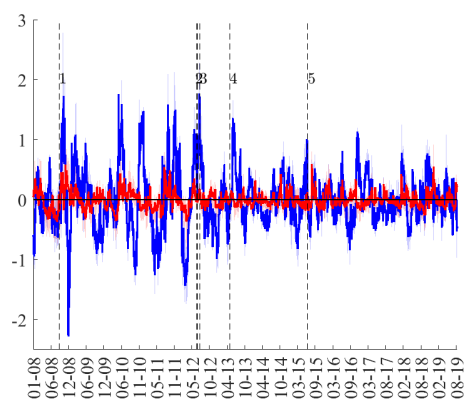
(b) VIX
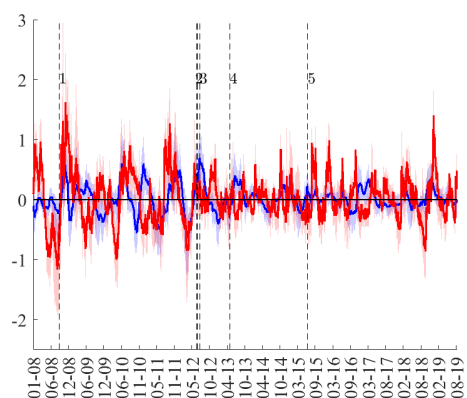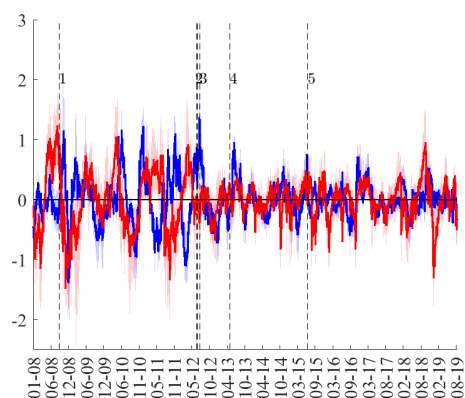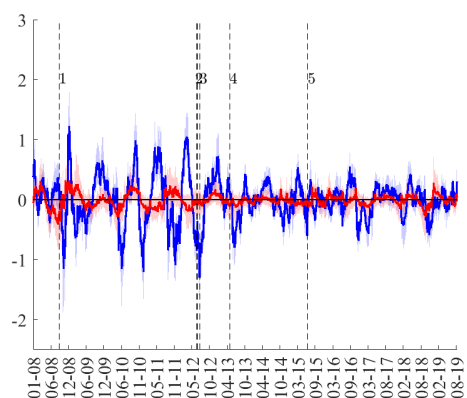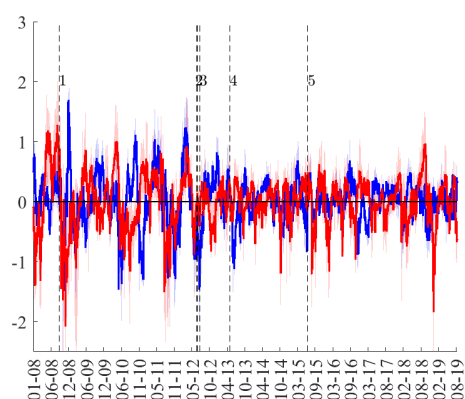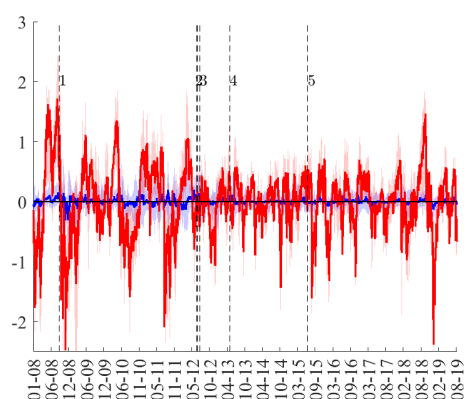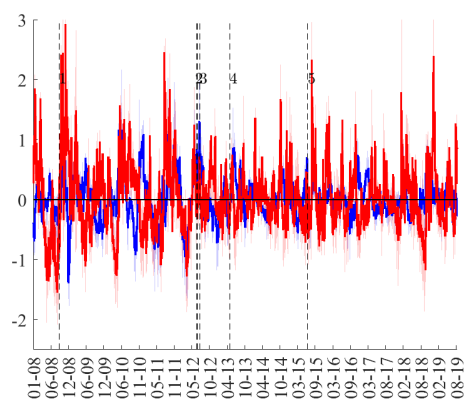
Notes: Shaded areas represent 68% HPD credible sets. Black dashed lines mark the following relevant events: 1.Lehman Brothers collapse; 2. Spain and Cyprus request for programme; 3. London speech; 4. Fed's "Taper tantrum"; 5. EG agrees on Greek 3rd programme. *Source:* Authors' calculations.

Figure 6: Daily shock series.

(a) Euro area stress

(b) Global risk aversion

Notes: Blue dashed lines in the left panel mark the following relevant events: 1. Spain and Cyprus request for programme; 2. London speech; 3. EG agrees on Greek 3rd programme. Red dashed lines in the right panel correspond to the following events: 1. Lehman Brothers collapse; 2. Fed's "Taper tantrum."
Source: Authors' calculations.

$$x_{i,t+h} = \alpha_i + \xi_h \varepsilon_t^z + \sum_{k=1}^{p} \beta_h x_{i,t-k} + \gamma \mathbf{Z}_{t-1} + \nu_{i,h,t+h} \tag{3.1}$$

with $i = 1, \ldots, N$, $t = 1, \ldots, T$. The parameter of interest in Equation (3.1) is ξ_h, which measures the effect that a shock (ε_t^z) at time t has on the variable of interest, $x_{i,t}$, after h months. Moreover, $\mathbf{Z}_{t-1}$ is a vector of exogenous regressors containing the (log) USD nominal effective exchange rate and the (log) oil price. In what follows, we estimate Equation (3.1) by alternatively including the aggregated monthly euro area stress and global shocks on the right hand side.

3.1 Results

Euro area stress shocks and global risk aversion shocks both exert a significant impact on relevant economic variables of the EA as well as AEs and EMs.

For instance, euro area stress shocks have negative effects on both EA industrial production and inflation, whose magnitude is sometimes comparable to what observed for a global risk aversion shock (Table 6 and Figure 7a)[29]. A positive euro area stress shock indeed drops both EA industrial production and inflation by a maximum of 0.93% and 2.06 pps respectively (Figure 7b) against a peak reduction of 0.8% and 2.19 pps after a global shock. Euro area stress shocks can also impact intra-EA trade flows over the medium-term, by decreasing exports and imports by 3.28% and 3.15% respectively. Global risk shocks on the other hand entail more marked slowdowns in trade flows over the longer-term (Figures 7c and 7d), something which

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[29]These estimates refer to a unit increase in the shock of reference. As the shock series are standardised, this corresponds to a one-standard-deviation increment.

Table 6: Maximum impact of euro area stress and global risk aversion shocks

Variable / Shock	IP	Inflation	Exports to EA	Exports to RoW	Imports from EA	Imports from RoW
Euro Area						
EA	-0.93%	-2.06pps	-3.28%		-3.15%	
	(12)[*]	(9)	(4)		(5)	
Global	-0.8%	-2.19pps	-5.31%		-4.94%	
	(11)	(12)	(12)		(12)	
Advanced Economies						
EA	-1.02%	-0.23pps	-2.79%	-2.34%	-1.68%	-2.39%
	(4)	(9)	(10)	(7)	(3)	(7)
Global	-1.50%	-0.13pps	-3.27%	-3.23%	-2.78%	-3.67%
	(12)	(11)	(12)	(12)	(12)	(12)
Emerging Markets						
EA	-0.68%	-0.30pps	-2.36%	-1.47%	-1.55%	-1.99%
	(3)	(9)	(10)	(7)	(5)	(3)
Global	-1.32%	-0.18pps	-2.97%	-2.67%	-2.72%	-3.43%
	(12)	(12)	(12)	(12)	(12)	(12)

Notes: [*] Numbers in parentheses represent the amount of months after a shock has taken place. As the shocks series are standardized, coefficients refer to a unit increment in the relevant shocks, which corresponds to an increase by one standard deviation.

is in line with the part of literature identifying globalization as the biggest driver of European trade after 1992 (see Corsetti et al. (2019)).

Looking at results for extra-EA economies, a euro area stress shock can trigger significant real economy effects in AEs via a compression in industrial production by 1.02% over a seven-month horizon, against a drop by 1.50% one year after a global shock (Figure 8a). In EMs, on the other hand, the negative impact on industrial production is more muted compared to AEs, as the contraction peaks at 0.68% three months after the shock (Figure 9a). Conversely, euro area stress shocks are more relevant than global shocks when it comes to assessing demand effects, since the downward pressure on RoW inflation (both AEs and EMs) is bigger than in the case of a global shock (-0.23 pps vs -0.13 pps in AEs and -0.30 pps vs -0.18 pps in EMs). However, the deflationary pressures deriving from a global shock seem more persistent than the effects stemming from euro area stress shocks.

As to international trade activity, euro area stress shocks entail a slowdown in exports and imports to and from non-EA economies, which is significant in both AEs (Figures 8e and 8f) and EMs (Figures 9e and 9f), though slightly more relevant for the former. Generally speaking, the impact of such shocks tends to be smaller compared to global risk aversion shocks. In addition, the latter seem to trigger more long-lasting slowdowns in both macroeconomic aggregates and global trade, while the repercussions of changes in euro area stress tend to fade away in a shorter

Figure 7: **Euro Area** - Impulse responses to a positive one s.d.euro area stress shock (blue) and a positive one s.d. global risk aversion shock (red)

(a) Industrial production

(b) Inflation

(c) Intra-euro area exports

(d) Intra-euro area imports
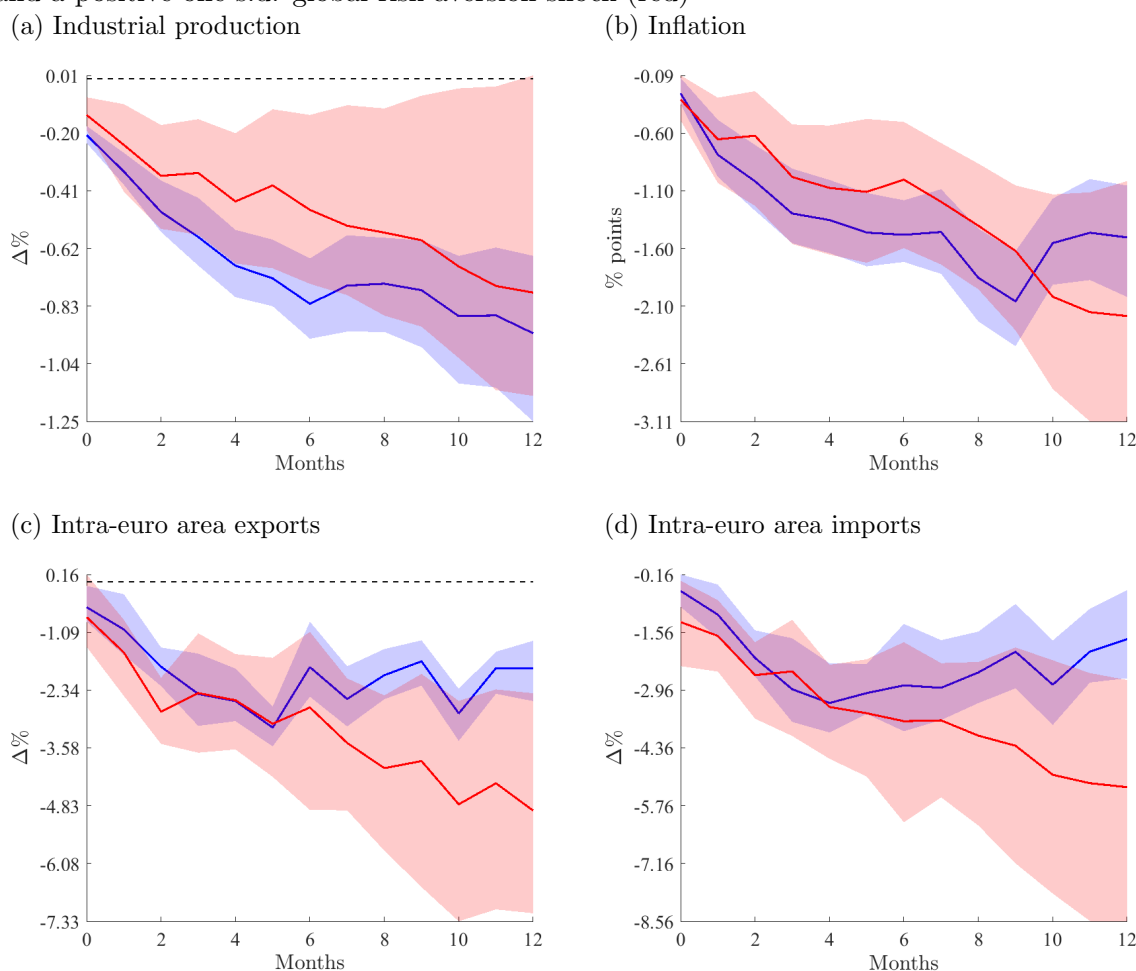
Notes: Inflation is defined as the y-o-y percentage change of the CPI. Δ%: log-change. Shaded areas are 68% HPD credible sets.
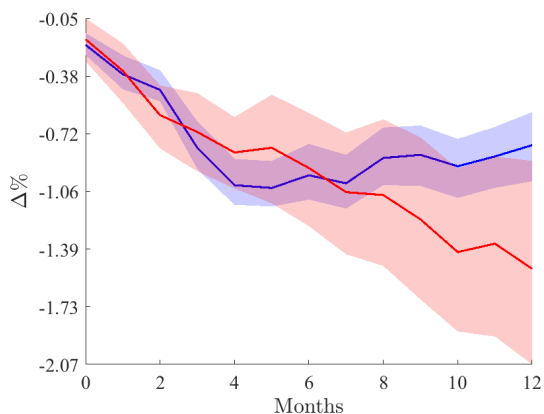*Source:* Authors' calculations.

time frame[30]. *Ceteris paribus*, a positive one-standard-deviation euro area stress shock has the following *average* effects over a one-year horizon: i) it decreases industrial production by 0.8% in AEs and 0.3% in EMs; ii) it pushes down yearly inflation by 0.17 pps in AEs and 0.18 pps in EMs; iii) it depresses euro area trade flows due to a decrease in both exports and imports with both AEs (-1.11% and -1.78% respectively) and EMs (-1.51% and -0.88% respectively); iv) it shrinks exports to the RoW by 1.34% in AEs and 0.8% in EMs, as well as imports from the RoW by both AEs and EMs (-1.3% and -1% respectively). While these estimates might look surprisingly substantial, however they correspond to a shock whose magnitude (one-standard deviation) is comparable to what observed when Spain and Cyprus requested for financial assistance. So, the results we have discussed above correspond to fairly large euro area stress shocks.

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[30]A caveat to these findings derives from the inclusion in our sample of some (non-EA) EU members, which might bias our estimates given their particular linkages with EA members. However, our results are robust to the exclusion of these countries from the estimation sample, as shown in Section D.2.

Figure 8: **Advanced economies** - Impulse responses to a positive one s.d.euro area stress shock (blue) and a positive one s.d. global risk aversion shock (red)
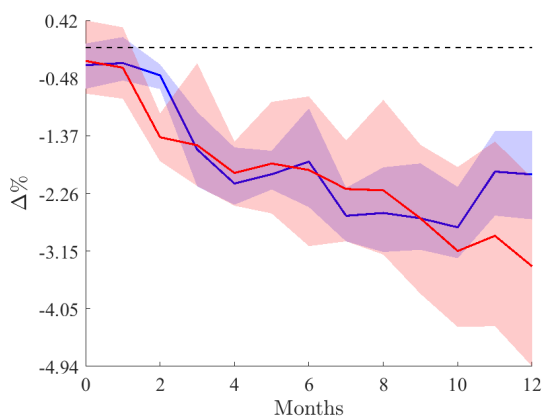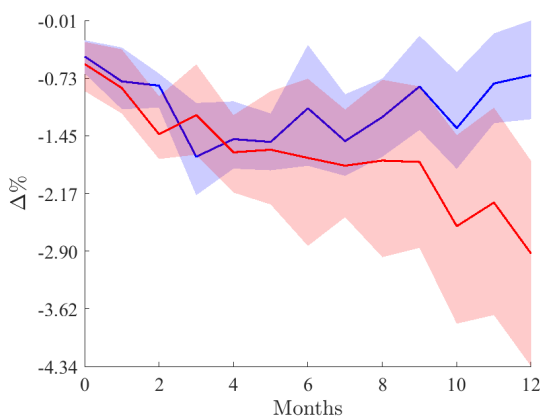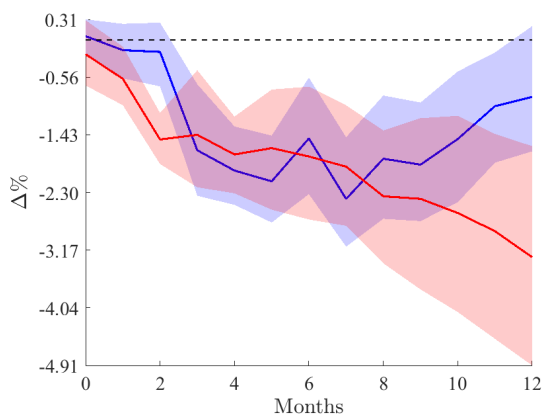
(a) Industrial production
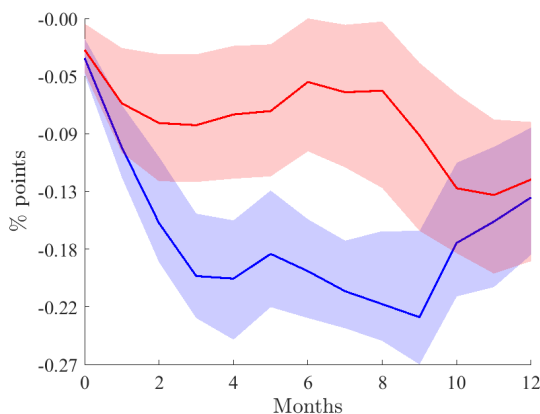
(b) Inflation

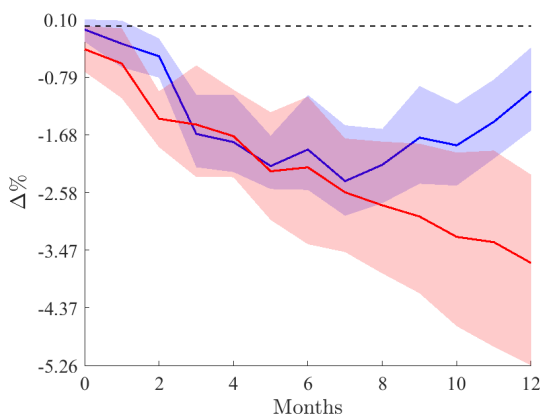(c) Exports to euro area

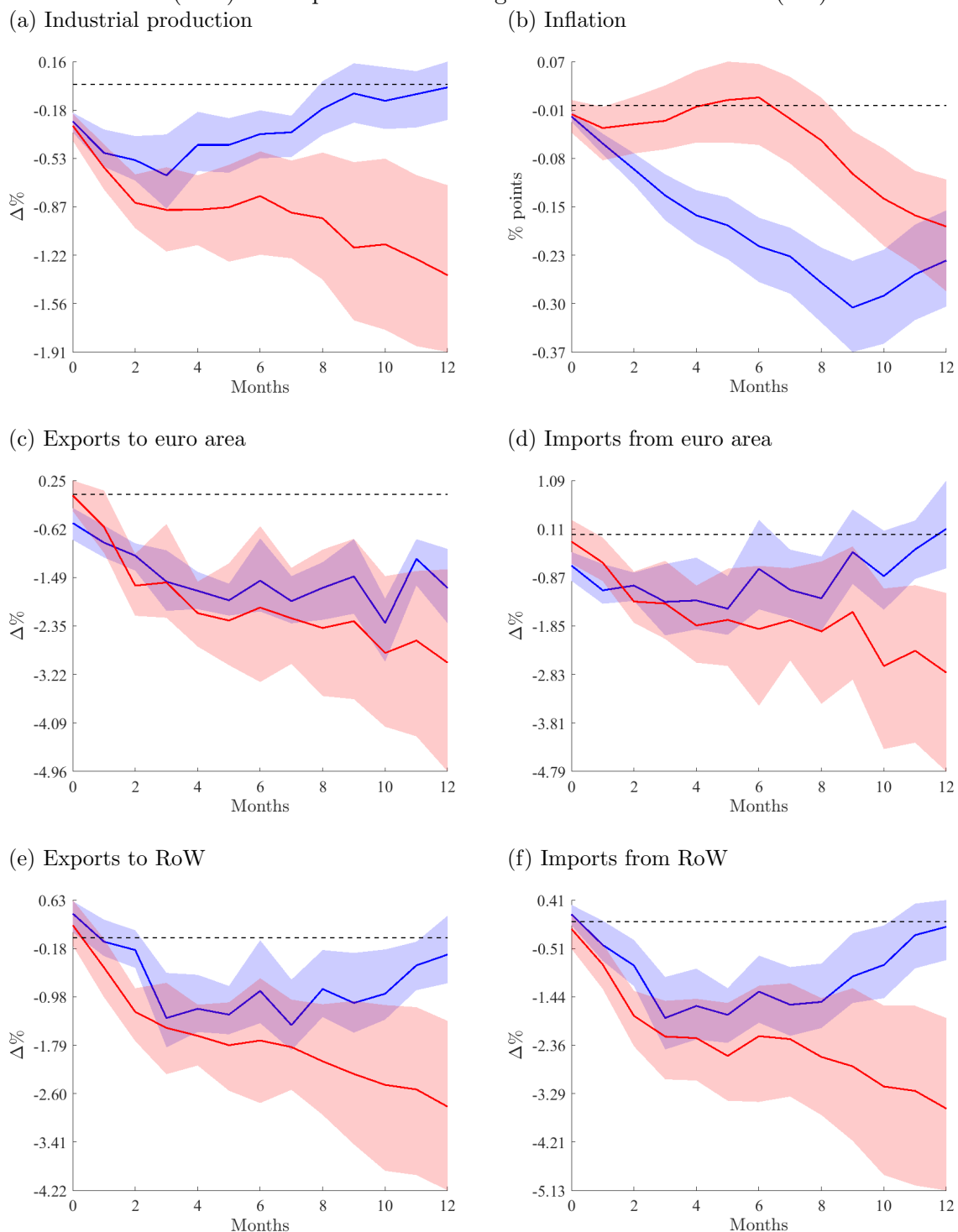(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. $\Delta\%$: log-change. Shaded areas are 68% HPD credible sets.
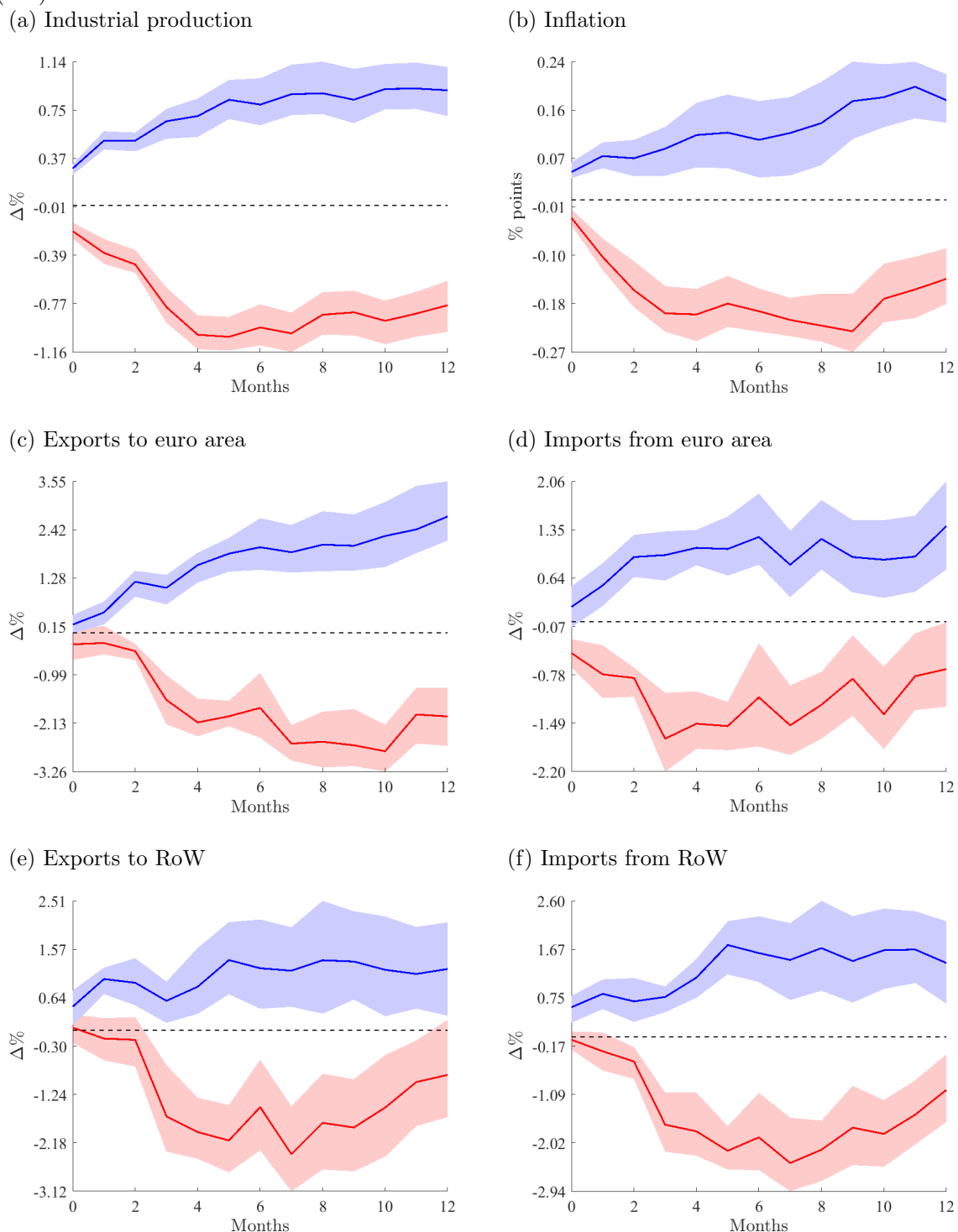*Source:* Authors' calculations.

Figure 9: **Emerging and developing economies** - Impulse responses to a positive one s.d. EA stress shock (blue) and a positive one s.d. global risk aversion shock (red)

(a) Industrial production

(b) Inflation

(c) Exports to euro area

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. Δ%: log-change. Shaded areas are 68% HPD credible sets.
Source: Authors' calculations.

When disentangling between positive and negative shocks, a decrease in EMU tensions, corresponding to a negative euro area stress shock, can have more enduring positive spillovers compared to a setback (Figures 10 and 11). Though the maximum impact is roughly symmetric across positive and negative shocks, effects of negative shocks can still be significant after one year, especially in AEs (Table 7). A negative one-standard-deviation euro area stress shock, indeed, implies that, *on average*: i) industrial production increases by 0.73% in AEs and 0.45% in EMs: ii) yearly inflation goes up by 0.12 pps in AEs and 0.19 pps in EMs; iii) euro area imports are pushed up by 1.7% from AEs and 1.88% from EMs, while exports to both AEs and EMs increase by around 0.9%; iv) exports of both AEs and EMs to the RoW are boosted by around 1%, while imports from the RoW jump by 1.3% in AEs and 1.5% in EMs.

Table 7: Maximum impact of euro area stress shocks - positive vs negative

Variable / Shock	IP	Inflation	Exports to		Imports from	
			EA	RoW	EA	RoW
Advanced Economies						
EA+	-1.04%	-0.24%	-2.64%	-2.09%	-1.58%	-1.85%
	(7)[*]	(9)	(10)	(7)	(3)	(5)
EA-	0.99%	0.20%	2.56%	1.51%	1.04%	1.01%
	(11)	(11)	(12)	(5)	(12)	(5)
Emerging Markets						
EA+	-0.50%	-0.38%	-2.45%	-1.84%	-1.41%	-1.31%
	(3)	(9)	(10)	(3)	(5)	(5)
EA-	0.58%	0.37%	2.34%	1.82%	1.22%	1.37%
	(2)	(11)	(5)	(2)	(2)	(5)

Notes: [*] Numbers in parentheses represent the amount of months after a shock has taken place. As the shocks series are standardized, coefficients refer to a unit increment in the relevant shocks, which corresponds to an increase by one standard deviation.
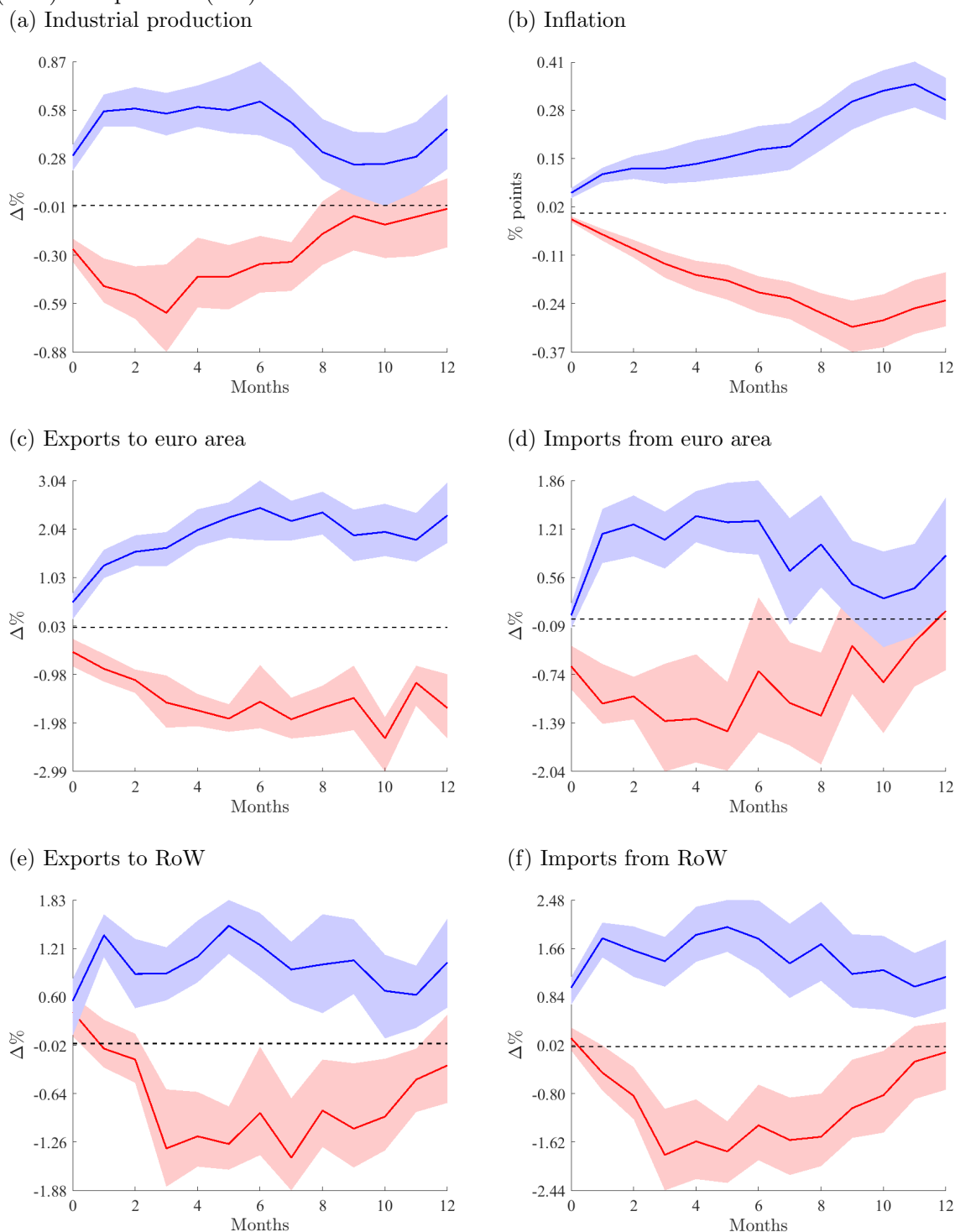
Figure 10: **Advanced economies** - Impulse responses to a one s.d. negative (blue) and positive (red) euro area stress shock

(a) Industrial production

(b) Inflation

(c) Exports to euro area

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. $\Delta\%$: log-change. Shaded areas are 68% HPD credible sets.
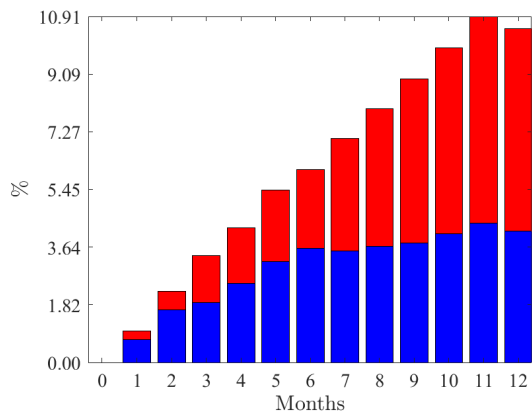*Source:* Authors' calculations.

Figure 11: **Emerging and developing economies** - Impulse responses to a one s.d. negative (blue) and positive (red) euro area stress shock

(a) Industrial production

(b) Inflation

(c) Exports to euro area

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. $\Delta\%$: log-change. Shaded areas are 68% HPD credible sets.
Source: Authors' calculations.

Local projection IRFs have shown that euro area stress shocks might have a sizeable impact on the macroeconomic performance of extra-EA AEs and EMEs, which is even bigger than what observed for a global risk aversion shock in some cases (e.g., inflation). However, our estimates relate to shocks that correspond to quite extreme events, which have the potential to become "global" from the standpoint of extra-EA economies. Moreover, as these events are quite rare, they should not systematically contribute to the volatility of macroeconomic aggregates.

We gather additional evidence on this particular aspect by carrying out a forecast error variance decomposition of the local projection IRFs. With this purpose, we adopt the methodology proposed by Gorodnichenko and Lee (2019), which is outlined in Section D.1.

As expected, global risk aversion shocks are generally more relevant in that they account for a higher share of the variance of all the variables considered, both in AEs (Figure 12) and EMEs (Figure 13). Notably, the cumulative contribution of both global and euro area stress shocks is bigger for AEs compared to EMEs. Indeed, while on the one hand the two shocks combined can explain a maximum share of variance ranging from around 11% (industrial production) to 13% (exports to RoW) in AEs, on the other hand the range drops down to between 4.5% (inflation) to approximately 10% (imports from RoW) for EMEs. Out of these shares, less than half is attributable to euro area shocks.

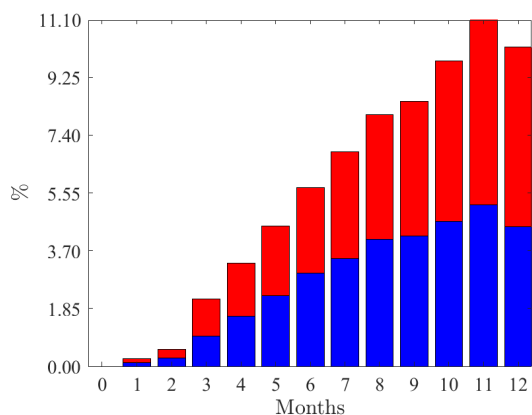Figure 12: **Advanced economies** - Forecast error variance decomposition of local projection IRFs

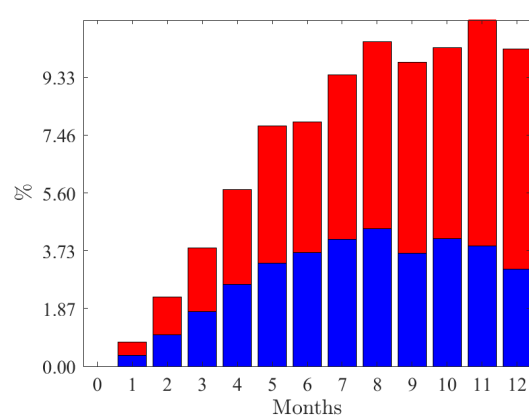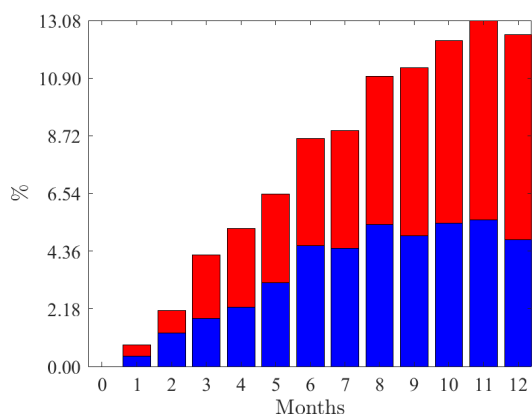(a) Industrial production

(b) Inflation
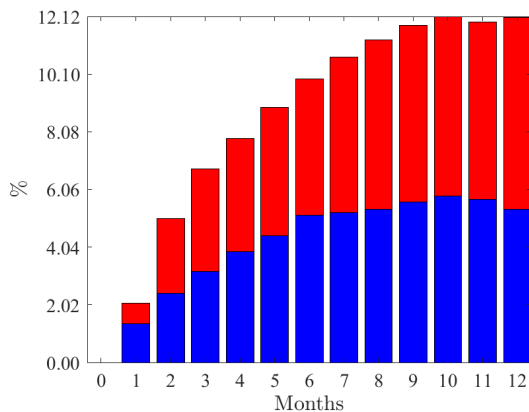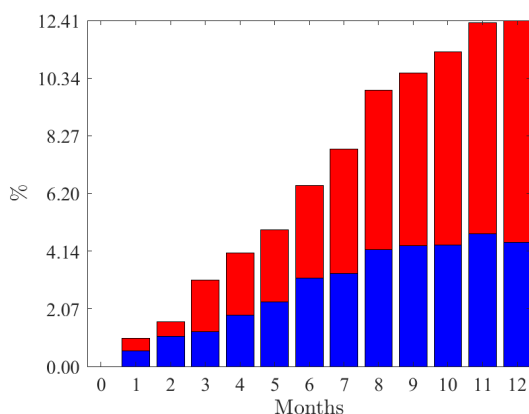

(c) Exports to euro area

(d) Imports from euro area
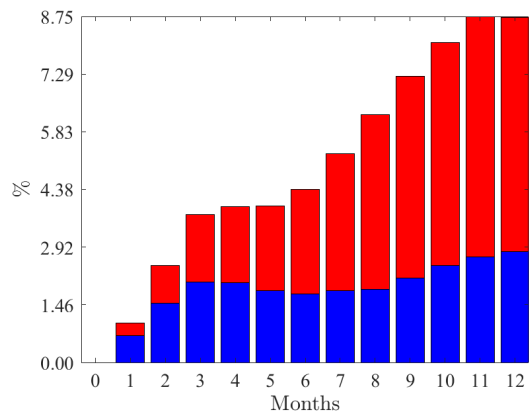

(e) Exports to RoW

(f) Imports from RoW

Notes: Contributions are expressed as % share of total variance. Red bars refer to global shock contributions, blue bars to euro area stress shock contributions. Estimates are significant at the 68% confidence level.
Source: Authors' calculations.

Figure 13: **Emerging and developing economies** - Forecast error variance decomposition of local projection IRFs

(a) Industrial production

(b) Inflation

(c) Exports to euro area

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Contributions are expressed as % share of total variance. Red bars refer to global shock contributions, blue bars to euro area stress shock contributions. Estimates are significant at the 68% confidence level.
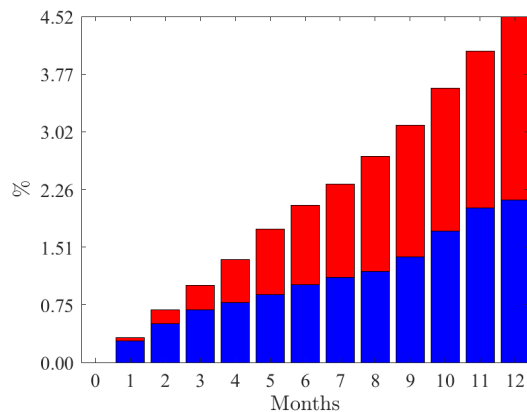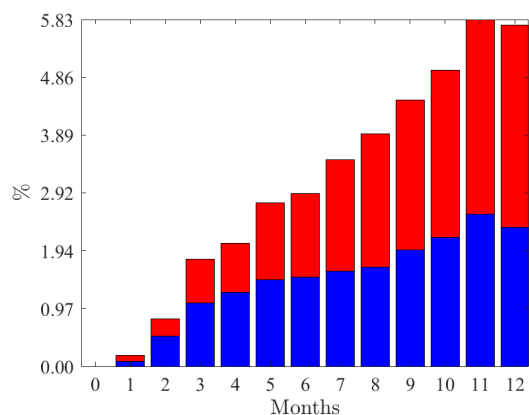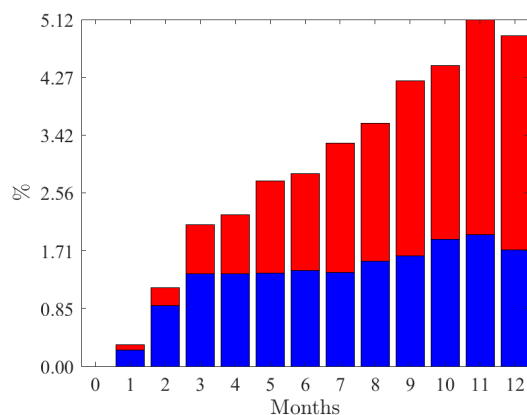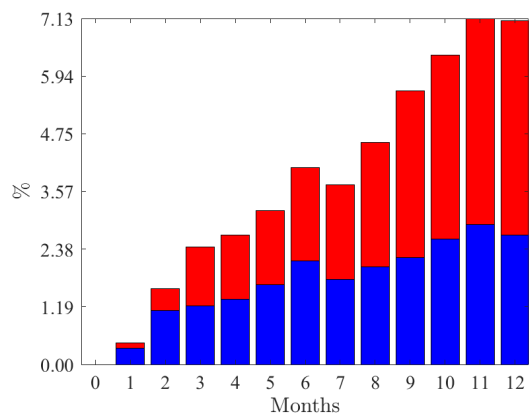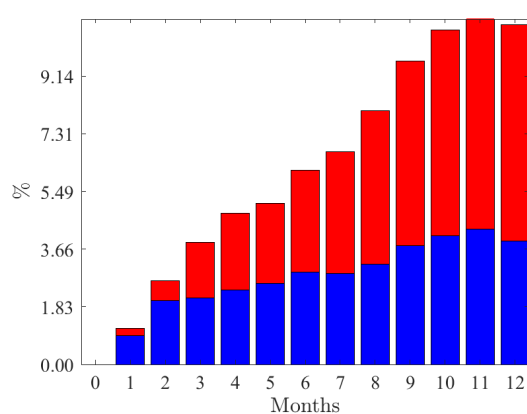*Source:* Authors' calculations.

4 Conclusion

This paper investigates what we call the "international dimension of an incomplete EMU" which consists of the potential effects of progress or setbacks in the completion of EMU on the global economy. In this sense, our analysis provides a contribution to the ongoing debate about the completion of the Economic and Monetary Union.

With this aim, we first construct a measure of EMU cohesion and we show that it approximates well the progress (or slowdown) in the completion of EMU. The second step of our analysis then consists of applying structural and narrative techniques to daily financial data to disentangle between "euro area stress shocks" and global risk aversion shocks. It is shown that, even if the effects of these shocks are qualitatively similar and therefore difficult to distinguish, the empirical strategy proposed in Section 2.1 is nonetheless able to tease the two out and to produce statistically different results.

Finally, in Section 3 we construct IRFs via panel local projections to estimate the effects of euro area stress shocks onto macroeconomic aggregates in the rest of the world. Our main finding is that a decrease in the cohesion of EMU has an overall negative impact on the economy of the rest of the world, both on the demand and the supply side. In addition, these shocks entail a generalized slowdown in global trade, not only because of a decrease in imports and exports from and to the euro area, but also due to a drop in trade flows outside the euro area. While these effects do not generally change across AEs and EMs and appear to be broadly symmetric, the positive impact of an increase in EMU cohesion is found to be generally more persistent over time than the drawbacks stemming from a setback in the completion of the EMU. In short, our results provide evidence that the incomplete nature of EMU is not only a problem for the euro area but also for the rest of the world.

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Appendices

A Data and Countries

Table A.1 reports the variables used in our estimations, together with the sources.

Table A.1: Variables and sources

	Sources
Daily SVAR	
EA stress variable[1]	ECB SDW[+]
EA equity price index[2]	ECB SDW
Euro Effective Exchange Rate[3]	ECB SDW
VIX	DataStream
World Equity Price Index (excl. EA)[4]	Bloomberg
US 10-year govt bond yield	Bloomberg
EMBI+ spread (excluding Europe)[5]	Haver Analytics
Monthly Local Projections	
Industrial Production Index	DataStream
Consumer Price Index	Haver Analytics
Imports/Exports	IMF DOTS[*]

Definitions: [1] Average 10-year government bond spread of Italy and Spain against Germany; [2] Dow Jones Euro Stoxx 50 EUR Price Index; [3] Exchange rate against a basket consisting of the currencies of the main 38 EA trading partners (NEER-38); an increase in the €NEER implies an appreciation of the euro against other currencies; [4] FTSE World Equity price index, excluding Eurobloc; [5] Spread of the yields on emerging market debt over the entire US Treasury curve. *Sources:* [+] Statistical Data Warehouse; [*] Direction of Trade Statistics *Notes*: monthly series are seasonally adjusted.

The countries included in the panel local projections in Section 3 are reported below.

Advanced Economies

Australia, Canada, Denmark, Japan, Norway, Sweden, Switzerland, United Kingdom, United States

Emerging Markets and Developing Economies

Argentina, Brazil, Bulgaria, Chile, China, Czech Republic, Hungary, India, Indonesia, South Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey

B The Bayesian VAR

The structural VAR in Equation (2.1) can be rewritten in companion form as:

$$A_0 Y_t = A_+ \mathbf{Y}_{t-1} + \varepsilon_t, \tag{B.1}$$

where $A'_+ = [\mathbf{c}', A'_1, \ldots, A'_p]$ is an $m \times n$ matrix and $\mathbf{Y}'_{t-1} = [\mathbf{1}, Y'_{t-1}, \ldots, Y'_{t-p}]$ is an $m \times 1$ vector, with $m = Np + 1$. The reduced-form representation of Equation (B.2) is then:

$$Y_t = B\mathbf{Y}_{t-1} + u_t, \tag{B.2}$$

where $B = A_0^{-1} A_+$, $u_t = A_0^{-1} \varepsilon_t$ and $E[u_t u'_t] = \Sigma = (A_0 A'_0)^{-1}$.

B.1 Impulse response functions

Denote as $\boldsymbol{\Theta}$ the vector of structural coefficients from Equation (B.2): $\boldsymbol{\Theta} \equiv (A_0, A^+)$. Given this, the response of the ith variable to the jth structural shock at horizon k is the (i, j)th element of matrix $\mathbf{L}_k(\boldsymbol{\Theta})$ which is defined recursively as:

$$\mathbf{L}_k(\boldsymbol{\Theta}) = \begin{cases} (A_0^{-1})' & \text{if} \quad k = 0 \\ \sum_{\ell=1}^{k} (A_0^{-1} A_\ell)' \mathbf{L}_{k-\ell}(\boldsymbol{\Theta}) & \text{if} \quad 1 \le k \le p \\ \sum_{\ell=1}^{p} (A_0^{-1} A_\ell)' \mathbf{L}_{k-\ell}(\boldsymbol{\Theta}) & \text{if} \quad p < k < \infty \end{cases} \tag{B.3}$$

B.2 Structural shocks and historical decomposition

Given $\boldsymbol{\Theta}$, the structural shocks at time t are:

$$\varepsilon_t(\boldsymbol{\Theta}) = A_0 Y_t - A_+ \mathbf{Y_{t-1}}, \quad \text{for } t = 1, \ldots, T. \tag{B.4}$$

Therefore, the cumulative contribution of the jth shock to the observed changes of the ith variable between t and $t + h$ is given by:

$$H_{i,j,t,t+h}(\boldsymbol{\Theta}, \varepsilon_t, \ldots, \varepsilon_{t+h}) = \sum_{\ell=0}^{h} \mathbf{e}'_{i,n} \mathbf{L}_\ell(\boldsymbol{\Theta}) \mathbf{e}_{j,n} \mathbf{L}_\ell(\boldsymbol{\Theta}) \mathbf{e}_{j,n} \mathbf{e}'_{j,n} \varepsilon_{t+h-\ell}, \quad \text{for } i \ge 1, j \le N, h \ge 0, \tag{B.5}$$

where $\mathbf{e}_{j,n}$ is the jth column of the identity matrix I_N.

B.3 Traditional sign restrictions

We impose traditional sign and zero restrictions following Rubio-Ramírez et al. (2010) and Arias et al. (2018). Notably, such restrictions can be expressed in the following functional form:

$$\Gamma(\boldsymbol{\Theta}) = (\mathbf{e}'_{1,n} \mathbf{F}(\boldsymbol{\Theta})' \mathbf{S}'_1, \ldots, \mathbf{e}'_{n,n} \mathbf{F}(\boldsymbol{\Theta})' \mathbf{S}'_n)' > \mathbf{0}. \tag{B.6}$$

We then impose restrictions on both A_0 and $\mathbf{L}(\boldsymbol{\Theta})$ by appropriately setting $\mathbf{S}_j$ and $\mathbf{F}(\boldsymbol{\Theta})$ in Equation (B.6). For instance, restrictions on the impulse response functions (IRFs) can be

imposed by defining $\mathbf{F}(\mathbf{\Theta})$ as vertically stacking the IRFs at different horizons on which we want to impose restrictions and, then, $\mathbf{S}_j$ as a $s_j \times r_j$ matrix of 0s, 1s and -1s corresponding to the horizons and variables over which to impose the r_j restrictions to identify shock j. For restrictions on A_0, on the other hand, we set $\mathbf{F}(\mathbf{\Theta}) = \mathbf{\Theta}$ and we define $\mathbf{S}_j$ as an $s_j \times r_j$ matrix of 0s, 1s and -1s corresponding to the elements of A_0 that we want to restrict.

B.4   Narrative restrictions

We adopt the classification and formalization of narrative sign restrictions proposed by Antolín-Díaz and Rubio-Ramírez (2018).

B.4.1   Signs of the structural shocks

The first type of narrative restrictions concerns the signs of the structural shocks in correspondence of particular episodes occurring at known dates. Assume, for instance, that the sign of the jth shock is positive (negative) at s_j episodes at dates $t_1, \dots, t_{s_j}$. This can be imposed in the SVAR by setting:

$$\mathbf{e}'_{j,n}\varepsilon_{t_\nu}(\mathbf{\Theta}) \begin{cases} > 0 \\ (< 0) \end{cases} \quad \text{for } 1 \leq \nu \leq s_j. \tag{B.7}$$

B.4.2   Contributions of the structural shocks

The second class of narrative restrictions relates to the importance that a particular structural shock has at a point in time. Notably, researchers might have additional information indicating that a certain shock has been the most important contributor to the unexpected movements of the variable of interest at well-defined dates. Such information can be incorporated in the model by imposing additional restrictions on the historical decomposition.

This can be done in two ways, by specifying either: (a) that shock j was the most (least) important driver of the unexpected change in a variable during some periods; or (b) that shock j was the overwhelming (negligible) driver of the unexpected change in a variable during some periods.   For case (a), the restrictions can be imposed on the historical decomposition as follows:

$$|H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\mathbf{\Theta}, \varepsilon_{t_\nu}(\mathbf{\Theta}), \dots, \varepsilon_{t_\nu+h}(\mathbf{\Theta}))|$$
$$- \max_{j' \neq j} |H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\mathbf{\Theta}, \varepsilon_{t_\nu}(\mathbf{\Theta}), \dots, \varepsilon_{t_\nu+h}(\mathbf{\Theta}))| \quad \begin{cases} > 0 \\ (< 0) \end{cases} \tag{B.8}$$

for $1 \leq \nu \leq s_j$. For case (b), instead, the restrictions on the historical decomposition become:

$$|H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\boldsymbol{\Theta}, \varepsilon_{t_\nu}(\boldsymbol{\Theta}), \ldots, \varepsilon_{t_\nu+h}(\boldsymbol{\Theta}))|$$

$$- \sum_{j' \neq j} |H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\boldsymbol{\Theta}, \varepsilon_{t_\nu}(\boldsymbol{\Theta}), \ldots, \varepsilon_{t_\nu+h}(\boldsymbol{\Theta}))| \quad \begin{cases} > 0 \\ \\ (< 0) \end{cases} \tag{B.9}$$

for $1 \leq \nu \leq s_j$.

B.5 Bayesian estimation

We adopt the algorithm proposed in Section III of Antolín-Díaz and Rubio-Ramírez (2018) to estimate the SVAR via Bayesian methods. Notably, the algorithm is an adaptation of the approach proposed by Rubio-Ramírez et al. (2010) and Arias et al. (2018) to take the narrative sign restrictions into account.

Given Equation (B.7), Equation (B.8) and Equation (B.9), narrative sign restrictions can be characterized as:

$$\phi(\boldsymbol{\Theta}, \varepsilon^\nu) > \mathbf{0}, \tag{B.10}$$

where $\varepsilon^\nu = (\varepsilon_{t_1}, \ldots, \varepsilon_{t_\nu})$ are the structural shocks constrained by the narrative sign restrictions. Differently from traditional sign restrictions, then, narrative sign restrictions depend on structural shocks as well. By Equation (B.4) above:

$$\varepsilon_t = g_h(Y_t, \mathbf{Y_{t-1}}, \boldsymbol{\Theta}) \quad \text{for } 1 \leq t \leq T, \tag{B.11}$$

with $Y_t = g_h^{-1}(\varepsilon_t; \mathbf{Y_{t-1}}, \boldsymbol{\Theta})$ for $1 \leq t \leq T$. Combining Equation (B.11) with Equation (B.10) leads to:

$$\tilde{\phi}(\boldsymbol{\Theta}, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu) = \phi(\boldsymbol{\Theta}, g_h(Y_{t_1}, \mathbf{Y_{t_1-1}}, \boldsymbol{\Theta}), \ldots, g_h(Y_{t_\nu}, \mathbf{Y_{t_\nu-1}}, \boldsymbol{\Theta})) > \mathbf{0} \tag{B.12}$$

where $Y^\nu = (Y_{t_1}, \ldots, Y_{t_\nu})$ and $\mathbf{Y}_{\mathbf{t-1}}^\nu = (\mathbf{Y_{t_1-1}}, \ldots, \mathbf{Y_{t_\nu-1}})$. Hence, Equation (B.12) is continuous on the parameters given the data and is continuous on the structural shocks given the parameters.

As in Arias et al. (2018), we consider the orthogonal reduced-form parameterization of Equation (B.2), which depends on Σ, B and Q, where $Q \in \mathcal{O}(n)$, the set of all orthogonal $n \times n$ matrices. The mapping from $\boldsymbol{\Theta}$ to (B, Σ, Q) requires a decomposition of Σ, $h(\Sigma)$, satisfying: $h(\Sigma)'h(\Sigma) = \Sigma$, where h is differentiable. Usually, $h(\Sigma)$ is chosen to be the Cholesky decompo-

sition of Σ. Therefore, the mapping between $\boldsymbol{\Theta}$ and (B, Σ, Q) can be defined as:

$$f_h(\boldsymbol{\Theta}) = \left(\underbrace{(A_+ A_0^{-1})}_{B}, \underbrace{(A_0 A_0')^{-1}}_{\Sigma}, \underbrace{h((A_0 A_0')^{-1} A_0)}_{Q} \right), \tag{B.13}$$

where $h((A_0 A_0')^{-1} A_0)$ is an orthogonal matrix. The inverse of f_h is then:

$$f_h^{-1}(B, \Sigma, Q) = \left(\underbrace{h(\Sigma)^{-1} Q}_{A_0}, \underbrace{B h(\Sigma)^{-1} Q}_{A_+} \right). \tag{B.14}$$

Using Equation (B.14), Equation (B.12) can be rewritten as:

$$\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu) = \tilde{\phi}(f_h^{-1}(B, \Sigma, Q), Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu) > \mathbf{0}.$$

B.5.1   Posterior with traditional sign restrictions

The posterior of (B, Σ, Q) subject to traditional sign restrictions is:

$$
\begin{aligned}
&\pi(B, \Sigma, Q | \mathbf{Y}^T, \boldsymbol{\Gamma}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu)) \\
&= \frac{\overbrace{\pi(\mathbf{Y}^T | B, \Sigma)}^{Likelihood} \overbrace{\pi(B, \Sigma, Q | \boldsymbol{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0})}^{Prior}}{\int \pi(\mathbf{Y}^T | B, \Sigma) \pi(B, \Sigma, Q | \boldsymbol{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0}) d(B, \Sigma, Q)},
\end{aligned}
\tag{B.15}
$$

where $\mathbf{Y}^T = \{Y_{1-p}, \ldots, Y_0, \ldots, Y_T\}$. As the likelihood function does not depend on Q and the function characterizing the sign restrictions, $\boldsymbol{\Gamma}(f_h^{-1}(B, \Sigma, Q))$, does not depend on the structural shocks, traditional sign restrictions simply truncate the prior of (B, Σ, Q).

B.5.2   Posterior with narrative sign restrictions

The posterior of (B, Σ, Q) subject to narrative sign restrictions is:

$$
\begin{aligned}
&\pi(B, \Sigma, Q | \mathbf{Y}^T, \boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu)) \\
&= \frac{\overbrace{\pi(\mathbf{Y}^T | B, \Sigma, Q, \boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu) > \mathbf{0}))}^{Likelihood} \overbrace{\pi(B, \Sigma, Q)}^{Prior}}{\int \pi(\mathbf{Y}^T | B, \Sigma, Q, \boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu) > \mathbf{0}) \pi(B, \Sigma, Q) d(B, \Sigma, Q)}.
\end{aligned}
\tag{B.16}
$$

In this case, the function characterizing the narrative restrictions, $\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}_{\mathbf{t-1}}^\nu))$, depends on the structural shocks, thus implying that narrative sign restrictions truncate the likelihood function.

The truncated likelihood can be rewritten as:

$$
\pi(\mathbf{Y}^T | B, \Sigma, Q, \boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}))
$$
$$
= \frac{\left[\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}\right] \pi(\mathbf{Y}^T | B, \Sigma)}{\int \left[\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}\right] \pi(\mathbf{Y}^T | B, \Sigma) d\mathbf{Y}^T} \quad . \tag{B.17}
$$

In addition, the denominator of Equation (B.17) is:

$$
\int \left[\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}\right] \pi(\mathbf{Y}^T | B, \Sigma) d\mathbf{Y}^T
$$
$$
= \int \left[\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}\right] \left(\prod_{t=1}^{T} \pi(Y_t | \mathbf{Y}_{\mathbf{t-1}}, B, \Sigma)\right) d(Y_1, \dots, Y_T)
$$
$$
= \int \left[\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}\right] \left(\prod_{t=1}^{T} \frac{\pi(g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q)) | \mathbf{Y}_{\mathbf{t-1}}, B, \Sigma)}{\upsilon_{g_h}(g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q)))}\right) d(\varepsilon_1, \dots, \varepsilon_T)
$$

where $\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) = \phi(f_h^{-1}(B, \Sigma, Q, \varepsilon^\nu))$ and υ_{g_h} is the volume of function g_h evaluated at $g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q))$. By Equation (B.11):

$$
\upsilon_{g_h}(g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q))) = |\Sigma|^{-1/2} \quad \text{for } 1 \le t \le T.
$$

It follows that:

$$
\int \left[\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}\right] \left(\prod_{t=1}^{T} \frac{\pi(g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q)) | \mathbf{Y}_{\mathbf{t-1}}, B, \Sigma)}{\upsilon_{g_h}(g_h^{-1}(\varepsilon_t; \mathbf{Y}_{\mathbf{t-1}}, f_h^{-1}(B, \Sigma, Q)))}\right) d(\varepsilon_1, \dots, \varepsilon_T)
$$
$$
= \int \left[\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}\right] (\prod_{t=1}^{T}(\varepsilon_t) d(\varepsilon_1, \dots, \varepsilon_T)
$$
$$
= \int \left[\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}\right] (\prod_{s=1}^{\nu}(\varepsilon_{t_s}) d(\varepsilon_{t_1}, \dots, \varepsilon_{t_\nu}).
$$
$$
\tag{B.18}
$$

By using Equation (B.18), Equation (B.17) can be rearranged as:

$$
\pi(\mathbf{Y}^T | B, \Sigma, Q, \boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}))
$$
$$
= \frac{\left[\boldsymbol{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y}^\nu_{\mathbf{t-1}}) > \mathbf{0}\right] \pi(\mathbf{Y}^T | B, \Sigma)}{\omega(B, \Sigma, Q)}, \tag{B.19}
$$

where $\omega(B, \Sigma, Q) = \int \left[\tilde{\boldsymbol{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}\right] (\prod_{s=1}^{\nu}(\varepsilon_{t_s})) d(\varepsilon_{t_1}, \dots, \varepsilon_{t_\nu})$.

Therefore, the truncated likelihood can be simply formulated as a weighted likelihood, with weights that are inversely proportional to the probability of satisfying the narrative restriction.

B.5.3 Posterior with both traditional and narrative sign restrictions

By assuming a normal-inverse-Wishart-uniform prior for (B, Σ, Q), it follows that $\pi(B, \Sigma, Q) = \pi(B, \Sigma)$. Therefore, the posterior subject to, respectively, traditional and narrative sign restrictions becomes:

Traditional sign restrictions

$$\pi(B, \Sigma, Q | \mathbf{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0}) \propto \left[\mathbf{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0} \right] \pi(\mathbf{Y^T} | B, \Sigma) \pi(B, \Sigma)$$

Narrative sign restrictions

$$\pi(B, \Sigma, Q | \mathbf{Y^T}, \mathbf{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y_{t-1}^\nu}) > \mathbf{0}) \propto \frac{\left[\mathbf{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y_{t-1}^\nu}) > \mathbf{0} \right] \pi(\mathbf{Y}^T | B, \Sigma)}{\omega(B, \Sigma, Q)} \pi(B, \Sigma).$$

Consequently, the posterior of (B, Σ, Q), subject to both traditional and narrative sign restrictions, is:

$$
\begin{aligned}
&\pi(B, \Sigma, Q | \mathbf{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0}, \mathbf{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y_{t-1}^\nu}) > \mathbf{0}) \\
&\propto \left[\mathbf{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0} \right] \frac{\left[\mathbf{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y_{t-1}^\nu}) > \mathbf{0} \right] \pi(\mathbf{Y}^T | B, \Sigma)}{\omega(B, \Sigma, Q)} \pi(B, \Sigma).
\end{aligned}
\tag{B.20}
$$

B.5.4 Algorithm to draw from the posterior

Given the normal-inverse-Wishart-uniform priors and posteriors for (B, Σ, Q), the algorithm used to independently draw from the posterior under both traditional and narrative sign restrictions consists of the following steps:

1. Independently draw (B, Σ) from the normal-inverse-Wishart posterior of the reduced-form parameters and Q from the uniform distribution over $\mathcal{O}(n)$.

2. Check whether $\mathbf{\Gamma}(f_h^{-1}(B, \Sigma, Q)) > \mathbf{0}$ and $\mathbf{\Phi}(B, \Sigma, Q, Y^\nu, \mathbf{Y_{t-1}^\nu}) > \mathbf{0}$ are satisfied.

3. If not, discard the draw. Otherwise set the importance weight of (B, Σ, Q) as follows:

   (a) Take N independent draws of ε^ν from the standard normal distribution.

   (b) Approximate $\omega(B, \Sigma, Q)$ as the proportion of N satisfying $\tilde{\mathbf{\Phi}}(B, \Sigma, Q, \varepsilon^\nu) > \mathbf{0}$ and set the importance weight to $1/\omega(B, \Sigma, Q)$.

4. Return to step 1 until the required number of draws has been reached.

5. Draw with replacement from the set of (B, Σ, Q) using the importance weights computed in step 3b.

C BVAR robustness checks

This section reports several robustness checks performed on the specification of Equation (2.1) above. Notably, we check the validity of the baseline setup's working assumptions concerning: i) the need for additional variables to exactly qualify the relationship between EASTR and EMBI+ and, thus, get a complete identification of shocks; ii) the addition of narrative restrictions on top of the traditional sign and magnitude restrictions; iii) the appropriateness of the lag choice ($p = 2$).

C.1 Simplified setup

In this section we estimate a three-variable SVAR and we use simple sign restrictions to identify the euro area and global risk aversion shocks.

Specifically, given Equation (2.1), we set $Y_t = \{EASTR_t, EMBI_t, \Delta_t\}$, with $\Delta_t = EASTR_t - EMBI_t$. The identification scheme is based on the assumption that a euro area stress shock positively impacts the EASTR variable to a larger extent than the EMBI+ spread, thus leading to an increase in Δ_t. On the other hand, a global risk aversion shock impacts the EMBI+ spread more than the EASTR variable, thus leading to a decrease in Δ_t (see Table C.2).

Table C.2: Simplified sign restrictions

Variables \ Shocks	EA stress	Global
$EASTR_t$	> 0	≥ 0
$EMBI_t$		> 0
Δ_t	> 0	< 0

Figure C.1 depicts the IRFs to an increase by 10 bps in, respectively, the EASTR variable (positive euro area stress shock) and the EMBI+ spread (positive global risk aversion shock). The most striking difference compared to the baseline setup is given by the IRFs of the EASTR variable, in that they are not statistically different across the two shocks. This simpler setup, though appealing given the much reduced computational burden, is not suitable for the purpose of our exercise, as we are also interested into the dynamics concerning other financial indicators. Including the VIX, equity prices, the NEER and the US 10 year yield indeed allows us to characterize some of the most interesting qualitative features of the two shocks. As shown in Section 2.2, a global risk aversion shock triggers a flight-to-safety reaction, while a euro area stress shock does not. These mechanisms cannot be detected without including additional variables and restrictions.

Further insights are provided by the comparison across the structural shocks series that are

Figure C.1: IRFs - euro area stress (blue) and global risk aversion (red)

EASTR

EMBI+

Δ_t
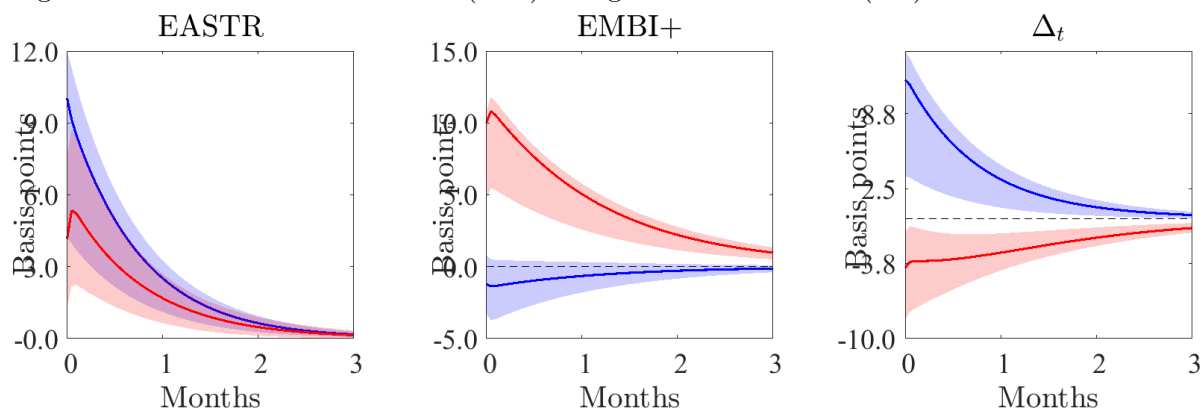
Notes: Shaded areas represent 68% HPD credible sets. In this setup, euro area stress shocks are represented by increases in the EASTR variable, while global risk aversion shocks are given by increases in the EMBI+.
Source: Authors' calculations.

Figure C.2: Daily shock series in the simplified model (red), in the model with traditional restrictions (green) and in the model with narrative restrictions (blue).

(a) Euro area stress
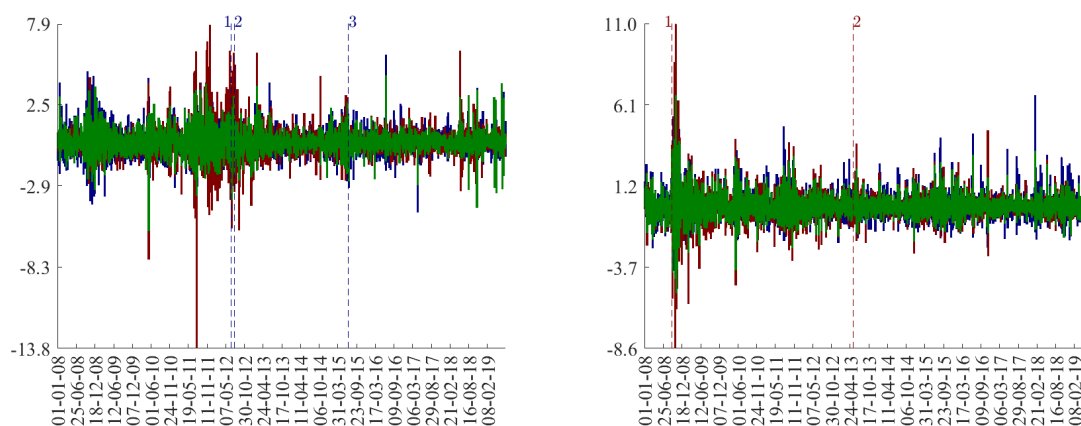
(b) Global risk aversion

Notes: Blue dashed lines in the left panel mark the following relevant events: 1. Spain and Cyprus request for programme; 2. London speech; 3. EG agrees on Greek 3rd programme. Red dashed lines in the right panel correspond to the following events: 1. Lehman Brothers collapse; 2. Fed's "Taper tantrum."
Source: Authors' calculations.

obtained in three different frameworks: the simplified setup, the SVAR with traditional restrictions and the SVAR with narrative restrictions (red, green and blue bars in Figure C.2). Figure C.2a shows that the series of euro area stress shocks as estimated in the baseline model is much more volatile compared to the estimates produced by the seven-variable models with traditional sign restrictions (green bars) and narrative restrictions (blue bars, our baseline). This is particularly evident over the period 2011-2012 and, to a lesser extent, towards the end of the sample. In addition, we also find that the correlation coefficients across the euro area shock series estimated in the three models are generally high (Table C.3).

Table C.3: Estimated correlation coefficients across shock series

Shocks	EA stress		Global risk aversion	
	Model II	Model III	Model II	Model III
Model I	0.61	0.51	0.88	0.61
	(0.00)	(0.00)	(0.00)	(0.00)
Model II		0.75		0.88
		(0.00)		(0.00)

Notes: Model I: three-variable SVAR; Model II: seven-variable SVAR with sign + magnitude restrictions; Model III: seven-variable SVAR with narrative restrictions (baseline). P-values in parentheses.

C.2 Comparing sign, magnitude and narrative restrictions

Figures C.3 and C.4 display the impulse response functions (IRFs) with traditional (sign and sign + magnitude) and narrative restrictions, for a 10-basis-point increase in the EASTR variable and a 1% increase in the VIX respectively, which, in our framework, correspond to a positive euro area stress shock and a positive shock to global risk aversion. Generally speaking, the imposition of the narrative restrictions makes the point estimates more precise than in the frameworks with only sign and magnitude restrictions ("traditional" settings henceforth). The difference in the results is particularly evident in Figure C.3, which shows that narrative restrictions allow for a much sharper identification of the euro area stress shock as well as of the impact on the other endogenous variables. In particular, in the traditional settings, an increase in the EASTR variable does not have any significant impact on either the US 10-year yield or the EMBI+ spread. By adding the narrative restrictions, the former increases on impact by around 6 bps, while the latter is significantly impacted by an average of +1.76 bps over a three-month horizon. Such dynamics could not be captured by relying on sign and magnitude restrictions only. On top of that, a quick comparison with the IRFs to a global risk aversion shocks shows how a relatively narrow set of narrative restrictions is able to unveil the inherent different nature of the two shocks, in particular when considering the effects on the US 10-year yield (Figure C.4).

In this regard, the traditional settings tend to overestimate the impact that a 1% increase in the VIX exerts on the EASTR variable, the US 10-year yield and the EMBI+ spread (Figure C.4). In these cases, indeed, the absolute average difference among the IRFs is in the order of 3.7, 2.1 and 3.5 basis points respectively.
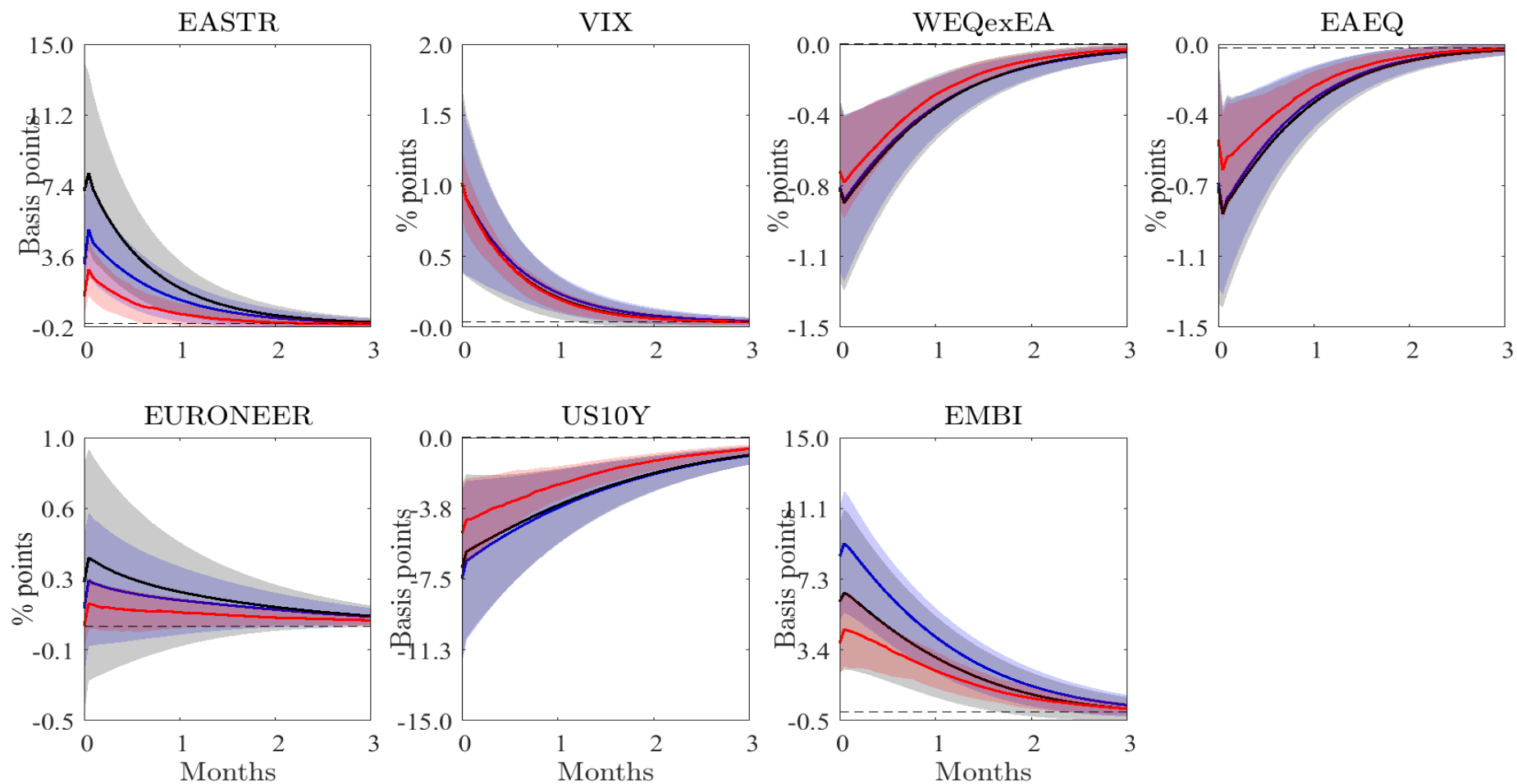
Figure C.3: IRFs for a EA stress shock (10-basis points increase in EASTR) - sign (black), magnitude (blue) and narrative (red) restrictions
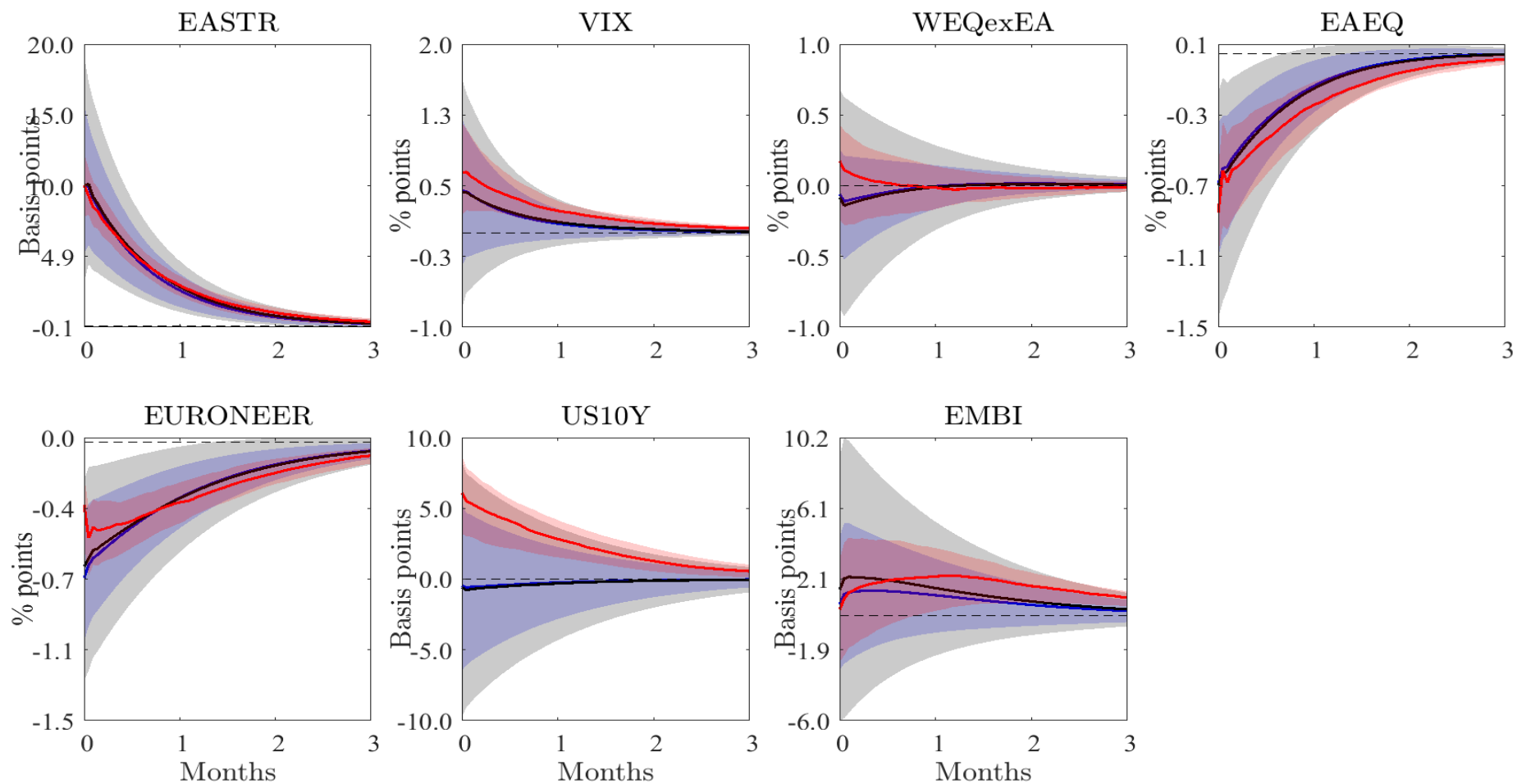
Notes: Shaded areas represent 68% HPD credible sets.
Source: Authors' calculations.

Figure C.4: IRFs for a global risk aversion shock (1% increase in VIX) - sign (black), magnitude (blue) and narrative (red) restrictions

C.3   Lag length

In this section we discuss the choice of the lag length made in the baseline setting ($p = 2$). Notably, we take into consideration one of the most popular Bayesian model comparison criteria, which is based on posterior marginal likelihood. This particular approach is generally found more suitable compared to standard information criteria, which might provide contrasting indications[31]. In this context, we compute the marginal likelihood by making use of the methodology proposed by Chan and Eisenstat (2018), which is based on integrated likelihood, for $p = 1, \ldots, 4$ (Table C.4). Results suggest the the VAR(2) specification is the one delivering the maximum (log-)likelihood value.

Table C.4: Estimated posterior marginal likelihood

Lag length	$p = 1$	$p = 2$	$p = 3$	$p = 4$
Marginal likelihood	-2997	**-2404.6**	-2581.5	-2775.9
	(0.00)	(0.00)	(0.01)	(0.01)

Notes: Standard errors in parentheses. Refer to Chan and Eisenstat (2018) for technical details.

We then check whether this specification is able to fully grasp the dynamics of the data. Notably, we test for the normality and autocorrelation of reduced-form residuals (i.e., $u_t = A_0^{-1} \varepsilon_t$) after estimating the baseline setting of Equation (2.1). Figure C.5 and Figure C.6 show that the residuals follow a standard normal distribution. A quick look at Figure C.7 also shows no autocorrelation in the estimated residuals, which is also confirmed by the Ljung-Box Q test.

---

[31]In our case, the lag length suggested by the Schwartz information criterion would be $p = 1$, while Akaike and Hannan-Quinn criteria would deliver $p = 4$, thus suggesting a fairly different specification.

Figure C.5: QQ-plots for residuals of SVAR(2)
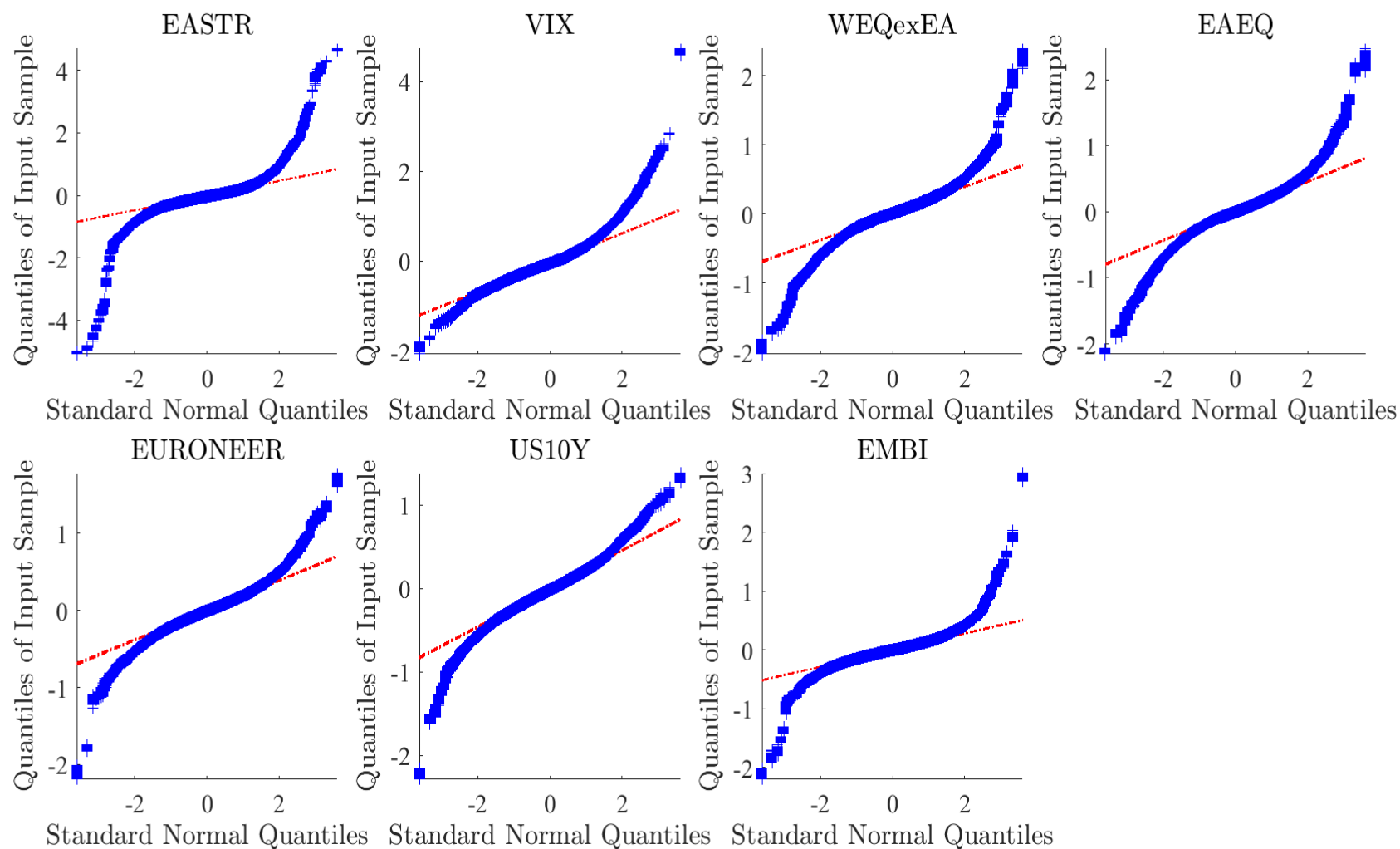
Notes: These charts plot the quantiles of a standard normal distribution (*x*-axis) against the quantiles of the posterior distribution of the vectors in $u_t = A_0^{-1}\varepsilon_t$.
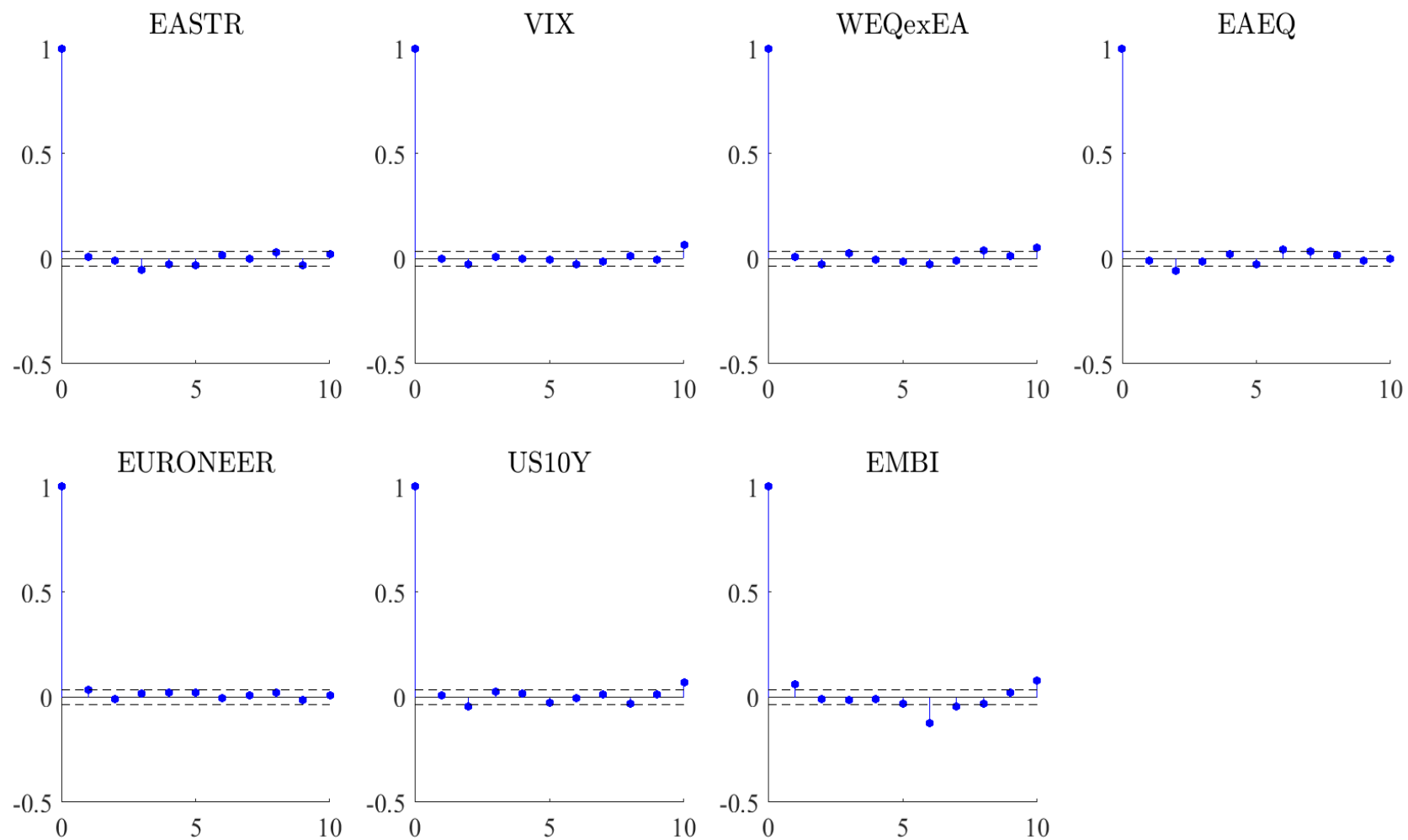
Source: Authors' calculations.

Figure C.6: Posterior densities for residuals from Equation (2.1)
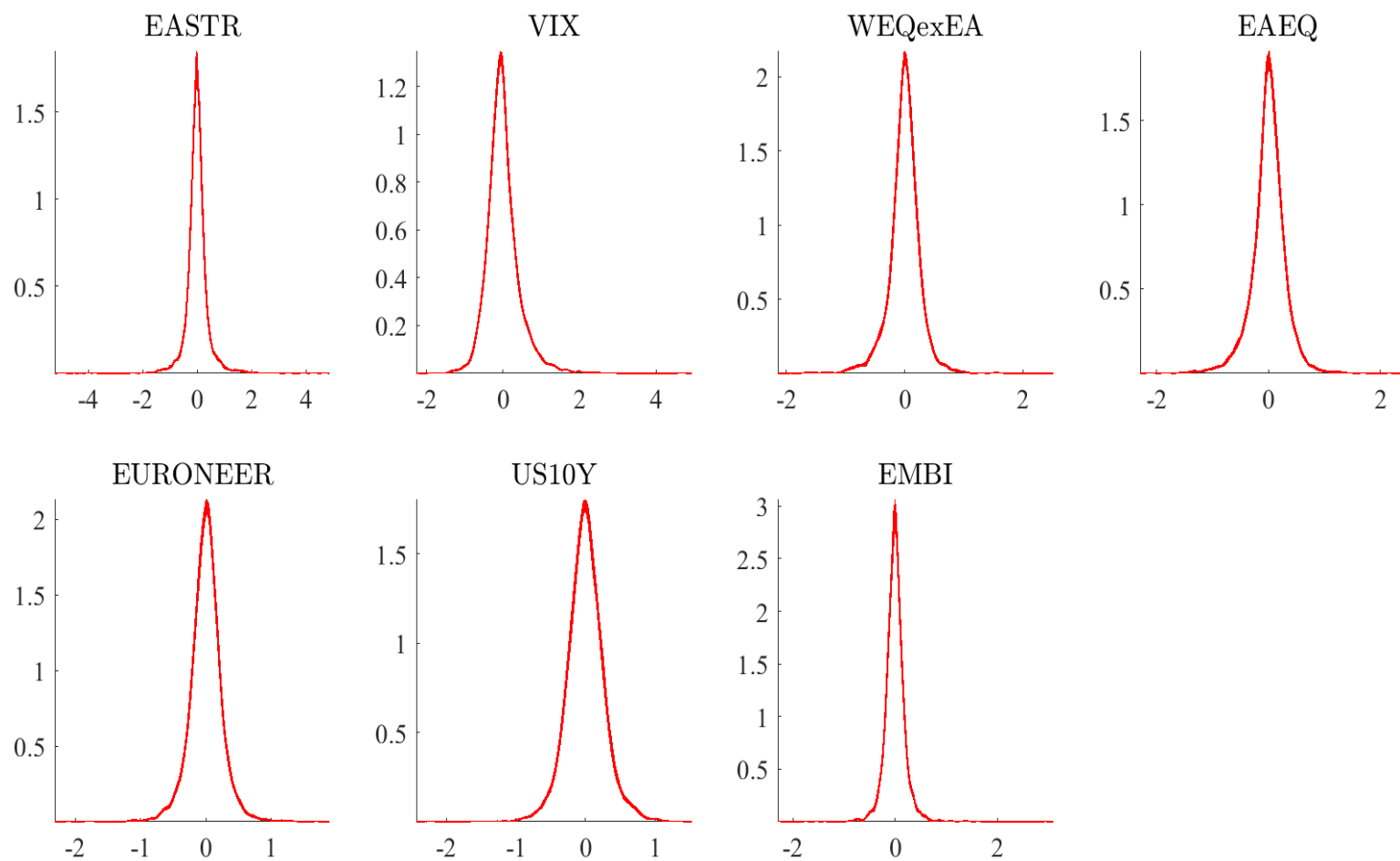
Notes: These charts plot the posterior densities of the vectors in $u_t = A_0^{-1} \varepsilon_t$.
Source: Authors' calculations.

Figure C.7: Autocorrelation functions for residuals of SVAR(2)

D Local projections

D.1 Variance decomposition

This section explains the methodology adopted to estimate the forecast error variance decomposition of panel local projections in Section 3. In particular, we extend the approach devised by Gorodnichenko and Lee (2019) to a panel setting.

Notably, the estimated residuals of Equation (3.1), $\hat{\nu}_{i,h,t+h}$, are considered as the estimate of the forecast error, $\hat{f}_{i,t+h|t-1}$, where $f_{i,t+h|t-1} = (y_{i,t+h} - y_{i,t-1}) - P[y_{i,t+h} - y_{i,t-1}|\Omega_{i,t-1}])$, and $P[y_{i,t+h} - y_{i,t-1}|\boldsymbol{\Omega}_{i,t-1}])$ is the projection of $y_{i,t+h} - y_{i,t-1}$ onto $\boldsymbol{\Omega}_{i,t-1} = [\varepsilon_t^z, x_{i,t-1}, \ldots, x_{i,t-p}, \boldsymbol{Z}_{t-1}]$. Consequently, the forecast error can be decomposed as variations of ε_t^z as follows:

$$f_{i,t+h|t-1} = \psi_{z,0}\varepsilon_{t+h}^z + \cdots + \psi_{z,h}\varepsilon_t^z + \eta_{t+h|t-1}.$$

Specifically, the share of variance explained by ε_t^z at horizon h is:

$$s_h = \frac{var(\psi_{z,0}\varepsilon_{t+h}^z + \cdots + \psi_{z,h}\varepsilon_t^z)}{var(f_{i,t+h|t-1})},$$

which can be rewritten as:

$$s_h = \frac{\mathbf{covar}(f_{i,t+h|t-1}, \boldsymbol{Z}_t^h)[\mathbf{var}(\boldsymbol{Z}_t^h)]^{-1}\mathbf{covar}(\boldsymbol{Z}_t^h, f_{i,t+h|t-1})}{\mathbf{var}(f_{i,t+h|t-1})}, \tag{D.1}$$

where $\boldsymbol{Z}_t^h = [\varepsilon_{t+h}^z, \ldots, \varepsilon_t^z)]$. At each horizon h we run the following regression:

$$\hat{f}_{i,t+h|t-1} = \alpha_{z,0}\varepsilon_{t+h}^z + \cdots + \alpha_{z,h}\varepsilon_t^z + \upsilon_{i,t+h|t-1}. \tag{D.2}$$

The estimator of the forecast error variance decomposition at horizon h, $\hat{s}_h^{R^2}$, is then given by the R^2 of Equation (D.2).

D.2 Different sample coverage

In this section we re-estimate Equation (3.1) over a panel of countries that excludes (non-EA) EU members as of July 2019. Results, reported in Table D.5 and displayed in Figures D.8 and D.9 below, are not statistically different from what already discussed in Section 3.1. Our analysis is then found robust to the presence of these countries in the sample.

Figure D.8: **Extra-EU Advanced economies** - Impulse responses to a positive one s.d. euro stress shock (blue) and a positive one s.d. global risk aversion shock (red)
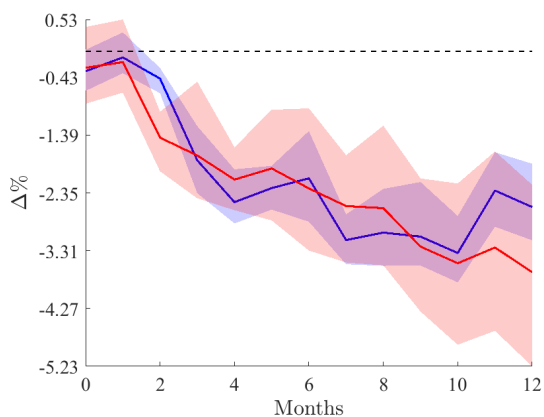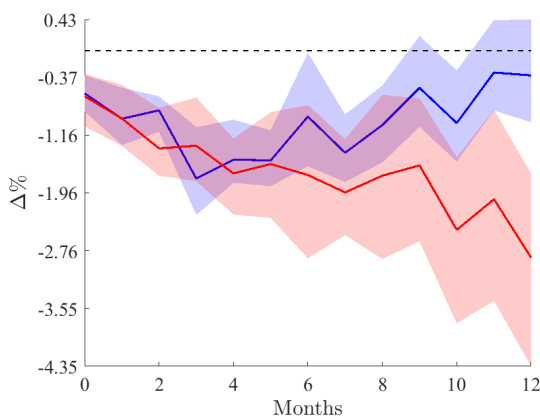
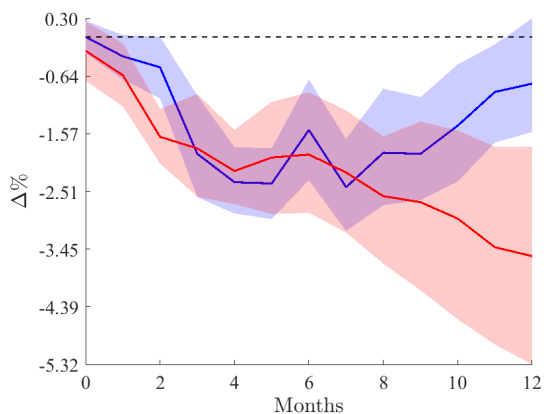(a) Industrial production
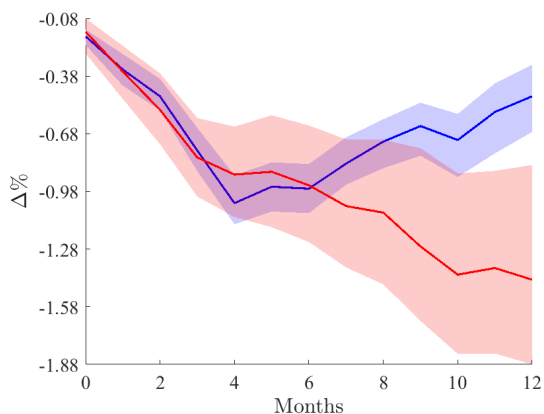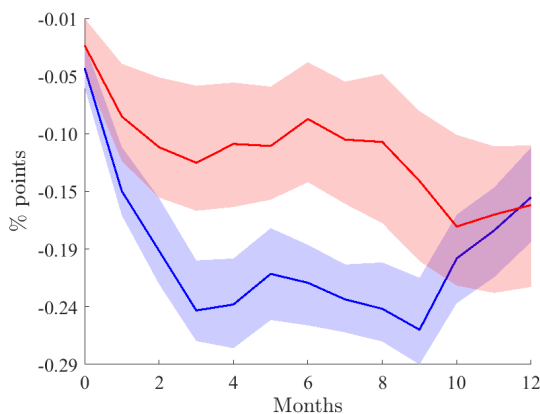
(b) Inflation

(c) Exports to euro area

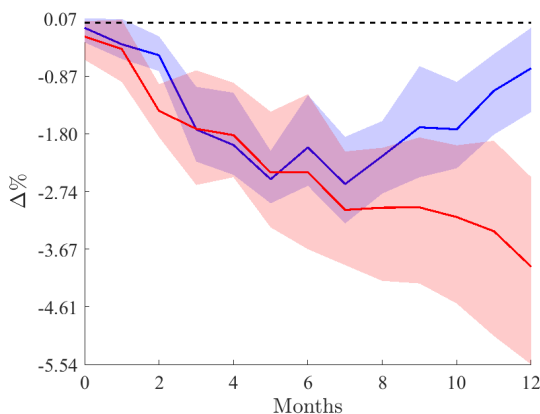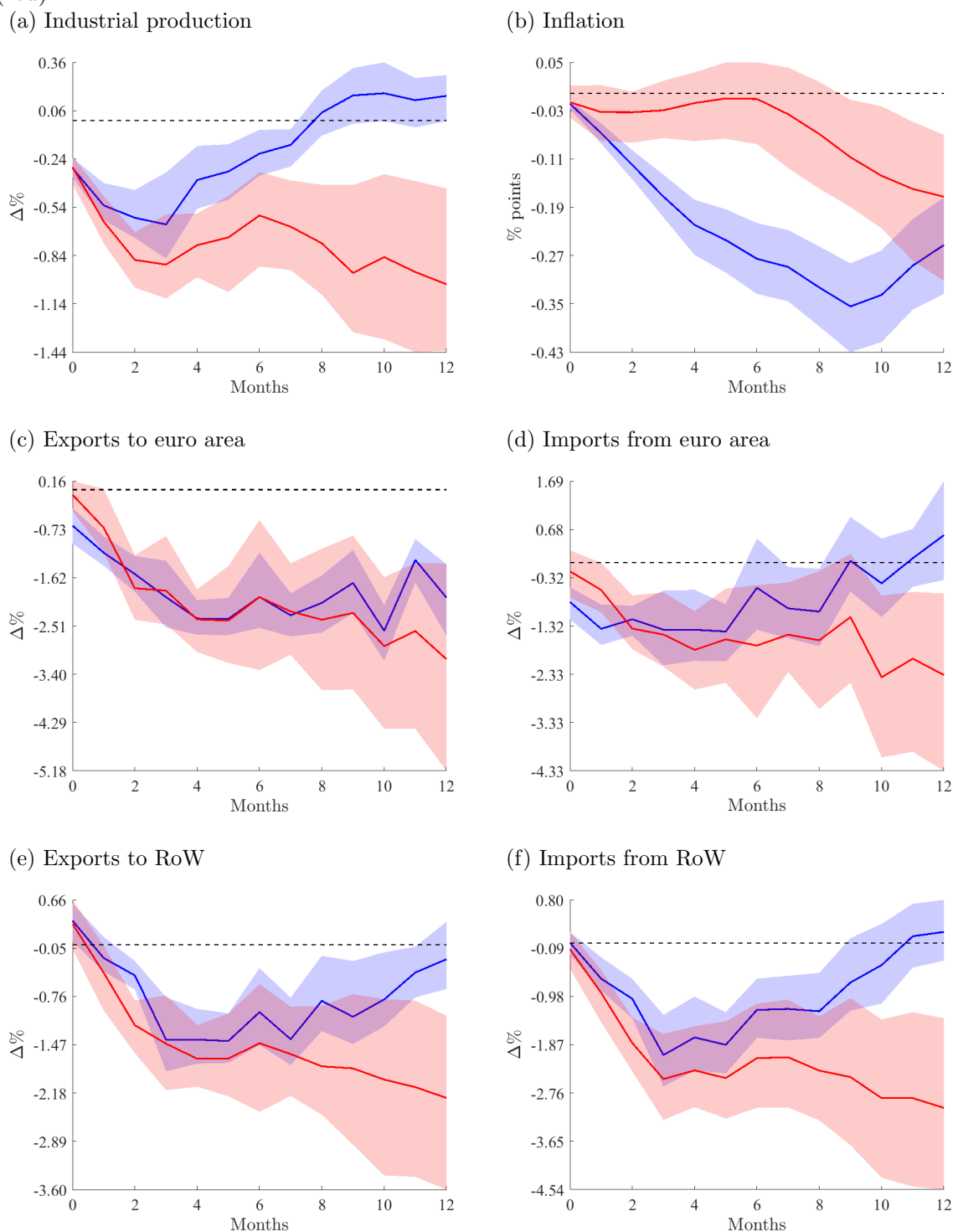

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. Δ%: log-change. Shaded areas are 68% HPD credible sets.
Source: Authors' calculations.

Figure D.9: **Extra-EU Emerging and developing economies** - Impulse responses to a positive one s.d.euro area stress shock (blue) and a positive one s.d. global risk aversion shock (red)

(a) Industrial production

(b) Inflation

(c) Exports to euro area

(d) Imports from euro area

(e) Exports to RoW

(f) Imports from RoW

Notes: Inflation is defined as the y-o-y percentage change of the CPI. Δ%: log-change. Shaded areas are 68% HPD credible sets.
Source: Authors' calculations.

Table D.5: Maximum impact of euro area stress and global risk aversion shocks

Variable Shock	IP	Inflation	Exports to		Imports from	
			EA	RoW	EA	RoW
Extra-EU Advanced Economies						
EA	-1.02%	-0.27pps	-3.29%	-2.28%	-1.57%	-1.94%
	(6)[*]	(9)	(10)	(7)	(3)	(5)
Global	-1.46%	-0.16pps	-4.14%	-3.78%	-2.76%	-3.81%
	(12)	(10)	(12)	(12)	(12)	(11)
Extra-EU Emerging Markets						
EA	-0.48%	-0.45pps	-2.79%	-2.01%	-1.35%	-1.28%
	(2)	(9)	(10)	(3)	(3)	(5)
Global	-1.06%	-0.16pps	-3.04%	-2.91%	-2.50%	-2.38%
	(12)	(12)	(12)	(12)	(12)	(12)

Notes: [*] Numbers in parentheses represent the amount of months after a shock has taken place.

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