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Fiscal Policy Spillovers in the Euro Area - a new assessment *

António Afonso[1] and Daniel Loureiro[2]

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Abstract

We compute a GVAR to estimate the fiscal spillovers on output, consumption, investment, employment, and income, from 2002Q1 to 2021Q4, with 16 Euro Area (EA) countries. We found that a budget balance expansionary shock in Germany would generate positive spillovers on output and employment. Negative cross-country effects on consumption were also found. No significant spillovers on investment or income were observed following this shock. Greater and more significant spillovers were found after an EA global shock. There are also positive effects on private investment. However, a global shock still does not generate significant effects on income and increases the magnitude of the negative short-run spillovers on consumption. Greece is one of the countries more affected by short-run negative spillovers. Finally, national and global fiscal shocks put upward pressure on prices and generate negative effects on public debt. From a policy perspective, we recommend the reinforcement of the fiscal coordination framework.

Keywords: Euro Area, fiscal spillovers, policy coordination, GVAR
JEL Codes: C32, E62, F42, F45

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* The opinions expressed herein are those of the authors and do not necessarily reflect those of the authors' employers. Any remaining errors are the authors' sole responsibility.

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1 Introduction

The contemporary literature almost unanimously presents a case for at least some degree of fiscal policy coordination in the Euro Area (EA). Nevertheless, the discussion regarding the exact net advantages of that coordination and its distribution across countries is still far from settled.

An important share of these benefits and costs arise from the cross-country effects of fiscal policy shocks. Hence, we contribute to the discussion by focusing, at the EA level, on three main research questions. (i) Does a country-specific fiscal shock spillover to other countries? (ii) Does a coordinated fiscal policy shock generate larger cross-country effects? (iii) What are the macroeconomic variables affected by the cross-country effects and what is the size and sign of those spillovers?

Positive spillovers, mainly resulting from the trade channel, are often pointed out as one of the main reasons to coordinate fiscal policies (Alloza et al., 2019; Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). On the contrary, negative effects could also be present, due to the response of the interest rate and the exchange rate.

Notwithstanding, the estimation of these cross-country effects is marked by considerable uncertainty (Alloza et al., 2019) and a still reduced number of papers on the topic (Belke & Osowski, 2019). Not only theoretical and empirical studies often present opposite results, as different econometric approaches often lead to different conclusions. So, the empirical evidence is not enough to safely conclude for the existence or not of bilateral spillovers and their signal. Moreover, most of the studies on the topic center the analysis on the effects on output. Spillovers on consumption, investment, employment, and income are far less studied, particularly with empirical methods. Then, even more uncertainty arises. Any general conclusion or the comparison with theoretical models is therefore incomplete. Assessing the international effects on these variables becomes essential to fully understand the consequences of a foreign fiscal shock. This, together with the dispersion of results

obtained with different methods, makes the study of spillovers in the EA a contemporaneous and unsolved question.

So, to address these questions, we follow Pesaran et al. (2004) and we compute a Global VAR (GVAR). Then, apart from the effects on output, we also contribute to the literature by augmenting the model to estimate spillovers on private consumption, private investment, employment and income.

Overall, because of country-specific (CS) budget balance negative shocks in some of the largest economies, we found a positive response of the other countries' output, following previous studies on the topic (Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). We also found positive cross-country effects on employment after CS shocks, although these are only statistically significant for a reduced number of countries after a shock in Germany. Regarding the consumption, while no significant effects arise in the longer run, negative effects were found in the first quarters after the shocks. These conclusions regarding the cross-country effects on consumption contradict theoretical (Corsetti et al., 2009; Lozej & Walsh, 2021) and empirical (Beetsma & Giuliodori, 2011) findings, although the possibility was already raised by Barbier-Gauchard and Betti (2021). As for the private investment and income, no significant effects were observed after a CS shock.

Greater and more significant spillovers were found after an EA global shock. So, apart from greater effects on output and employment, we also observe positive and statistically significant effects on private investment. On the contrary, a global shock still does not generate significant effects on income and increases the magnitude of the negative short-run spillovers on consumption.

Greece is one of the countries more affected by short-run negative spillovers, due to its size and duration. A global shock can trigger negative and statistically significant effects on Greek output, consumption and employment during the first three quarters and on investment during the initial six quarters.

Finally, we also observed that a CS or an EA fiscal shock puts upward pressure on prices in most countries, mainly more than two years after the shock, and generates negative effects on public debt, mainly during the first year.

Therefore, several policy recommendations result from our study. It is clear that coordination amplifies the positive cross-country effects of fiscal shocks. Therefore, additional efforts should be carried to ensure the implementation of a successful framework. However, a coordinated shock may also magnify short-run negative responses on output, employment and investment in some countries. Therefore, the gains of coordination are not free from costs, which should be carefully weighted when implementing such policies. Redistributing the costs of the common fiscal policy or provide short-run financial support to these countries may contribute to surpass these costs. Finally, these short-run negative responses can also reduce the acceptance of the policy, raising political concerns.

In section 2, we discuss the main theoretical and empirical findings of the existent literature. Then, we detail the methodology and the data used in section 3 and we discuss the results in section 4. In section 5, we perform a sensitivity analysis with some possible alternatives. In section 6, we present a brief conclusion.

2 Literature review

Taking advantage of positive spillovers on output has been pointed out in the literature as one of the main reasons to coordinate fiscal policies (Alloza et al., 2019; Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). While negative spillovers arise from the response of the interest rate and the exchange rate to a fiscal shock, positive spillovers can be found mainly due to the trade channel (Alloza et al., 2019; Hebous & Zimmermann, 2013; Ilori et al., 2022; Ricci-Risquete & Ramajo-Hernández, 2015). When a country implements an expansionary fiscal policy, the government spending may directly increase imports, and it boosts domestic economic activity, which also intensifies

imports (Alloza et al., 2019; Beetsma & Giuliodori, 2011). If this impact on imports could be minimized, the multiplier effect of the fiscal policy would be maximized (Beetsma & Giuliodori, 2011).

If we consider the case in which several trading partners of a given country are implementing expansionary fiscal shocks, the aggregate effect in exports is greater than the sum of the individual results, as those countries promoting the shock also benefit from positive spillovers among them (Alloza et al., 2019). Hence, it seems clear that with everything else constant, these cross-border trade effects justify coordination, given that it internalizes an externality from national fiscal policies. The coordinated fiscal expansion maximizes the fiscal multipliers obtained with a given shock or allows to get the same multipliers as in the absence of coordination but with lower financial effort (Hebous & Zimmermann, 2013).

The overall net spillovers depend on the importance of the previously described mechanism. If the negative spillovers induced by interest rates and exchange rates, the financial channel, are greater than the ones promoted from the trade channel, coordination may be desirable to *minimize* and *prevent* the consequences of these spillovers, and so to ensure prudent levels of fiscal stimulus. If the opposite occurs, coordination can be claimed as an important process to *maximize* and *take advantage of* the effects of spillovers (Alcidi & Gros, 2015).

Theoretical studies tend to find overall negative or neglectable spillovers (Blanchard et al., 2017; Cwik & Wieland, 2011; Forni et al., 2010; Gadatsch et al., 2015), mostly due to the major role of interest rate in these models, when compared to trade (Cwik & Wieland, 2011). However, this result depends largely on the monetary policy reaction (Barbier-Gauchard & Betti, 2021; Blanchard et al., 2017; Lozej & Walsh, 2021). When the Zero Lower Bound is reached, greater cross-country effects can be verified (Blanchard et al., 2017). Similarly, small (larger) positive output spillovers tend to be noticed when monetary policy is active (passive) (Lozej & Walsh, 2021). Nevertheless, some authors have also found positive cross-country effects in a theoretical framework (Barbier-Gauchard & Betti, 2021; Corsetti et al.,

2009; Davoine & Molnar, 2020). For Davoine and Molnar (2020) these positive spillovers would be even greater when shocks are debt-financed. Differently, Corsetti et al. (2009) argued that positive spillovers can arise when the short-run positive fiscal shocks are complemented with credible fiscal sustainability plans for the long-run.

Contrary to most of the previous theoretical results, empirical studies applied to the EA tend to estimate positive spillovers on output (Alloza et al., 2019; Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ilori et al., 2022; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015), though some differences subsist. First, Hebous and Zimmermann (2013) concluded for the presence of positive spillovers on output, only following an EA fiscal shock. When bilateral spillovers were estimated, the sign of the effects differed from case to case, but overall the results were not statistically significant. Nevertheless, Ricci-Risquete and Ramajo-Hernández (2015) found positive, but very small, spillovers following country-specific (CS) fiscal shocks. These effects were greater the larger the economy promoting those shocks (Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015) and the greater the trade between the countries (Poghosyan, 2020). Besides, Poghosyan (2020) concluded that tax shocks would promote larger spillovers than revenue shocks. Similarly to Hebous and Zimmermann (2013), they noticed that the spillovers arising from the global shock would be greater than the ones resulting from domestic shocks.

However, Hebous and Zimmermann (2013) highlighted that larger spillovers were not the only benefits of a coordinated shock. Considering global and CS shocks of similar size, the fiscal cost to each country would be lower under coordination. Then, even if the effect of the EA wide shock on output was lower, it could still be preferable due to the lower financial burden of the shock. Still, as explained before, the EA wide shock would generate larger spillovers on output (Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015).

Nevertheless, in both theoretical and empirical studies, several authors have found that the size of the spillovers depend on the exact fiscal variable to implement the shock (Alloza et al., 2019; Barbier-Gauchard & Betti, 2021; Davoine & Molnar, 2020; Goujard, 2017), on the macroeconomic conditions (Goujard, 2017), and even from country to country, given the evidence of heterogeneity in the estimated cross-country effects (Alloza et al., 2019; Davoine & Molnar, 2020; Goujard, 2017; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). Alloza et al. (2019) concluded that fiscal shocks based on public investment would likely increase the size of these cross-country effects. Similarly, Goujard (2017) estimated negative spillovers on output from fiscal consolidation episodes and found that government spending shocks would generate larger spillovers than revenue shocks. Furthermore, these effects would vary according to the exact country considered and to the macroeconomic situation. Finally, Ilori et al. (2022) argued that although significant and positive, the spillovers within the Euro Area did not seem to be different from the ones between non-Euro Area countries. On the contrary, for Goujard (2017), countries belonging to a monetary union tend to register greater spillovers, given the greater link in terms of international trade.

Focusing on the effects of a US fiscal shock, Faccini et al. (2016) found that the American shock would keep the trade balance between the USA and the rest of the world almost unchanged. These results suggest, according to the authors, a greater role of the financial channel in explaining the international transmission of government spending shocks. While international trade between EA countries is more relevant than between the USA and the rest of the world, Faccini et al. (2016) work still underlines the potential importance of the financial channel, particularly the interest rates.

Besides, although focusing on US originating shocks, Faccini et al. (2016) also found that the spillovers were not influenced by the macroeconomic conditions or the international order. Changes between recession and expansion or the creation of the EA have not significantly changed the outcome. These results oppose the findings

of Auerbach and Gorodnichenko (2013) for OECD countries. These authors found that the significant positive spillovers on output would be larger during recessions.

In spite of the overall similar conclusions, it is important to highlight that the empirical approach was different across the literature. For instance, Beetsma and Giuliodori (2011) relied on the estimation of SVARs, extending the domestic models with an additional variable (foreign output), capturing the economic activity in the other EA countries. Given that this foreign variable is computed as a weighted average, the authors considered GDP and trade weights as alternative approaches.

Differently, Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Herna´ndez (2015) estimated GVARs. As in Beetsma and Giuliodori (2011), the CS VARs also had to be extended with a vector of foreign variables, computed as weighted averages. Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) considered trade weights in the computation of the foreign variables, although Hebous and Zimmermann (2013) also used capital flows when computing financial foreign variables. However, while Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) considered fixed weights, Camarero et al. (2021) relied on time-varying weights. So, the weights used to compute the foreign variables vary yearly, according to the evolution of the underlying bilateral trade shares.

However, the previously described empirical strategies have in common the fact that they use models with a reduced number of variables. To study additional effects, variables have to be introduced one at a time. To solve this problem, Ilori et al. (2022) estimated a Bayesian VAR, which allowed the estimation of a greater number of parameters while relying on usual VAR practices and identification strategies. Then, BVARs using Gibbs sampling were estimated to compute spillovers from fiscal shocks originating in the USA or Germany. Besides, to assess the international spillovers, the model was augmented with foreign output. However, While in previous studies (Beetsma & Giuliodori, 2011; Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015) the foreign variables were

computed as a weighted sum of the variables of each foreign country, in Ilori et al. (2022) the estimation is repeated bilaterally.

Finally, other approaches, such as the estimation of IRFs with local projections (Alloza et al., 2019), the estimation of a factor-augmented VAR (Faccini et al., 2016), or the estimation of a smooth transition VAR (Auerbach & Gorodnichenko, 2013), can also be found in the literature. Nevertheless, to the best of our knowledge, the estimation of a GVAR is the most tested and used methodology for the computation of international spillovers. So, considering the scope of our study, we chose to rely on this method, as it will be explained further on.

Besides, the fact that several empirical studies applying different methodologies have concluded for the presence of positive spillovers on output could seem to suggest a low sensitivity of the results to the method used. Nevertheless, additional questions remain. First, although most of the empirical literature points to spillovers with the same signal, the size of those spillovers differs. While Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) concluded that the spillovers resulting from a CS shock would be either insignificant or positive but very small, Beetsma and Giuliodori (2011) and Ilori et al. (2022) found positive cross-country effects after fiscal shocks in the largest economies.

Moreover, even using the same estimation model, the results can still be sensible to the several methodological choices, such as the number of lags in the model, the data used, and the variables considered and their computation. Beetsma and Giuliodori (2011) found positive output spillovers both when the foreign output was computed based on GDP weights and imports weights. Yet, while for the GDP weights, the results were not statistically significant, more significant results were reported for the import weights. Such difference is not surprising, as the second approach attributes greater relative importance to the main trading partners.

Hence, one can understand that the empirical results vary according to the methods applied by each author. So, further empirical work is still necessary to test the validity of the main findings identified in the literature. Additionally, most of the

empirical literature on the topic focus on the impacts of a fiscal shock in the other countries' output. Nevertheless, exactly what other macroeconomic variables are contributing to or being affected by the overall effect on output is often ignored.

Considering the theoretical literature, positive spillovers on private consumption have been found (Corsetti et al., 2009; Lozej & Walsh, 2021). Besides, Lozej and Walsh (2021) also concluded that the fiscal stimulus in the EA would generate positive spillovers on investment, employment, and income. The persistence of these effects would depend on the instrument used to implement the shock. Differently, (Barbier-Gauchard & Betti, 2021) found that the effects on private consumption, wages, and employment can be either positive or negative, depending on the variables used to implement the shock.

Focusing on the empirical literature, Faccini et al. (2016) found positive spillovers on consumption and investment following a fiscal stimulus in the US. According to the author, this result would arise mainly due to the effects on the interest rate (the US fiscal shock reduces the interest rates in the foreign economies). Then, an important question can be posed. At least in normal times, the interest rate is expected to increase in the EA in response to a fiscal shock (Heipertz & Verdun, 2004), at least if it origins from a big economy or a group of countries. So, assessing whether a fiscal shock in the largest economies or in all the countries at once produces impacts on consumption and investment becomes a relevant question. Beetsma and Giuliodori (2011) presented a first answer, concluding for positive spillovers on consumption and investment. Yet, the literature analyzing these effects is still clearly insufficient for a general conclusion and further work is necessary.

Hence, the analyzed papers concluded for positive spillovers on output between EA countries, particularly following an aggregate fiscal shock. Even so, considerable uncertainty about the results and the transmission channel persist (Alloza et al., 2019), mostly because of the still reduced number of papers on the topic (Belke & Osowski, 2019). Not only theoretical and empirical studies often present opposite results, as the econometric approaches lead to different conclusions. At the time, the

empirical evidence is not enough to safely conclude for the existence or not of bilateral spillovers and their signal. Besides, whether or not the existent cross-country effects are magnified between EA countries, compared to the rest of the world, and whether or not those effects depend on the macroeconomic situation is also unclear in the literature. This uncertainty, together with the dispersion of results obtained with different methods, makes the study of spillovers in the EA a contemporaneous and unsolved question.

Moreover, spillovers on consumption, investment, employment, and income are far less studied, particularly with empirical methods. So, even more uncertainty arises. Any general conclusion or the comparison with DSGE models is therefore incomplete. Assessing the international effects on these variables becomes essential to fully understand the consequences of a foreign fiscal shock.

3 Methodology

As explained in the previous section, there is considerable uncertainty regarding the effects of a fiscal shock in the other countries' macroeconomic variables. Even if we can find previous literature regarding output spillovers, the existent empirical studies on the cross-country effects on private consumption, investment, employment, and income is far from enough.

Given this gap in the literature, we chose to rely on one the most widely used models for the estimation of spillovers (Belke & Osowski, 2019; Camarero et al., 2021; Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015). So, we followed Pesaran et al. (2004) and we computed a Global VAR (GVAR), a model particularly suited to study the international propagation of shocks (Camarero et al., 2021). By identifying the geographic source of each shock, it is possible to isolate impulses originating in each country (Caporale & Girardi, 2013).

So, we contribute to the literature by providing additional empirical evidence on the cross-country effects of a fiscal shock. Particularly, we explore the results on several macroeconomic variables, which have not been sufficiently studied. Assessing the overall impact on output is useful and necessary. However, understanding what other macroeconomic variables are affected is not a minor question, both for the country's macroeconomic performance and for the groups of agents impacted by the policy.

Moreover, we also contribute to the literature from a technical perspective. While several studies rely on the use of time-fixed weights Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) by taking the average of a given period, we followed Camarero et al. (2021) and Dees et al. (2007) and we computed the foreign variables with time-varying weights. Additionally, we also differ from most of the literature regarding the choice of foreign variables in our baseline model. Caporale and Girardi (2013), Hebous and Zimmermann (2013), Poghosyan (2020), and Ricci-Risquete and Ramajo-Hernández (2015) computed a foreign variable for almost all domestic variables. However, as explained further on, we chose to follow Beetsma and Giuliodori (2011) and (Ilori et al., 2022), even though the econometric model is not the same, and rely on the foreign output as the unique foreign variable.

Besides, while most authors use quarterly data sets with greater length but fewer countries (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015)[3], we chose to include as many EA members as possible, even if we had to use a shorter data set. Therefore, we consider data for 16 EA countries, from 2002 to 2021.

[3] Hebous and Zimmermann (2013) used data for 12 EA countries, from 1979 to 2009. Ricci- Risquete and Ramajo-Hernández (2015) used data from 1978 to 2009, for 14 EA countries. Poghosyan (2020) used data from 1980 to 2016, for 10 EA countries. Caporale and Girardi (2013) used data from 1999 to 2010 and considered only 11 countries.

3.1. Global VAR

Following Pesaran et al. (2004), the GVAR comprises two important steps. First, CS VARs are estimated, encompassing domestic and foreign variables. Then, in the second step, the CS VARs are stacked and the impulse response functions computed. We now detail each of these steps.

Step I: Country-specific VARs

For each considered country i, we estimate a CS VAR:

$$x_{i,t} = \alpha_{i,0} + \alpha_{1,i}t + \beta_{i,1}x_{i,t-1} + \cdots + \beta_{i,\rho}x_{i,t-\rho} + \delta_{i,0}x^{*}_{i,t} + \cdots + \delta_{i,\rho}x^{*}_{i,t-\rho} + u_{i,t} \quad (1)$$

The $kx1$ vector of domestic endogenous variables $x_{i,t}$ is regressed on a constant $\alpha_{i,0}$, on the $kx1$ vectors of lagged domestic endogenous variables $x_{i,t-\rho}$, and the $k^{*}x1$ vectors of lagged foreign variables $x^{*}_{i,t-\rho}$. k and k^{*} corresponds to the number of domestic and foreign variables considered, respectively. As in Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015), we also included a time trend, represented by the term $\alpha_{1,i}t$. Then, we model international interactions by augmenting the CS VARs with a vector of foreign variables, which we assume as weakly exogenous[2] (Belke & Osowski, 2019; Camarero et al., 2021; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). This assumption means that each economy has little weight in the EA's economy as a whole and allows to minimize the number of parameters to be estimated, thus surpassing the curse of dimensionality. Each foreign variable results from the weighted average of the corresponding national variables in the remaining countries:

[2] This assumption was later tested to verify its validity and the results are presented in Appendix B, table B1.

$$x^*_{i,t} = \sum_{j=1}^{n} w_{j,t}\, x_{j,t} \quad (2)$$

Following Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015), we considered international trade weights. The weight w_j of each foreign country j corresponds to the trade share of country j on the total international trade of the domestic country i with the considered partners[4]. Besides, we followed Camarero et al. (2021) and Dees et al. (2007) and we included time varying weights. The weights w_j vary each year, according to the underlying trade shares. The annual change of the foreign variables may reflect the variation of the actual foreign variable considered or of the trade shares. So, with this approach, we get to account for the evolution of each trading partner's relative importance.

Finally, we did not reject the hypothesis of a unit root in most variables for most countries[5]. Given that first differences would not eliminate the unit root in all cases, we considered the variables in levels and estimated the CS VARs in the error-correction form, as in (Belke & Osowski, 2019; Camarero et al., 2021; Caporale & Girardi, 2013; Metelli & Natoli, 2021; Ricci-Risquete & Ramajo-Hernández, 2015).

Step II: Global VAR

Having the CS VAR, we now rearrange the model, such that domestic and foreign variables are stacked in the same vector $z_{i,t} = \begin{pmatrix} x_{i,t} \\ x^*_{i,t} \end{pmatrix}$:

$$\left(\mathrm{I} - \delta_{\mathrm{i},0}\right)\mathrm{z}_{\mathrm{i,t}} = \alpha_{\mathrm{i},0} + \alpha_{1,\mathrm{i}}\mathrm{t} + \left(\beta_{\mathrm{i},1} - \delta_{\mathrm{i},1}\right)\mathrm{z}_{\mathrm{i,t-1}} + \cdots + \left(\beta_{\mathrm{i,m}} - \delta_{\mathrm{i,m}}\right)\mathrm{z}_{\mathrm{i,t-m}} + \mathrm{u}_{\mathrm{i,t}}, \quad (3)$$

where m=max{p,q}. Re-writing the model:

$$A_{i,0} z_{i,t} = \alpha_{i,0} + \alpha_{1,i} t + A_{i,1} z_{i,t-1} + \cdots + A_{i,m} z_{i,t-m} + u_{i,t} \quad (4)$$

[4] To the computation of the weights, we ignored the international trade with non-EA countries (or with EA countries not considered in this estimation), such that the sum of the foreign country's weights is one for each domestic country *i*.

[5] The results are presented in Appendix B, table B2, B3 and B4.

Given that $z_{i,t} = \begin{pmatrix} x_{i,t} \\ x^*_{i,t} \end{pmatrix}$, we can also express zi,t = Wixt, where Wi is a (ki + k∗) x k linkage matrix. ki is the number of domestic variables and k∗ is the number of foreign variables in the country-specific VAR. The matrix Wi is filled with zeros, ones, and the weights used to compute the foreign variables. We can thus get zi,t from all the variables in the model (xt is a vector with all the variables for all the countries stacked up). Introducing the new notation in the model:

$$A_{i,0}W_i x_t = \alpha_{i,0} + \alpha_{1,i}t + A_{i,1}(\beta_{i,1} - \delta_{i,1})W_i x_{t-1} + \cdots + A_{i,m}(\beta_{i,m} - \delta_{i,m})W_i x_{t-m} + u_{i,t} \quad (5)$$

Stacking up the model for all the countries considered:

$$G_0 x_t = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1} t + G_1 x_{t-1} + \cdots + G_m x_{t-m} + \boldsymbol{u_t} \quad (6)$$

$G_s, s = 0,\ldots,m$, α_0, α_1 and u_t comprise all the CS matrices.

Following Ricci-Risquete and Ramajo-Hernández (2015), we can go from the previous equation to the reduced-form VAR by multiplying all the terms by G_0^{-1}, as long as G_0 is invertible:

$$G_0^{-1}G_0 x_t = G_0^{-1\alpha_0} + G_0^{-1\alpha_1} t + G_0^{-1}G_1 x_{t-1} + \cdots + G_0^{-1}G_m x_{t-m} + u_t \quad (7)$$
$$\Leftrightarrow x_t = \kappa_0 + \kappa_1 t + F_1 x_{t-1} + \cdots + F_m x_{t-m} + \epsilon_t$$

From the previous equation, we can compute the IRFs. We can thus analyze the effects of a fiscal shock in one country on all the other countries' variables. In this regard, we follow the literature on fiscal shocks with GVAR models and rely on Generalized IRFs. Then, our fiscal shock encompasses discretionary and automatic policy, as spillovers do not depend on whether the policy is automatic or exogenous (Belke & Osowski, 2019; Hebous & Zimmermann, 2013). Moreover, we also differentiate between CS and global shocks, as in Belke and Osowski (2019), Hebous and Zimmermann (2013), and Ricci-Risquete and Ramajo-Hernández (2015), with the last representing the effects of a coordinated fiscal policy. Following Belke and Osowski (2019), Hebous and Zimmermann (2013), and Ricci-Risquete and Ramajo-

Hernández (2015), the EA shock corresponds to the weighted sum of national shocks, with the weights representing the share of each economy in the Euro Area's output in 2019.

3.2. Variables and data

Given the methodology defined and the literature review, we estimated the GVAR with quarterly data from 2002Q1 to 2021Q4, from 16 EA countries[6]. Instead of choosing a longer data-set with fewer countries, as in previous studies (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015), we relied on a wider data set with observations only after the full introduction of the Euro, to keep the EA at the core of the study. The variables were seasonally adjusted and computed in natural logarithm[7]. Moreover, we decided to include only one lag, as in Hebous and Zimmermann (2013), given the reduced number of observations for each variable.

As for the variables considered, in each CS VAR, we included: output, budget balance as percentage of GDP, net exports, public debt on GDP, GDP deflator, real interest rate, and real exchange rate. Following Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) the real interest rate and the real exchange rate were included to capture the financial channel (Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Ricci-Risquete & Ramajo-Hernández, 2015). The public debt ratio on GDP was introduced, as in Hebous and Zimmermann (2013), to control for the government budget constraint. The model is also augmented with a vector of foreign variables, assumed as weakly exogenous.

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[6] All the countries belonging to the EA by the end of 2022, except the ones that had to dropped due to data availability. So, in this estimation we considered data for the following countries: AT, BE, EL, ES, FI, FR, IE, IT, LT, LU, LV, NL, PT, SI, SK, DE.

[7] The budget balance on GDP and the trade balance are not always positive and so we did not take their logarithm.

Most of the authors that have estimated spillovers using a GVAR computed the foreign counterpart for the majority of the domestic variables. Any exceptions were due to the nature of the variables. For instance, given that the real exchange rate is already computed based on trade shares, no foreign exchange rate is typically included (Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Pesaran et al., 2004). Besides, Hebous and Zimmermann (2013) decided not to include foreign trade balance to avoid duplication.

Notwithstanding, considering that international trade is the most important transmission channel (Camarero et al., 2021; Dees et al., 2007; Hebous & Zimmermann, 2013) and that the foreign counterpart of a domestic variable is not necessary to account for the corresponding transmission mechanism, we took a different approach. We relied on the foreign output as the unique foreign variable. Although using a different econometric model, Beetsma and Giuliodori (2011) and Ilori et al. (2022) also estimated the spillovers using only the foreign output as the foreign variable. So, by considering as less foreign variables as possible, we reduce the number of parameters to estimate. Naturally, the domestic variables do not affect only the other countries' output. A fiscal shock, for instance, affects the output of the others, which by its turn affects the other variables of those countries. Nevertheless, in section 5, we analyze the sensibility of the results to different vectors of foreign variables.

Finally, we also performed four different extensions of the baseline model, each adding one of the following variables: private consumption, private investment, employment, and income. So, we computed the spillovers on each of these variables, while estimating the minimum number of parameters.

4 Discussion of the results

We now discuss the main results found in the estimation of our GVAR. We first discuss the spillover effects on output, following a CS or an EA wide budget balance shock. According to Poghosyan (2020) and Ricci-Risquete and Ramajo-Hernández (2015), the larger cross-country effects are observed when the shocks originate in the largest economies. So, we focus the analysis of the CS shocks on some of the largest economies of the monetary union: Germany (DE), France (FR), Italy (IT), and Spain (ES). The GIRFs are presented in figure 1[8].

[8] The GIRFs and the confidence intervals are plotted in separate figures according to the country implementing the shock in Online Appendix OA, figures OA1, OA2, OA3, OA4, and OA5.

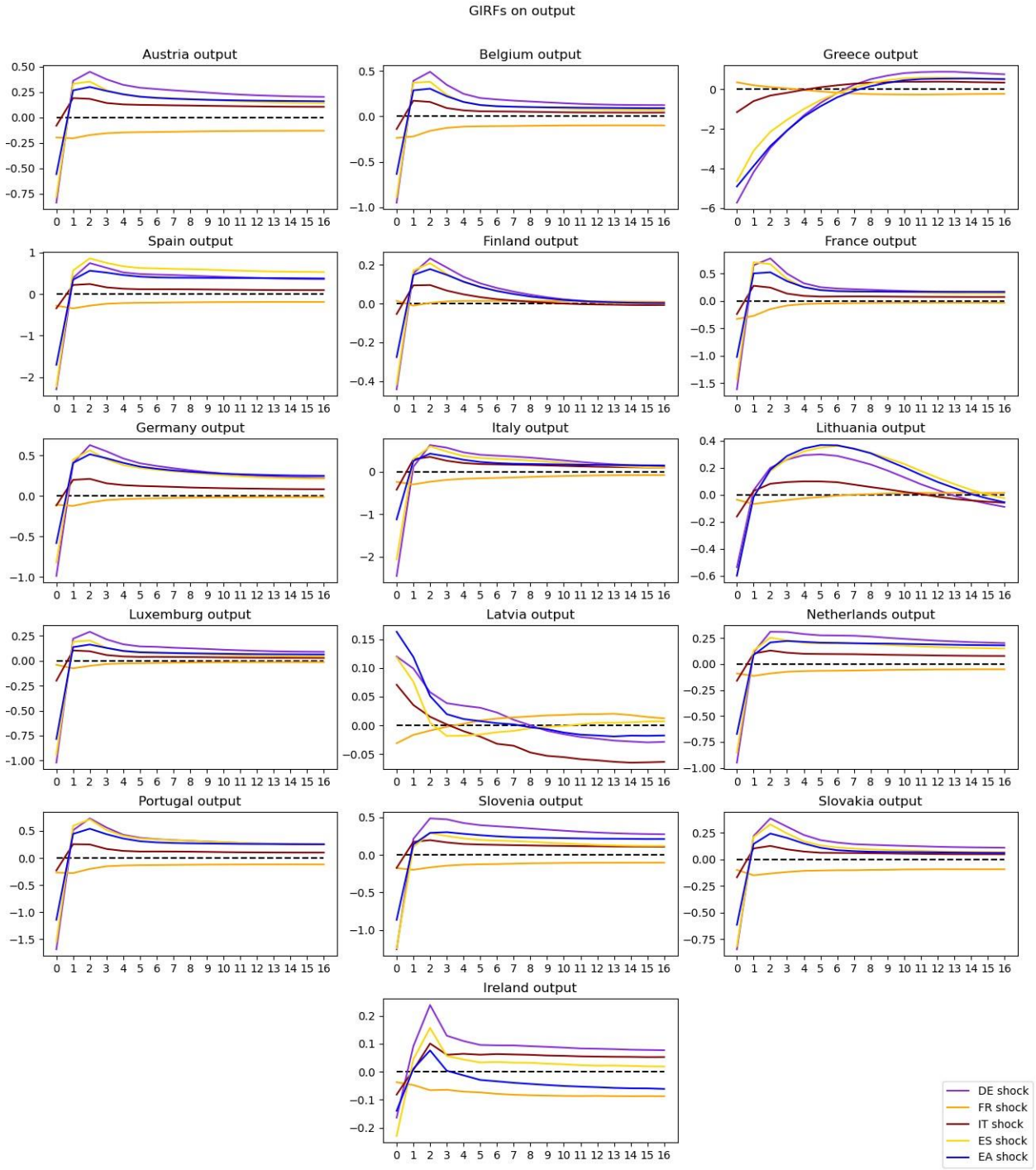

Figure 1: GIRFs on output. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

Focusing on the CS shocks first, the results depend on the country implementing the shock, as described by Alloza et al. (2019), Davoine and Molnar (2020), Goujard (2017), Hebous and Zimmermann (2013), and Ricci-Risquete and Ramajo-Hernández (2015). We noticed that the fiscal shock in DE is the one generating greater spillovers on the other countries, with some small exceptions, following the results of Poghosyan (2020) and Ricci-Risquete and Ramajo-Hernández (2015). Then, for most countries the output rises during the four years after an expansionary fiscal shock in DE, peaking after two quarters. The larger peaks are registered in Spain, France, and Portugal, with the GDP increasing 0.74%, 0.77%, and 0.73%, respectively, comparing to the case without the shock. In the following quarters, the effects on output slowly reduce, as in Poghosyan (2020). Notwithstanding, we must highlight that these results are only statistically significant in 9 of the 16 countries considered [9]. For most of these countries, the estimated spillovers become statistically significant two or three quarters after the shock and last, at least, until 4 years after the shock.

Differently, when the shock originates in ES or IT, almost no statistically significant results arise[10], though the effects are still positive for almost the entire period analyzed. So, our results of the CS shocks follow Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) findings. Almost all the effects of the CS shocks are insignificant. Nevertheless, as described, we did find some positive spillovers on output, mainly after a fiscal shock in DE, following the results of Ilori et al. (2022) and Beetsma and Giuliodori (2011).

However, we also found that a fiscal shock in France may reduce the output in several countries during the four years after the shock. Still, these results are only statistically significant for Belgium[11] and only reduce the GDP by 0.23% in the peak.

[9] Online Appendix OA, figure OA1. The reported effects are statistically significant in Austria, Belgium, Spain, France, Italy, Netherlands, Portugal, Slovenia, and Germany.
[10] Online Appendix OA, figures OA3 and OA4.
[11] Online Appendix OA, figure OA2.

For all the other countries zero or positive effects cannot be excluded. Once again, this finding follows Hebous and Zimmermann (2013) conclusion. When bilateral spillovers are estimated, the signal of the effect differs from case to case. Moreover, this finding highlights that the negative spillovers computed in the theoretical studies (Blanchard et al., 2017; Cwik & Wieland, 2011; Forni et al., 2010; Gadatsch et al., 2015) can also be found with an empirical approach. So, an important implication results from the CS shock in FR. The spillovers can be negative and statistically significant in at least one other country. Theoretical studies aiming to model these effects or policy makers should carefully consider their options.

In fact, if we instead focus on the immediate effects after the shock, we observe considerable negative spillovers. While these effects are not statistically significant if the shock originates in FR or IT, they become significant when we analyze a fiscal shock in DE or ES. In these cases, the immediate effects on the other countries are negative and statistically significant for 13 or 12 of the 16 countries analyzed, respectively. After that immediate effect, the spillovers become positive (but not necessarily significant) in most countries.

Moreover, Greece is one of the countries more affected by the negative short-run spillovers, with the GIRFs being negative for at least 6 quarters after a DE, ES or IT shock (although the effect is only significant in the first quarter after the DE shock). The GDP reduces by approximately 5.72%, 4.64%, or 1.16% immediately after a DE, ES, or IT shock, respectively, after which the negative effects slowly reduce.

Overall, we found that a CS budget balance negative shock in some of the largest economies in the EA increases the output of the other countries, following previous studies on the topic (Alloza et al., 2019; Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ilori et al., 2022; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015). If the shock originates in DE, rather than in ES and IT, more statistically significant results can be found. If the shock originates in FR, there are likely neglectable cross-country results, though negative effects can be statistically significant.

Then, we computed the EA shock and plot in the same figure 1. In general, comparing to the CS shocks in ES, IT or FR, we notice that positive and larger spillovers arise from the EA shock, peaking after two quarters. As after the DE shock, the largest peaks are observed in ES, FR, and PT, with the GDP increasing 0.56%, 0.52%, and 0.54%, respectively. This follows previous findings in the literature (Beetsma & Giuliodori, 2011; Hebous & Zimmermann, 2013; Ricci-Risquete & Ramajo-Hernández, 2015). These effects are statistically significant in 9 countries [12]. Besides, the lower band is negative but very close to zero in Netherlands, meaning that the spillovers are either positive or zero. A global shock, i.e., a coordinated policy would cause greater cross-country effects on output.

Nevertheless, it should be highlighted that comparing to the CS shock originating in DE, the difference of the effects on output are much smaller. In fact, for PT, IT, or ES, for instance, the spillovers arising from the global shock are almost the same as the ones resulting from the DE fiscal shock. Moreover, in Austria, Belgium or Netherlands, the effects of the EA shock on output are actually smaller than what had been estimated for the DE CS shock.

Therefore, a coordinated fiscal shock, i.e., a shock implemented by all EA countries requires less fiscal effort from each country (Hebous & Zimmermann, 2013) and increases the output of all the countries during the four years after the shock. Besides, for most countries, the global shock produces similar or greater impacts on output than a CS shock in DE. Even in the countries in which the fiscal shock produces similar effects to the one in DE, a coordinated action has additional benefits. First, the same results would be produced with much lower fiscal effort than what would be required if one country had to bear all the burden (Hebous & Zimmermann, 2013). Additionally, if we bear in mind that the shock is more likely to

[12] Online Appendix OA, figure OA5. The reported effects are statistically significant in Austria, Belgium, Germany, Spain, Finland, France, Italy, Portugal, and Slovenia.

be implemented the less the fiscal effort required, the global shock increases the likelihood of an expansionary policy to be implemented.

Nevertheless, as in the CS shocks, negative spillovers (and statistically significant in 12 of the 16 countries) on output are also estimated immediately after the shock. In the case of Greece, the global shock amplifies the negative effects on output, which now are also significant during the first three quarters. Once again, we find evidence of some negative cross-country effects, even after a global shock, as concluded by several theoretical studies (Blanchard et al., 2017; Cwik & Wieland, 2011; Forni et al., 2010; Gadatsch et al., 2015).

Moreover, we also plotted the cross-country effects on prices and public debt. First, from figure OB1 in Online Appendix OB, we can observe that a CS or an EA fiscal shock puts upward pressure on prices in most countries, mainly in the longer run. Nevertheless, the effects are lower than 0.1% in most countries. When we focus on the first quarters after the shock, negative effects are observed in several countries (EL, IT, and PT are some of the main examples).

Nonetheless, only part of the previously described effects on prices are statistically significant. A CS fiscal shock in ES, FR, or IT does not produce significant effects in any other countries' deflator. On the contrary, when the fiscal shock is implemented by DE, positive and statistically significant effects on prices are observed in Austria, Belgium, and Slovenia. While in the first two countries the impact on the GDP deflator is not greater than 0.5% in any quarter, in Slovenia the results reach as much as 0.13%. Additionally, DE's price index also significantly decreases immediately after the shock and in the first shock afterwards.

Similarly to the effects on output, a global shock magnifies the effects on deflator. When the shock is implemented at the EA level, positive and significant spillovers are observed in Austria, Belgium, and Slovenia, but also in France immediately after the shock. Negative effects are also registered in Germany and Greece in the first quarter after the shock.

Thus, similarly to Ricci-Risquete and Ramajo-Hernández (2015), we found that a Germany or an EA fiscal shock rises the prices in most countries, mainly in the longer run. In the short run, some negative effects can be observed, after which the prices rise to the long run level.

Differently, as it can be observed in figure OC1 – Online Appendix OC - a CS or an EA fiscal shock generates negative effects on public debt, mainly after the first year.

When the fiscal shock is implemented in DE, public debt significantly reduces in 8 of the 16 countries considered, although in different timings. In AT (from the 3rd quarter onwards), BE and FR (4th quarter onwards), and NL (5th quarter onwards) the negative and significant effects are registered sooner than in rest of the countries. The statistically significant negative spillovers observed ES, IT, PT, and SL occur mostly during the fourth year after the shock. Still, even if the significant effects are registered later, the impact on public debt is not necessarily lower. While in the peak public debt in AT, BE, FR and NL reduces 0.35%, 0.49%, 0.68%, and 0.67%, respectively, in ES, IT, PT and SL public debt reduces 1.28%, 0.57%, 0.61%, and 1.37%, respectively. Common to all countries, however, is the positive effect observed immediately after a DE expansionary fiscal shock (statistically significant in 6 countries). While in BE, FR, and NL this effect last only one quarter, in IT (2 quarters), EL (3 quarters), and DE (5 quarters) the positive spillovers on public debt last longer.

Our results follow Kempa and Khan (2017) findings. They have found that a GDP growth shock would generate negative spillovers on public debt, although the results would only be statistically significant for a DE growth shock. Applying to our case, it is straightforward to consider that the DE fiscal shock has positive effects on domestic output, leading to the described reduction of the public debt in the medium-run.

However, depending on the country implementing the CS shock, the spillovers on public debt may not be negative. When we compute a FR fiscal shock, the effects on most of the other countries' public debt is positive, and statistically significant

(for the entire period analyzed) in 3 of the 16 countries. Among these countries, the effects on public debt following a FR fiscal shock vary around 0.3%.

Finally, when we compute an EA fiscal shock, the public debt reduces in most countries, though this movement is only statistically significant for FR, where public debt reduces 0.49% in the peak. Nevertheless, the upper band of the GIRFs is approximately zero in IT, NL, and PT and so the spillover is likely negative or zero. Moreover, the EA shock also leads to an immediately and statistically significant public debt increase in 7 countries. This effect remains positive and significant until the first quarter in IT, and until 3 quarters after the shock in Germany and Greece.

Then, as described in the methodology, we extended the estimated model to include (one at a time) the consumption, investment, employment and income.

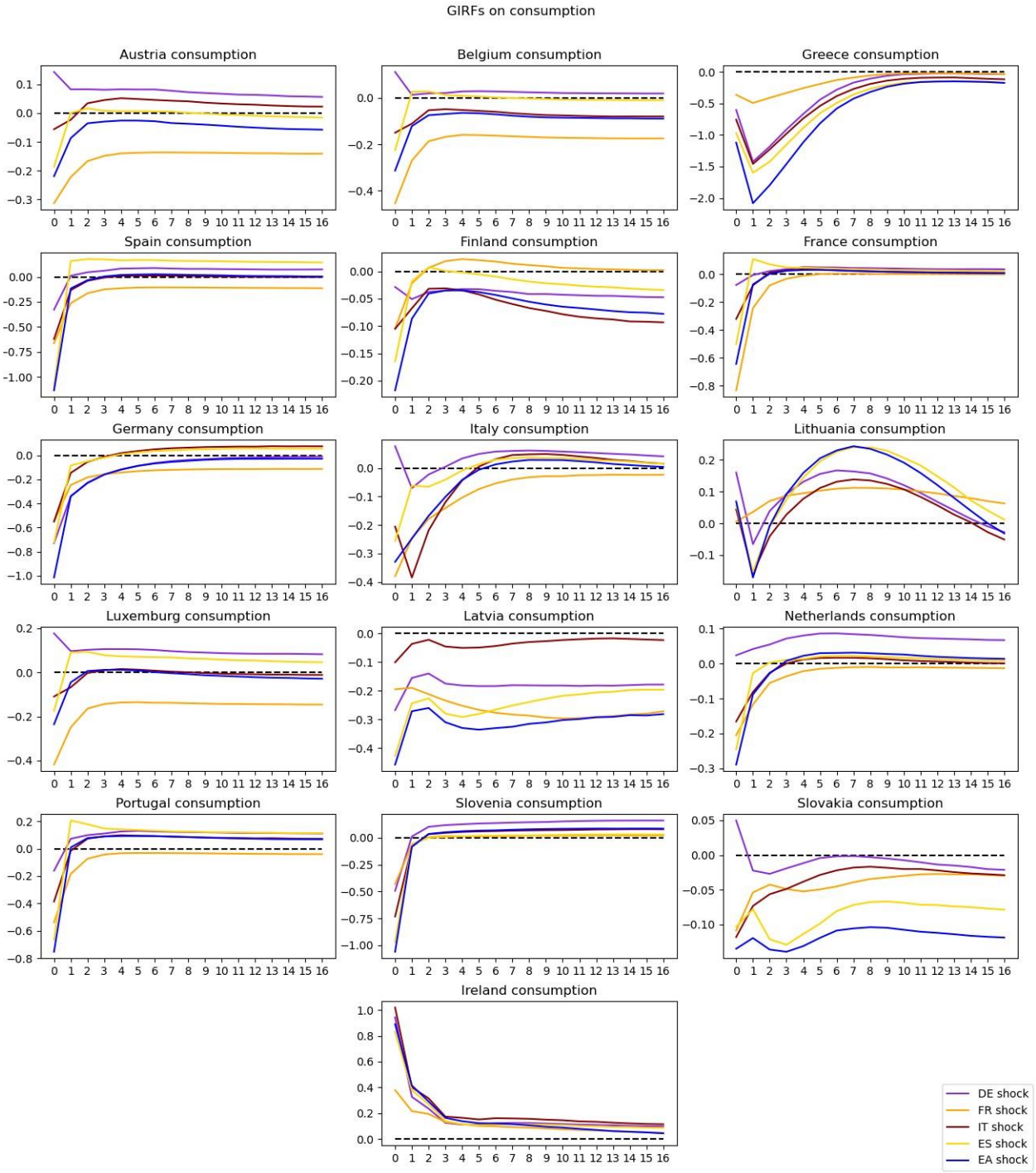

Figure 2: GIRFs on consumption. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

First, regarding the effects on consumption, from figure 2, we can conclude that in general, the spillovers on consumption are close to zero and not statistically significant[13]. Still, some exceptions can be noticed, mainly when we focus on the short-run. Immediately after an expansionary shock in IT 0.55%, FR or ES 0.72%, a statistically significant reduction in consumption is registered in DE. The same occurs in the case of an EA shock. Still, while the consumption in DE reduces between 0.55% and 0.72% after a given CS shock, it decreases 1.02% after a common shock. Similarly, the consumption reduces around 0.67% in Portugal immediately after a negative shock in Spain, and it also reduces in Slovenia by 0.97% or 1.06% immediately after the shock in Spain or in the EA.

Besides, more lasting effects are estimated in Greece. When Italy implements an expansionary budget balance shock, we estimate a statistically significant reduction of the consumption in the second and third quarters after the shock. If the shock is implemented in the EA a whole, the negative (and statistically significant) effects are estimated immediately after the shock and last until four quarters after the shock. Moreover, the response of consumption is once again greater after an EA shock. In the peak, the consumption in Greece reduces by 1.46% after the IT shock and 2.08% after the EA shock.

Therefore, although no significant spillovers are observed between the first and fourth year, an expansionary fiscal shock in some large economies may cause negative consequences on consumption in the first quarters. If countries coordinate their actions and implement a global shock, the short-run effects on consumption may be amplified and can last longer in some economies. These conclusions regarding the cross-country effects on consumption contradict theoretical (Corsetti et al., 2009; Lozej & Walsh, 2021) and empirical Beetsma and Giuliodori (2011) findings. Not only most of the spillovers on consumption are statistically

[13] The GIRFs and the confidence intervals are plotted in separate figures according to the country implementing the shock in Online Appendix OD, figures OD1, OD2, OD3, OD4, and OD5.

insignificant, as when we found significant effects, these are negative. These possibilities were raised by Barbier Gauchard and Betti (2021), when they concluded that the spillovers on consumption could be positive or negative, depending on the fiscal variable used to implement the shock. Nevertheless, a different specification of the CS VARs could considerably change these results, as explained in section 5.

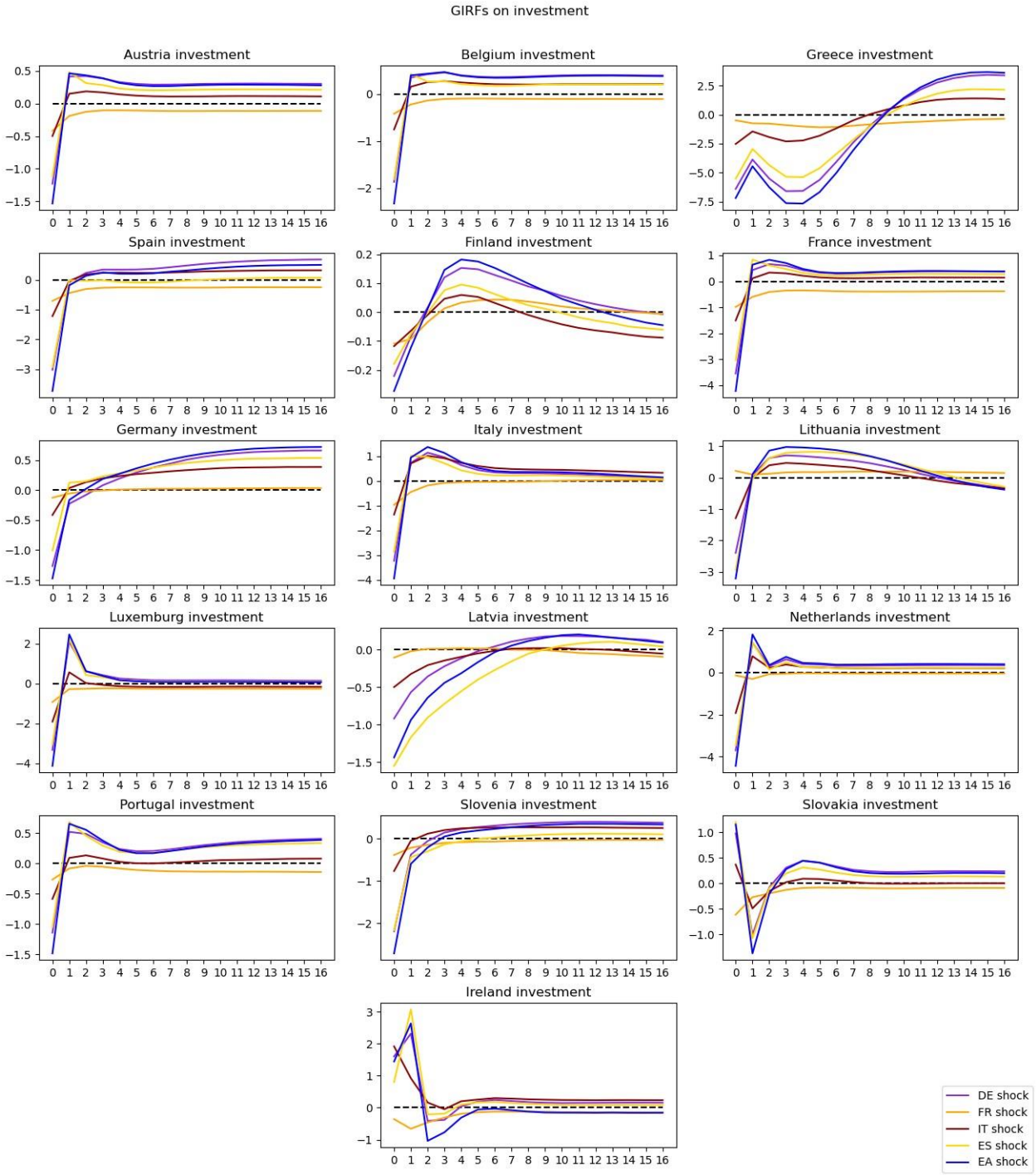

Figure 3: GIRFs on investment. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

As for the spillovers on investment, from figure 3 we can observe that in general no statistically significant effects result from the CS fiscal shocks[14], though most mean estimates point to positive effects on investment in most countries. Nevertheless, some negative and statistically significant spillovers were also estimated immediately after a shock in ES or in DE. Besides, in the case of Greece, this negative spillovers in the periods after the shock seem to last longer, though the results are not statistically significant in the case of the CS shocks. Once again, these results do not follow theoretical (Lozej & Walsh, 2021) or empirical Beetsma and Giuliodori (2011) findings, which had concluded for positive spillovers on investment.

Notwithstanding, our results become closer to Beetsma and Giuliodori (2011) and Lozej and Walsh (2021) conclusions when we estimated the effects of a EA shock. Positive and statistically significant spillovers were found in AT, DE and NL, with private consumption increasing 0.46%, 0.72%, and 1.8%, respectively. In Greece, the private investment varies considerably across the period. After a statistically significant reduction in the first 6 quarters after the EA shock, with responses lower than -6% in almost all quarters, it slowly increases during the remaining period. Then, the response becomes positive (and statistically significant) between 15 and 16 quarters after the shock, with effects greater than 3.5%.

Therefore, when we analyze the effects on private investment, we found that a coordinated action amplifies the effects of the policy and contributes to positive and statistically significant spillovers. Thus, not only the global shock produces greater effects on the output of all countries, as those effects are also associated with greater spillovers on private investment.

In the fourth model estimated, we replaced private investment for the employment and the results are presented in figure 4.

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[14] The GIRFs and the confidence intervals are plotted in separate figures according to the country implementing the shock in Online Appendix OE, figures OE1, OE2, OE3, OE4, and OE5.

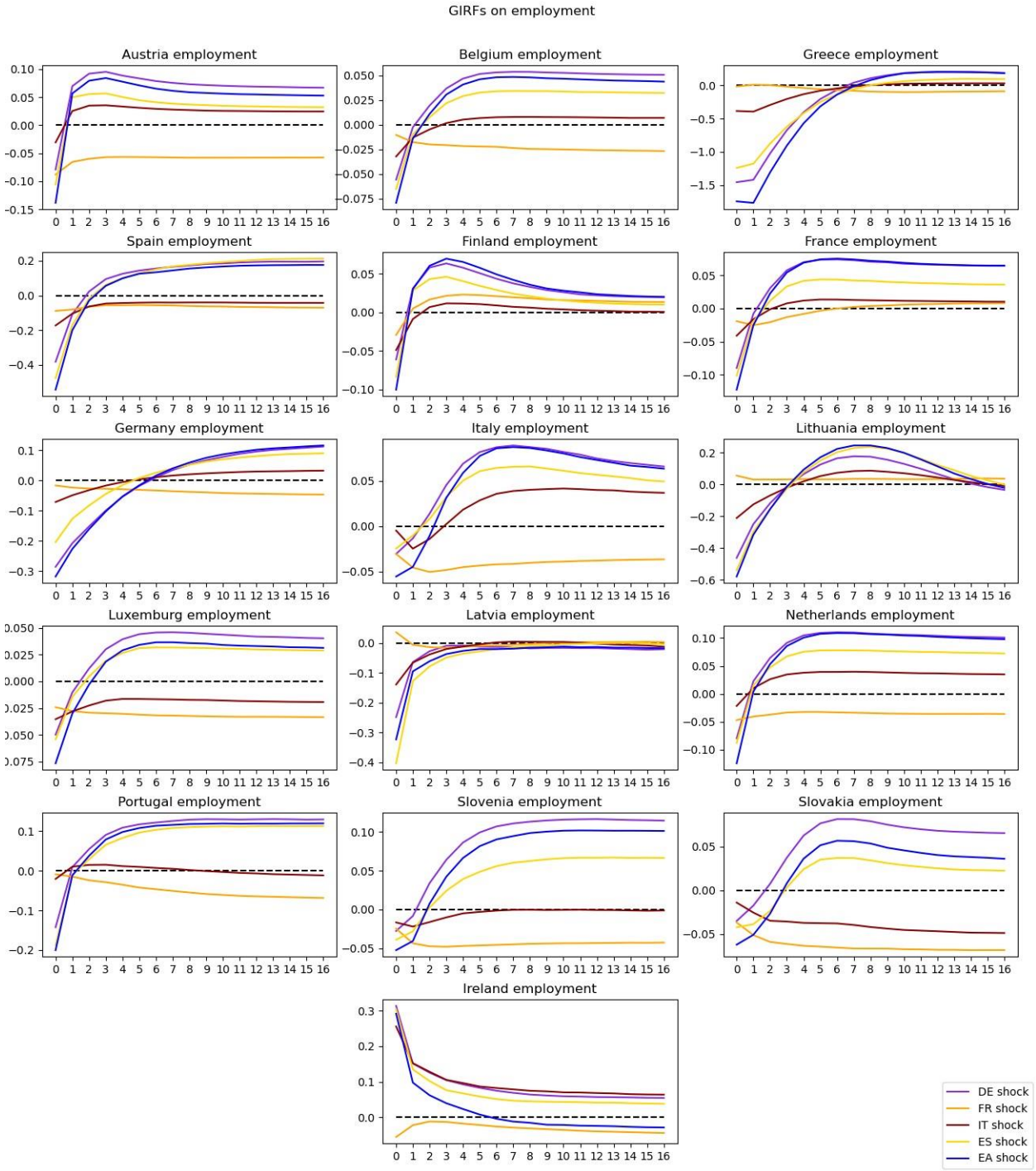

Figure 4: GIRFs on employment. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

From the figure above, we can observe positive spillovers on employment in most countries, after a CS shock in the largest economies. However, only the positive spillovers on employment in Belgium and Netherlands after a DE expansionary fiscal shock are statistically significant[15]. Employment rises 0.05% and 0.11% in BE and NL, respectively. Besides, in the case of a DE fiscal shock, we can also observe that there are several countries (Austria, France, Portugal, and Slovenia) in which the lower band is negative, but approximately zero. So, although we cannot conclude for the presence of positive spillovers, we can safely assume that the effects in the employment of these countries are likely positive or, in the worst-case scenario, zero.

However, when the budget balance shock originates in IT, FR or ES, no statistically significant spillovers arise, with some exceptions. Similarly to the effects on output, when the expansionary fiscal shock originates in ES, negative effects are observed in some countries immediately after the shock. Observing the plots, we notice that employment reduces in BE, FR and PT immediately after the Spanish negative budget balance shock. In the following periods the effect becomes positive, but not statistically significant.

Additionally, the global shock originates greater spillovers. If focus on the results for Austria, Belgium, France, Netherlands, Germany, Portugal, or Slovenia, for instance, we can clearly conclude that a simultaneous fiscal shock in all EA economies generates greater spillovers than most CS shocks. In the specific case of an expansionary shock, these effects are generally positive, increasing employment. However, it should be noted that the positive spillovers resulting from the global shock are only statistically significant in Netherlands and France, where employment rises 0.11% and 0.08%, respectively, in the peak. Still, if we consider Austria, Belgium, or Slovenia, for instance, we can observe that the lower band is approximately zero and so the global shock either increases employment or has no

[15] The GIRFs and the confidence intervals are plotted in separate figures according to the country implementing the shock in Online Appendix OF, figures OF1 OF2, OF3, OF4, and OF5.

effects (we can exclude the hypothesis that the EA expansionary shock reduces employment in these countries).

Nevertheless, some cases of negative spillovers on employment were also estimated. Immediately after the global shock, the impacts on employment are negative (and statistically significant) in 10 of the 16 countries considered. In fact, for Greece the spillover lower than -1.3% in the first three quarters (but not significant) and it persists negative until 5 quarters after the shock. In this case, the magnified effect of the expansionary global shock generates negative and significant effects on the Greek employment during at least three quarters. The median estimates for Ireland also suggest persistent negative spillovers, but the results are not statistically significant. Barbier-Gauchard and Betti (2021) underlined the possibility of positive or negative spillovers on employment, depending on the fiscal variable used to implement the shock.

So, we conclude that positive effects on employment can arise after a CS shock in the largest economies (mainly after a shock in DE), following Lozej and Walsh (2021) findings. However, negative impacts are also observed but limited to the periods immediately after the shock. Moreover, a global shock increases the positive effects on employment. Thus, a coordinated policy not only requires less fiscal effort from the countries implementing the shock, as it increases the employment more than the case of a CS shock.

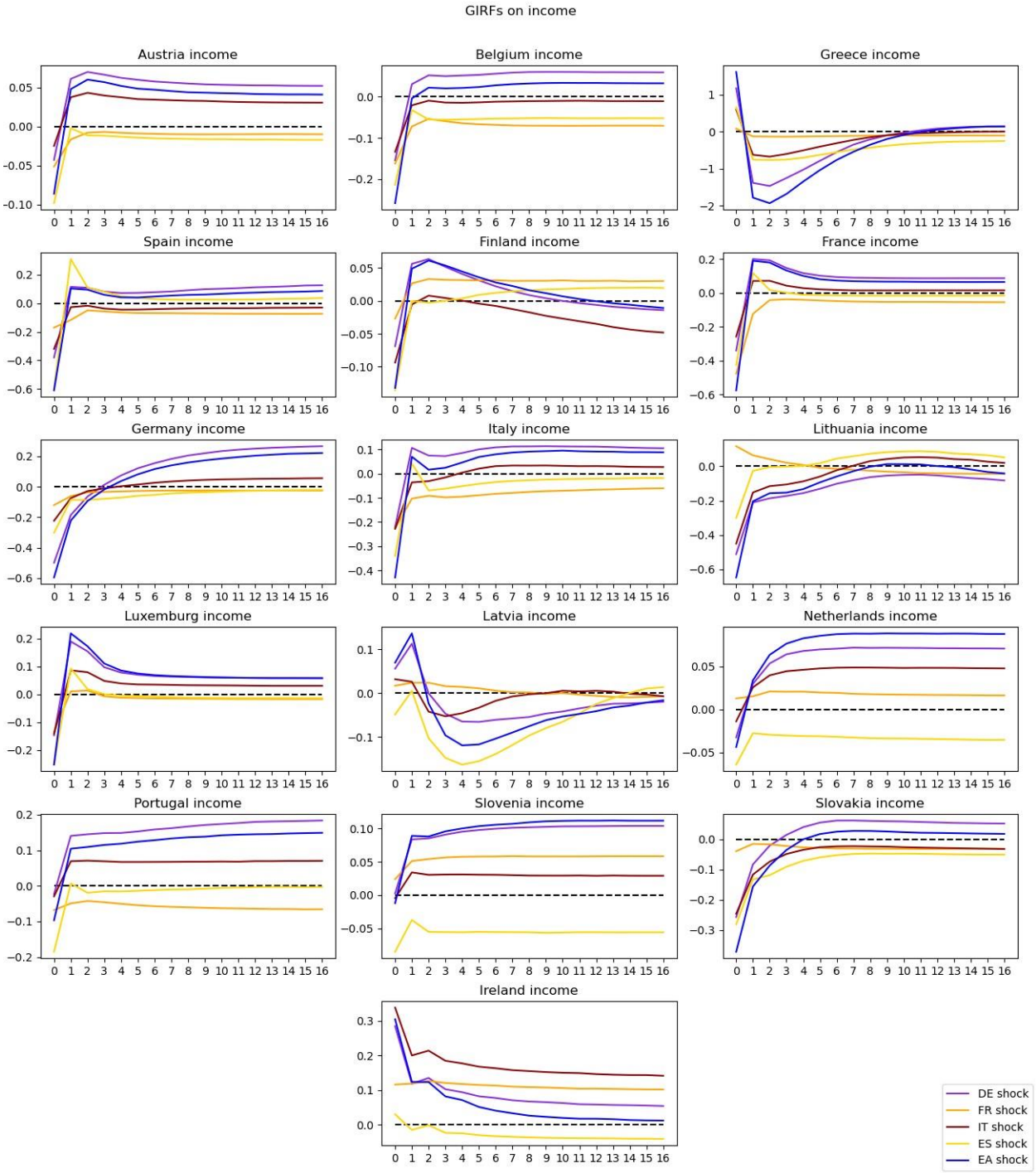

Figure 5: GIRFs on income. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

Finally, we also computed the spillovers on income. From figure 5, the estimated GIRFs vary according to the country where the shock originated and to the country in which we are measuring the effects on. While we estimate that expansionary shocks in DE or IT increase the income in most countries, the opposite occurs when the shocks originate in ES or FR. Nevertheless, the estimated GIRFs on income are not statistically significant, with some exceptions in the period immediately after the shock[16].

So, a negative fiscal shock in Spain would produce negative and statistically significant impacts on the income of Belgium and Finland, immediately after the shock. If the expansionary shock was implemented in France or Italy, the income would suffer a statistically significant reduction in Belgium and Slovakia, respectively.

As in the previous cases, when we computed the global shock, the effects are amplified in most countries, when compared to CS shocks (especially if that CS shock was not originated in DE). For instance, in AT, NL and SL the income would increase 0.06%, 0.09% and 0.11%, respectively, in the peak, more than what would result in most of the CS shocks.

Notwithstanding, these results are also not statistically significant, with one exception. In Greece, the EA shock leads to a negative and statistically significant reduction of the income during the first year after the shock. In this case, the lower spillover is registered two quarters after the shock, with the income reducing as much as 1.94%.

Hence, even if positive GIRFs were estimated, a CS or a global expansionary fiscal shock do not generate significant spillovers on the income of the other countries once the initial period after the shock is over. Still, during that initial period, i.e., immediately after the shock and during the first year, a CS shock or a global shock

[16] The GIRFs and the confidence intervals are plotted in separate figures according to the country implementing the shock in Online Appendix OG, figures OG1, OG2, OG3, OG4, and OG5.

can generate negative consequences to the income in some economies, contrary to what had been found by Lozej and Walsh (2021).

5 Sensitivity analysis

As detailed in section 3, we chose to augment the baseline VAR with the foreign output as the unique non-domestic variable. However, this option differed from most of the literature estimating spillovers with a GVAR (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015). Instead, we followed Beetsma and Giuliodori (2011) and Ilori et al. (2022), which have used a different econometric approach.

Moreover, Beetsma and Giuliodori (2011) found that the results were sensible to how the foreign variables were computed. So, to analyze the sensibility of the results to the choice of the foreign variables, we estimated three different versions of the baseline model.

First, we followed most of the GVAR literature (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Poghosyan, 2020; RicciRisquete & Ramajo-Hernández, 2015) and we computed the foreign counterpart of almost all domestic variables. Nonetheless, we did not include a foreign trade balance, to avoid duplication (Hebous & Zimmermann, 2013), and a foreign exchange rate, given that the real exchange rate is already computed based on trade shares (Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Pesaran et al., 2004). Additionally, we also did not compute a foreign price index, given that the evolution of the relative prices already affects the real exchange rate.

Overall, with this alternative, the spillovers on output become insignificant[17]. Unlike the results described in section 4, no statistically significant effects were found, even after a DE or a global fiscal shock. However, the worse performance of

[17] The GIRFs on output are presented in Online Appendix OH, figure OH1.

this model is not surprising. While this is a similar approach to most of the GVAR literature (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Metelli & Natoli, 2021; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015), we are using a shorter dataset, as explained in section 3. Then, the higher number of parameters to estimate, compared to our baseline model, together with a shorter dataset than most of the GVAR literature leads to poorer results under this alternative.

So, bearing in mind the necessity to reduce the number of parameters to estimate, we computed two other models. In the second alternative, we included the foreign output and the foreign budget balance in the vector of foreign variables. While keeping the output, we added the foreign budget balance to account for a more direct impact of the foreign fiscal shock in the domestic variables.

Unlike the previous results, in this second alternative we found positive and statistically significant spillovers on output, consumption, investment, employment, and income[18]. First, regarding the output, we found negative cross-country effects in the first quarters after a DE or an EA shock. After that period, the spillovers become positive and peak between the second and fifth quarters after the shock[19], after which the effects quickly vanish. Comparing to the results discussed in section 4, the spillovers on output disappear faster in this alternative. While in the baseline model, the results would peak, but the effects would be maintained relatively similar throughout the entire period analyzed, now the effects become almost irrelevant shortly after the peak.

[18] The GIRFs are presented in Online Appendix OI, in figures OI1, OI2, OI3, OI4, and OI5.

[19] These positive effects are statistically significant after a DE shock in the fourth quarter in four countries. In 9 other countries the spillover is not statistically significant, but the lower band is approximately zero. If a global shock is implemented, the effects are positive and significant in 6 countries. The significant spillovers last two quarters at most, but different countries register these effects in different periods (between the second and the fifth quarters, depending on the country we are measuring the effect on). In this case, the lower band is approximately zero in 7 other countries.

Regarding the consumption, statistically significant effects are only observed after a EA wide shock. Initially, the spillover is negative (and statistically significant in most countries), at least during the first two quarters. After that, the effect becomes positive, though it is only statistically significant in 6 countries and between the fifth and seventh quarters. After this peak, the effects reduce and become negative, although not statistically significant. So, unlike the results reported in section 4, we now also find some positive spillovers on consumption, which better fits previous findings from the theoretical literature (Corsetti et al., 2009; Lozej & Walsh, 2021).

The private investment, employment and income follow a similar dynamic after a DE or an EA shock. After negative effects in the first quarters, the spillovers increase and become positive in most countries[20]. Unlike the results described in section 4, the cross-country effects quickly converge to zero.

Finally, we also computed a third alternative, including the foreign output and a foreign interest rate as the foreign variables. Therefore, while still minimizing the number of parameters to estimate, a direct financial channel was included. Analyzing the spillovers on output[21], no statistically significant effects were found. Although some positive spillovers appear to arise after an initially negative reaction, none of these variations are significant. Thus, the estimation of the model with this specification produces considerably worse results than the baseline model or even alternative 2.

[20] Regarding private investment, the positive spillovers are also statistically significant in 3 or 8 countries if the shock is in DE or EA, respectively. These effects last mainly between the third and sixth quarter. Regarding the employment, positive statistically significant spillovers were only found after a EA shock. After the global shock, positive and significant effects can be observed in only 2 countries and these effects peak 5 quarters after the shock. Finally, after initial negative effects, positive and significant spillovers on income were also found in 7 or 9 countries, after a DE or a EA shock, respectively. These effects occur mainly between the third and fourth quarters after the shock.

[21] The results are presented in Online Appendix OJ, figure OJ1.

Overall, we found that the estimation of the cross-country spillovers after a fiscal shock is considerably sensitive to the specification of the model. Particularly, the choice of the foreign variables can considerably influence the results. Not only statistically significant effects may not be found with some specifications, the signal and the duration of the spillovers can also differ. As already explained, to consider as many countries as possible and to account only for the period of existence of the EA, we relied on a short dataset, comparing to previous studies (Caporale & Girardi, 2013; Hebous & Zimmermann, 2013; Poghosyan, 2020; Ricci-Risquete & Ramajo-Hernández, 2015). So, we expected that the greater the number of parameters to estimate, the worse the performance of the model. We consider this to be the main reason behind the absence of any relevant findings in alternatives 1 and 3. In the second alternative, however, the more direct connection between the budget balance of the country implementing the shock and the domestic variables makes the results closer to the ones reported in the baseline model and in previous literature. Even for the spillovers on consumption, investment, employment, and income, the results are consistent with the ones estimated in section 4. Therefore, a CS fiscal shock, mainly in DE, or a global shock lead to positive spillovers on these variables, even if some negative effects are registered in the first quarters after the shock. The duration of those positive effects, vary according to the specification of the model. Finally, as in section 4, the global shock amplifies the cross-country effects.

6 Conclusion

We estimate a GVAR, following Pesaran et al. (2004), a model particularly suited to study the international propagation of shocks (Camarero et al., 2021). Apart from the effects on output, we contribute to the literature by augmenting the model to estimate spillovers on private consumption, private investment, employment and income.

We found that most countries' output increases as a response to a CS shock in one of the largest economies of the EA. Similar responses were found on employment, although these are only statistically significant for a reduced number of countries after a shock in Germany. Regarding the consumption, negative effects were found in the first quarters after the shocks, contradicting previous theoretical (Corsetti et al., 2009; Lozej & Walsh, 2021) and empirical (Beetsma & Giuliodori, 2011) findings. As for the private investment and income, no significant effects were observed after a CS shock.

Greater and more significant spillovers on output, employment and investment were found after an EA global shock. On the contrary, a global shock still does not generate significant effects on income and aggravates the negative short-run spillovers on consumption. Particularly regarding the short-run negative spillovers, Greece is one of the most affected countries, not only on consumption, but also on output and employment.

Therefore, several policy implications result from our study. Our results highlight the benefits of coordinated fiscal policies. Still, its temporary but possibly negative effects on output, employment and investment in some countries also arise. Redistributing the burden of the common policy or provide short-run financial support to these countries may contribute to surpass these costs. Finally, these short-run negative spillovers can also reduce the acceptance of the policy.

From a research perspective, our results support the idea of positive but small bilateral spillovers on output, and larger effects after a global shock. The same arises for employment and investment, but not for consumption and income. Therefore, the cross-country welfare implications of a fiscal policy shock should be additionally studied. Moreover, the negative responses of consumption in the first quarters after the shock, in part contradicting previous theoretical literature, poses questions regarding the transmission mechanisms, which may also be studied in future research.

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Appendix A

Table A1 - Data: variables and sources

	Variable	Source	Dataset	Indicator	Unit of measure
1	Real GDP	Eurostat	$NAMQ_10_GDP$	Gross domestic product at market prices	Chain linked volumes (2015), million Euros
2	GDP Deflator	Eurostat	$NAMQ_10_GDP$	Gross domestic product at market prices	Price index (implicit deflator), 2015=100
3	Private consumption	Eurostat	$NAMQ_10_GDP$	Household and NPISH final consumption expenditure	Current Prices, million Euros
4	Private investment	Eurostat	$NAMQ_10_GDP$	Gross fixed capital formation	Current prices, million Euros
5	Employment	Eurostat	$NAMQ_10_PE$	Total employment national concept	Thousand persons
6	Income	Eurostat	$NAMQ_10_GDP$	Wages and salaries	Current prices, million Euros
7	Net exports	Eurostat	$NAMQ_10_GDP$	External balance of goods and services	Current prices, million Euros

	Variable	Source	Dataset	Indicator	Unit of measure
8	Budget balance	Eurostat	$GOV_{10}Q_{G}GN$	Net lend-*A* ing/borrowing	Percentage of GDP
9	Public debt	Eurostat	$GOV_{10}Q_{G}GD$	Government *BT* debt	Percentage of GDP
10	Real interest rate	Eurostat	$IRT_{L}T_{M}CBY_{Q}$	EMU conver-gence criterion bond yields	n.a.
11	Real ex-change rate	Eurostat	$IRT_{L}T_{M}CBY_{Q}$	Real effective exchange rate (deflator: con-sumer price index - 19 trading partners)	Index, 2015=100
12	Exports	Eurostat	DS-057555	Exports per trading partner	Euros
13	Imports	Eurostat	DS-057555	Imports per trading partner	Euros
14	Trade shares	Authors' own computation from variables [12] and [13]	n.a.	n.a.	Percentage of total trade

The real private consumption, private investment, income and net exports result from auhors' own computation based on the GDP deflator.

Appendix B

Table B1 - Weak exogeneity test

Country	Base model		With cons		With invest		With employ		With inc	
	F test	F critic	F test	F critic	F test	F critic	F test	F critic	F test	F critic
AT	0.4541	3.984	0.3659	3.9863	0.0589	3.9863	0.2315	3.9863	0.0344	3.9863
BE	0.6665	3.1359	0.5732	3.1381	0.755	3.1381	1.7622	3.1381	1.007	2.7758
EL	0.4333	2.5153	0.4485	2.3631	0.4562	2.2514	0.4126	2.3631	0.4381	2.3631
ES	0.7721	2.7459	0.4241	2.5177	0.4552	2.5177	0.809	2.5177	1.0492	2.5177
FI	1.1009	2.5201	0.6457	2.5226	0.813	2.5226	0.4962	2.753	1.2739	2.3631
FR	0.3439	3.1359	1.5857	2.7482	1.5347	2.5177	0.9438	2.7482	0.994	2.7482
IE	1.2819	2.3607	1.2437	2.2514	2.2873	2.2514	1.2558	2.3631	1.246	2.3631
IT	0.5803	2.3631	0.8435	2.3631	0.5233	2.2514	0.7082	2.3631	1.0912	2.3631
LT	0.4463	2.3607	0.643	2.3631	0.6728	2.3631	0.6268	2.3631	0.3035	2.3631
LU	1.4644	2.7459	1.07	2.7482	1.5761	2.7482	2.1947	2.5177	2.1127	2.7482
LV	0.5779	2.3607	1.2265	2.3631	1.1145	2.5177	0.5834	2.1665	0.3753	2.2514
NL	1.0287	2.7459	1.0882	2.7482	1.3291	2.7482	0.2049	2.7482	0.0583	2.7482
PT	0.8875	2.5153	0.8178	2.3683	0.2887	2.3631	0.3938	2.5177	0.5796	2.3631
SL	0.4526	2.7459	0.571	2.5177	0.4913	2.5177	1.5504	2.5177	0.6556	2.7482
SK	0.3522	2.5153	0.4404	2.3631	0.2595	2.3631	0.2756	2.5177	0.2767	2.3631
DE	0.332	3.1359	1.0884	2.7482	0.7832	3.1381	0.7447	3.1381	0.8946	3.1381

Table B2 - Unit Root ADF with levels and no time trend

First, we present the results for the ADF test with the variables in levels and without a time trend.

Country	output	budget balance	net exports	public debt	deflator	interest rate	exch rate
AT	-1.4315	-4.5683	-1.9031	-1.7357	0.3489	-1.1612	1.1156
BE	-1.0707	-3.2459	-1.9031	-1.7357	0.3489	-1.1612	1.1156
EL	-0.8843	-2.2943	-1.2031	-0.6827	-2.1086	-2.3858	-1.1422
ES	-2.3925	-2.0125	-1.0694	-0.7628	-0.0631	-0.9678	-2.706
FI	-1.7142	-2.1384	-2.2374	-0.8168	0.8408	-0.8808	-1.9128
FR	-1.3971	-3.1913	-1.8695	-0.8904	-1.4931	-0.7222	-0.1335
IE	1.5446	-1.6267	-3.3609	-2.0177	-0.939	-1.7938	-1.0275
IT	-2.8831	-2.7238	-1.3667	-0.402	-3.7102	-1.303	0.2468
LT	-1.5421	-2.9974	-1.3233	-1.312	-0.5405	-1.1074	-0.3415
LU	-0.8983	-3.278	-1.4686	-1.0829	-0.7134	-1.0283	-2.6056
LV	-2.074	-2.6219	-1.5846	-2.0981	-1.2091	-1.3964	-2.044
NL	-0.4453	-2.3069	-1.7595	-1.4921	-0.0847	-0.6927	-1.5109
PT	-2.1115	-3.1017	-1.45	-1.9187	-2.2294	-2.0799	0.5205
SL	-0.719	-3.1391	-1.0079	-0.8316	-1.075	-1.4851	-1.4578
SK	-2.4461	-3.8094	-2.3304	-0.8304	-4.005	-0.7822	-3.3747
DE	-0.8287	-2.2404	-2.6546	-1.8778	3.5683	-0.8029	-3.5261

The critical value is -2.89. The null hypothesis of a unit root is not rejected is the F value is greater than this value.

Table B3 - ADF test with levels and time trend

We also present the results for the ADF test with the variables in levels and with a time trend.

Country	output	budget balance	net exports	public debt	deflator	interest rate	exch rate
AT	-3.8520	-4.5387	-3.6667	-2.4648	-1.7947	-2.2986	-2.7189
BE	-3.5165	-3.6231	-3.3667	-2.4648	-1.7948	-2.2986	-2.7189
EL	-2.0485	-2.5468	-0.9608	-1.6153	-2.1021	-2.3729	-1.4913
ES	-2.6588	-2.1014	-1.6452	-2.1766	-2.0588	-1.5942	-2.1880
FI	-2.3526	-2.4658	-1.8439	-2.1084	-2.6070	-2.2399	-1.8655
FR	-4.182	-3.2208	-2.4931	-2.2719	-2.0192	-2.16	-2.7569
IE	-0.3143	-1.6057	-3.921	-1.9854	-2.2825	-2.3891	-3.0630
IT	-3.2941	-2.9216	-1.6934	-2.7522	-2.4962	-2.1314	0.3014
LT	-3.4038	-3.0071	-2.6462	-2.3569	-1.6765	-1.8043	-1.7930
LU	-2.5881	-3.2437	-2.6101	-1.3485	-1.6879	-2.2998	-1.8864
LV	-3.1326	-2.6383	-2.8415	-3.0514	-2.8305	-2.2782	-2.6113
NL	-2.9524	-2.3406	-7.2043	-1.2994	-1.3777	-2.3268	-0.8993
PT	-2.5467	-3.4303	-1.1197	-0.4945	-2.7722	-2.3830	-0.9354
SL	-1.7611	-4.3545	-2.1608	-1.7169	-2.1254	-2.4442	-0.8163
SK	-1.7704	-3.5968	-1.8220	-2.4916	-2.3615	-2.2415	-2.2119
DE	-3.1702	-2.1095	-2.7787	-1.7538	0.5245	-2.2143	-1.9948

The critical value is -3.45. The null hypothesis of a unit root is not rejected is the F value is greater than this value.

Table B4 - ADF test with first differences and no time trend

We also present the results for the ADF test with the variables in first differences and without a time trend.

Country	output	budget balance	net exports	public debt	deflator	interest rate	exch rate
AT	-4.6963	-5.1332	-5.8790	-4.5850	-6.6318	-5.7311	-3.2955
BE	-7.9198	-8.9947	-5.8790	-4.5850	-6.6318	-5.7311	-3.2955
EL	-5.2821	-9.7471	-9.2686	-5.6794	-2.3404	-5.1903	-3.0553
ES	-7.6658	-8.1880	-5.6364	-2.8117	-1.1824	-5.6804	-4.1929
FI	-6.0846	-6.6024	-9.7297	-2.8530	-5.2577	-6.4551	-3.5682
FR	-8.6143	-8.9008	-7.4523	-4.3274	-8.1891	-7.0674	-4.0795
IE	-6.1563	-5.8946	-10.0898	-1.9697	-3.9987	-4.6789	-3.4515
IT	-7.5082	-5.7549	-5.1932	-4.3631	-3.3186	-5.5577	-4.1092
LT	-3.3631	-8.9519	-4.1737	-3.6924	-5.5317	-6.8579	-3.3787
LU	-6.3164	-6.1640	-6.0463	-6.5866	-4.3642	-3.9517	-6.0596
LV	-2.6050	-9.2319	-5.3388	-2.2975	-3.1322	-4.6795	-3.9031
NL	-4.5552	-7.8584	-7.3485	-5.6008	-5.7819	-6.5575	-5.3947
PT	-8.5125	-7.1133	-6.3605	-2.8628	-2.6501	-4.2880	-3.5062
SL	-6.3643	-8.6132	-7.6934	-4.1034	-3.4792	-3.9057	-5.3782
SK	-6.6490	-4.4894	-5.4910	-4.3999	-1.9243	-5.5652	-1.9800
DE	-7.6992	-7.4104	-5.7696	-4.7908	-3.2856	-7.2818	-5.5510

The critical value is -2.89. The null hypothesis of a unit root is not rejected is the F value is greater than this value.

Online Appendices

OA - GIRFs on output and confidence intervals

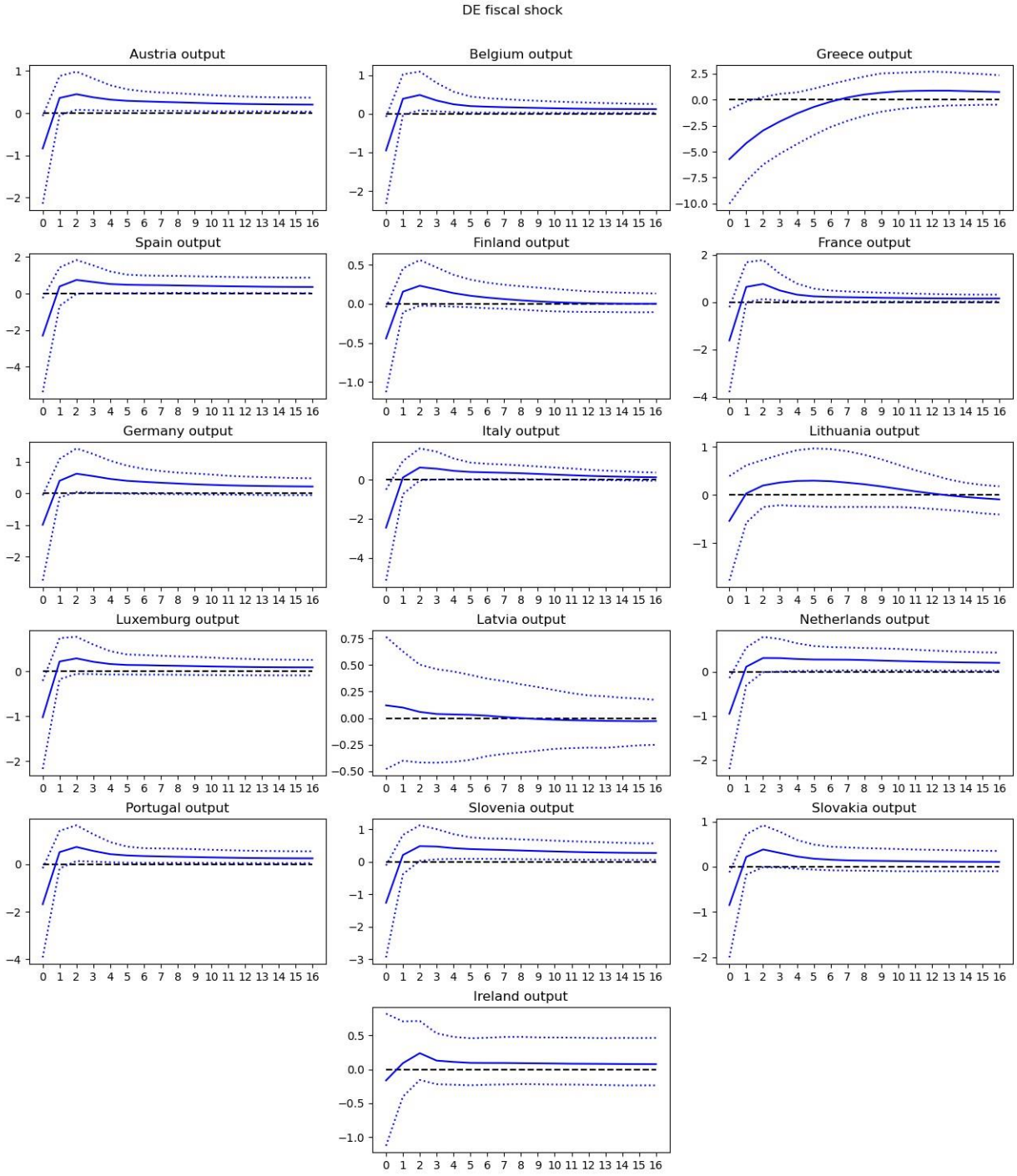

Figure OA1: *GIRFs on output of a DE budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.*

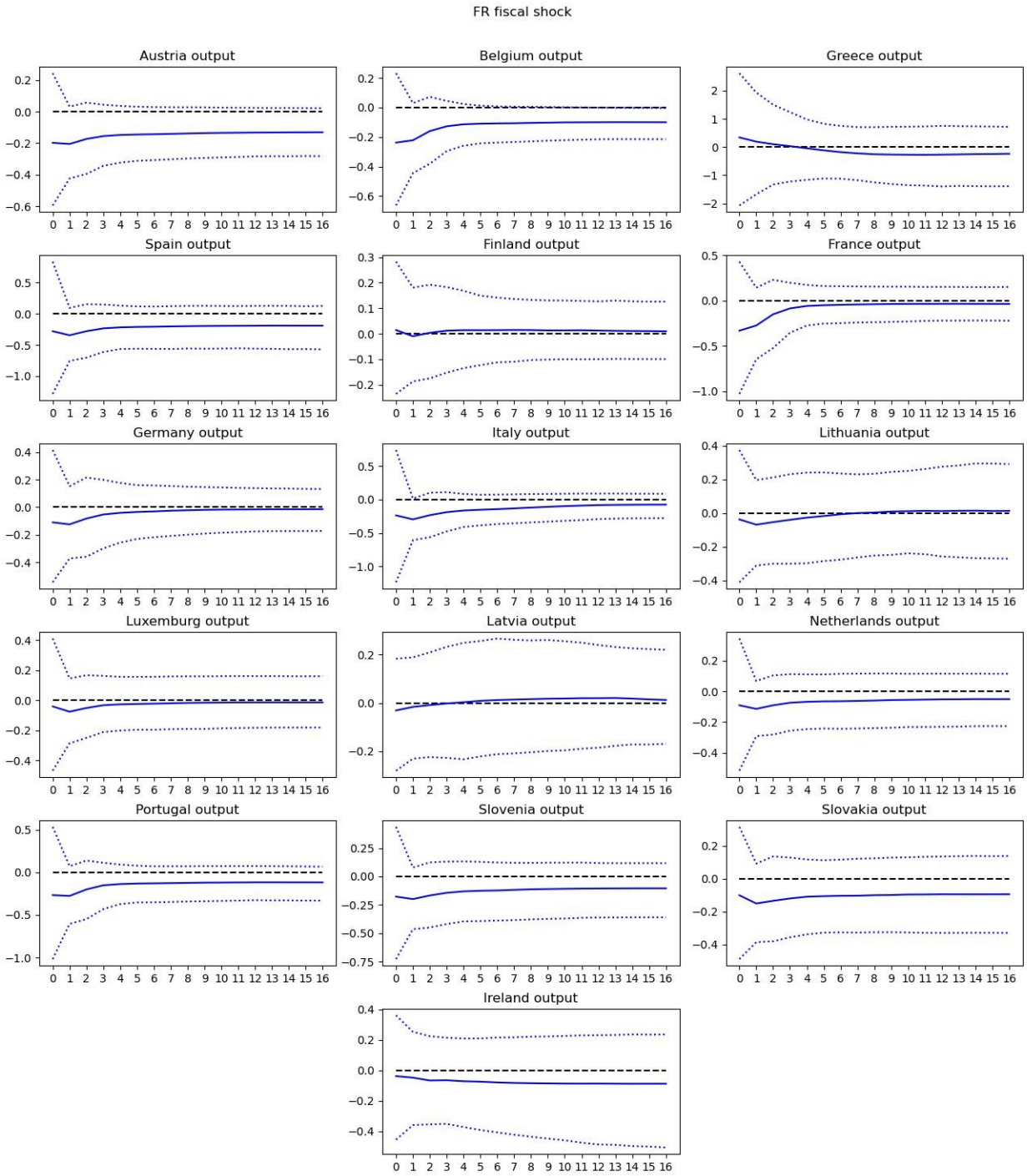

Figure OA2: GIRFs on output of a FR budget balance shock. All values are reported

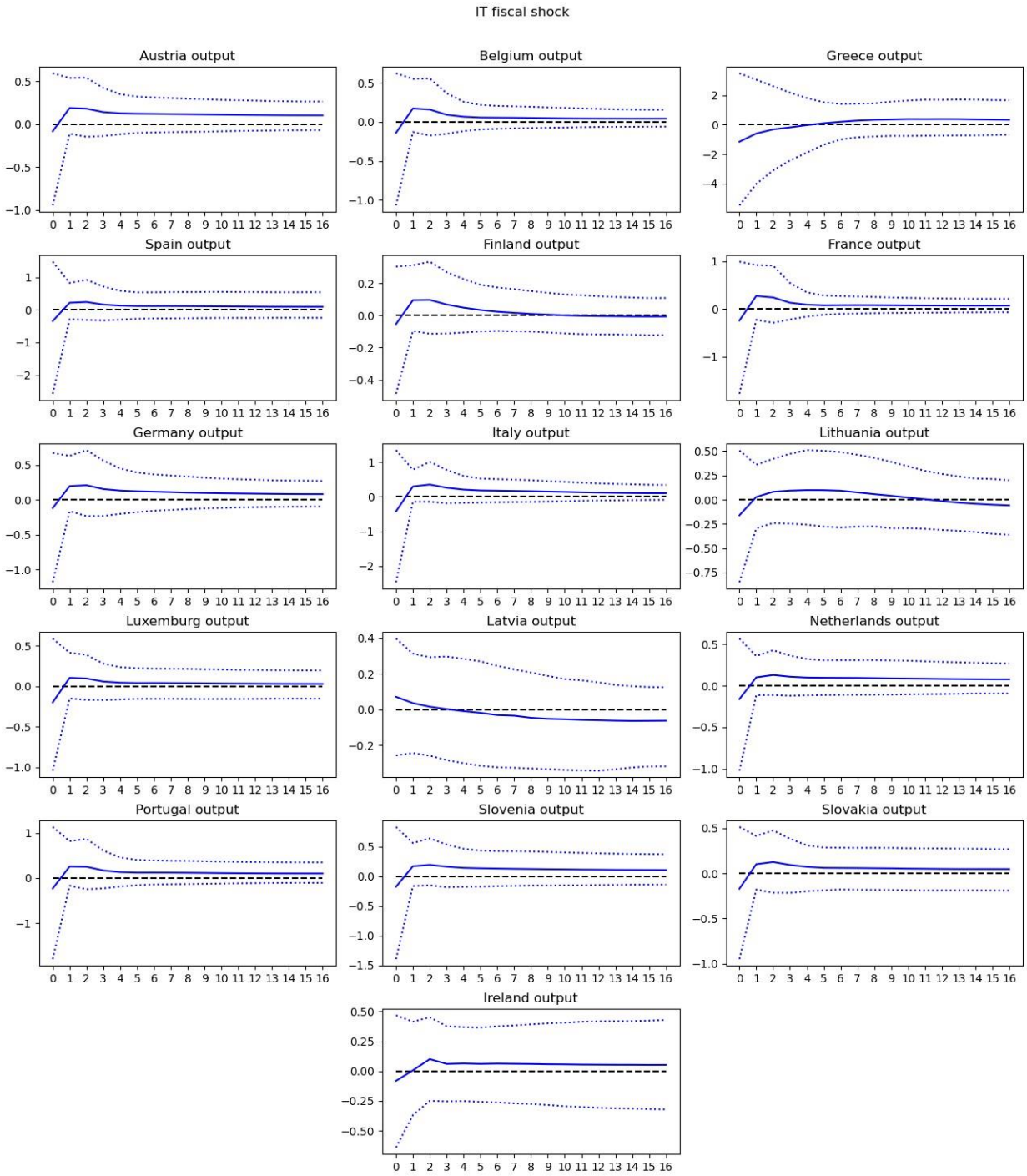

Figure OA3: *GIRFs on output of an IT budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.*

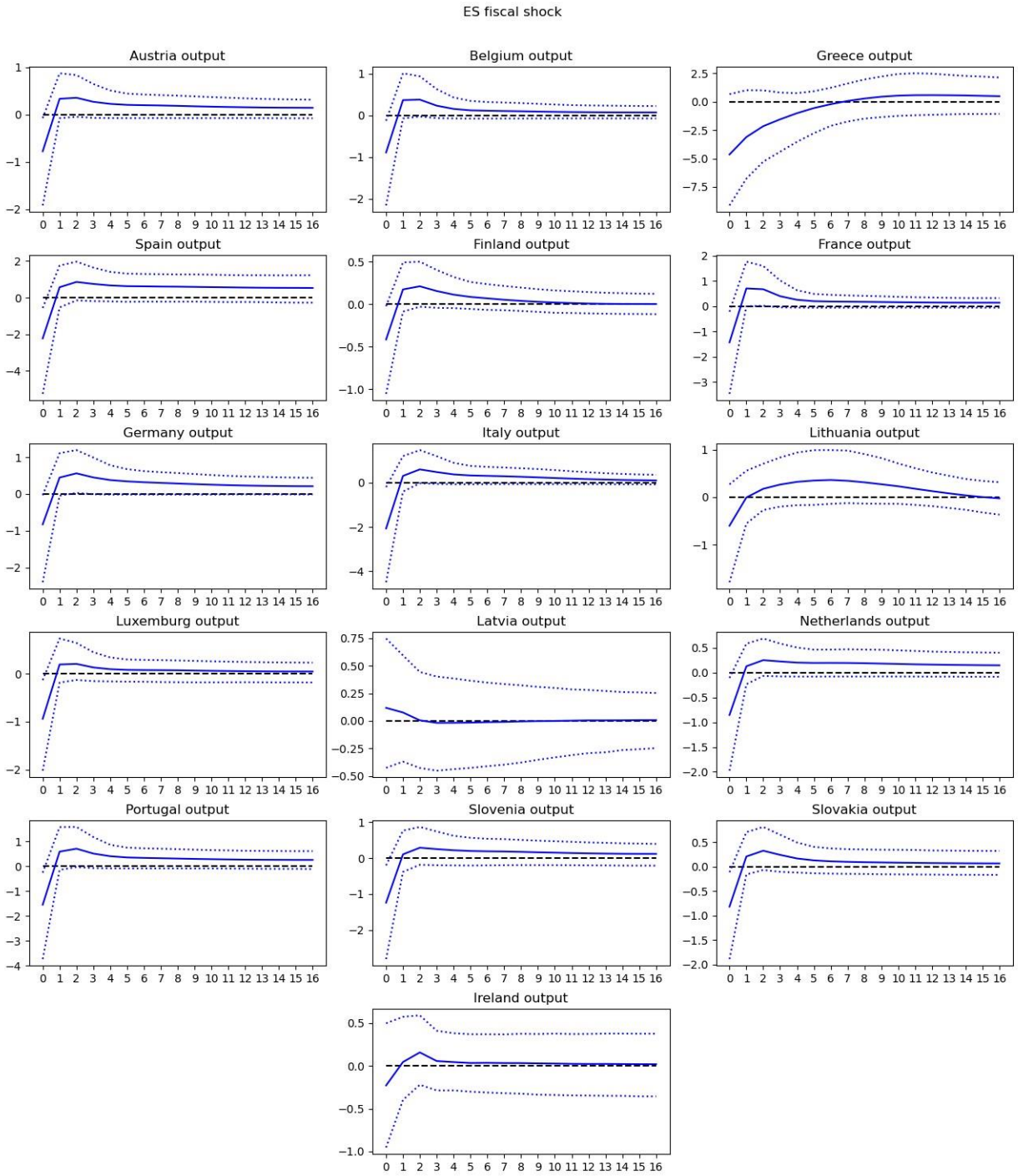

Figure OA4: *GIRFs on output of an ES budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.*

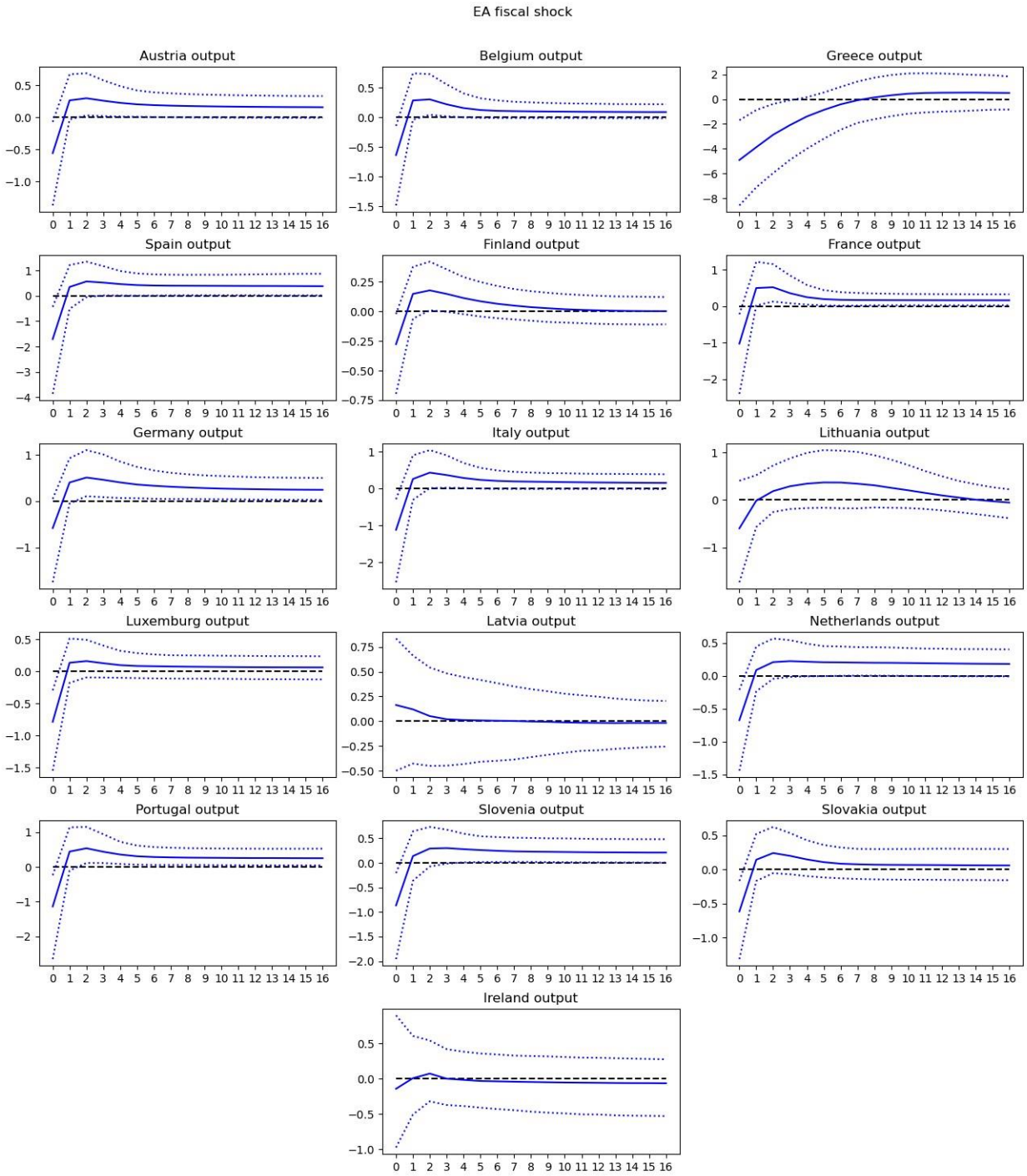

Figure OA5: GIRFs on output of an EA budget balance shock. All values are *reported in percentage and correspond to the bootstrap estimates after 2500 replications.*

OB - GIRFs on prices

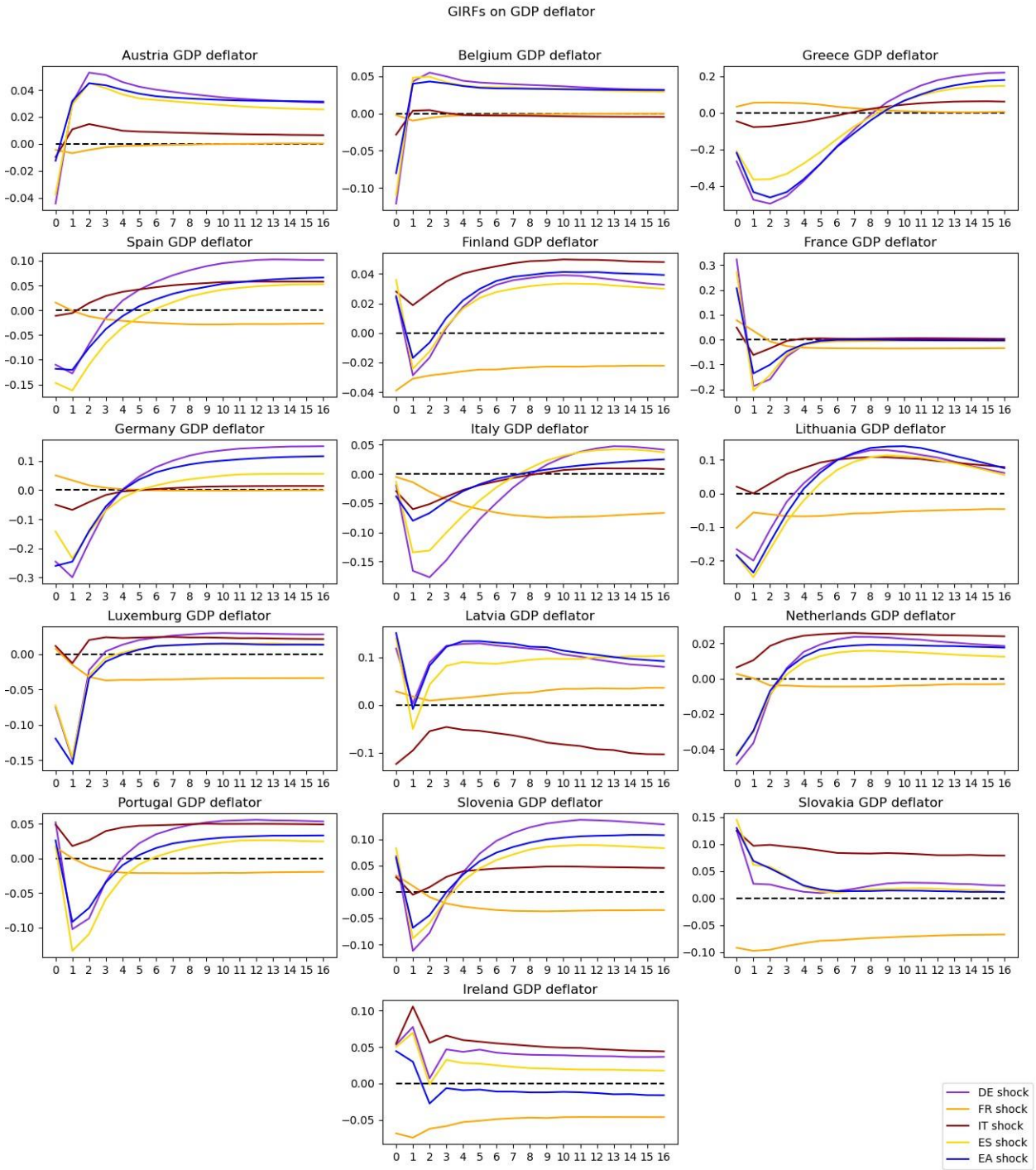

Figure OB1: GIRFs on prices. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

OC - GIRFs on public debt

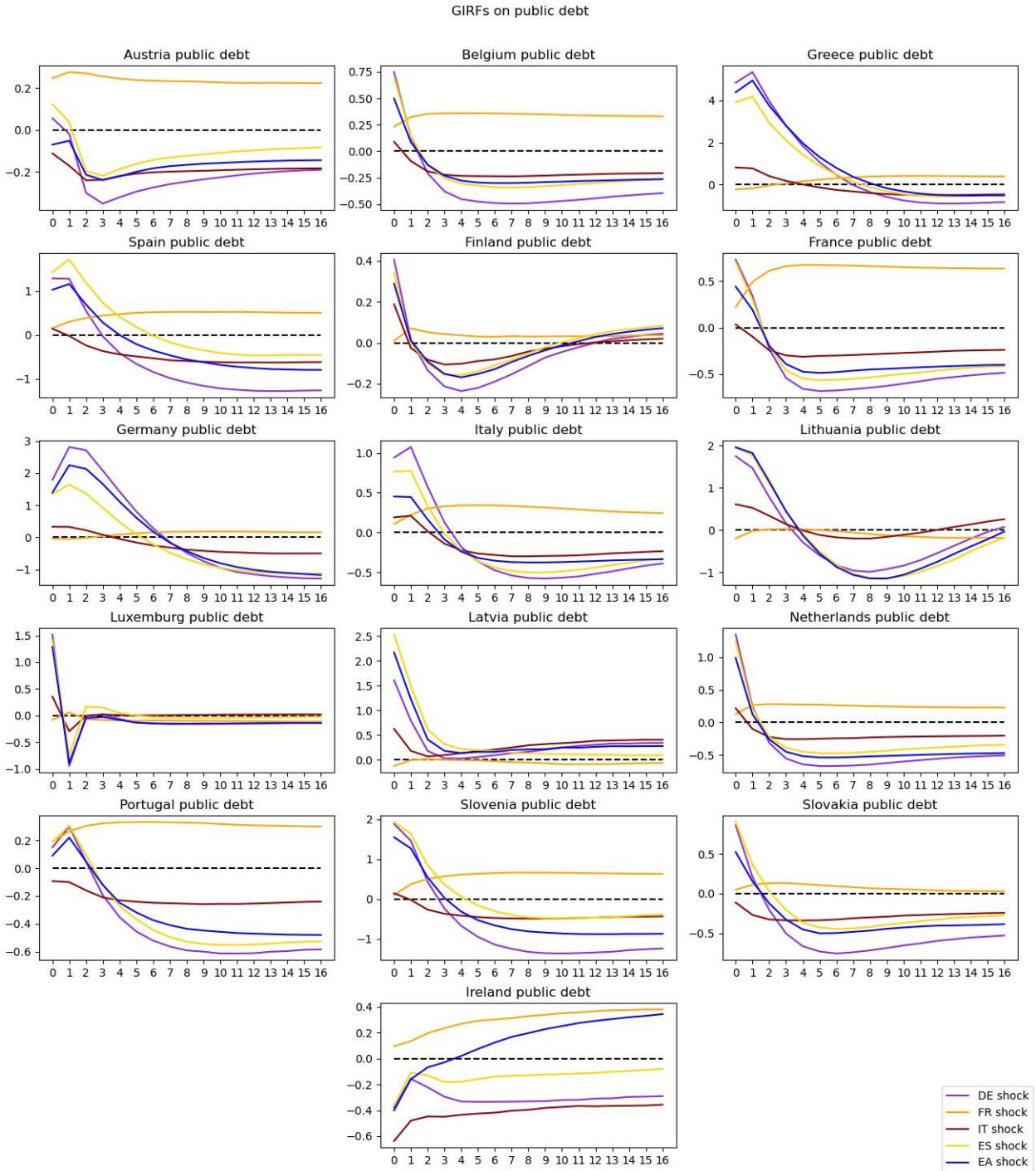

Figure OC1: GIRFs on public debt. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

OD - GIRFs on private consumption and confidence intervals

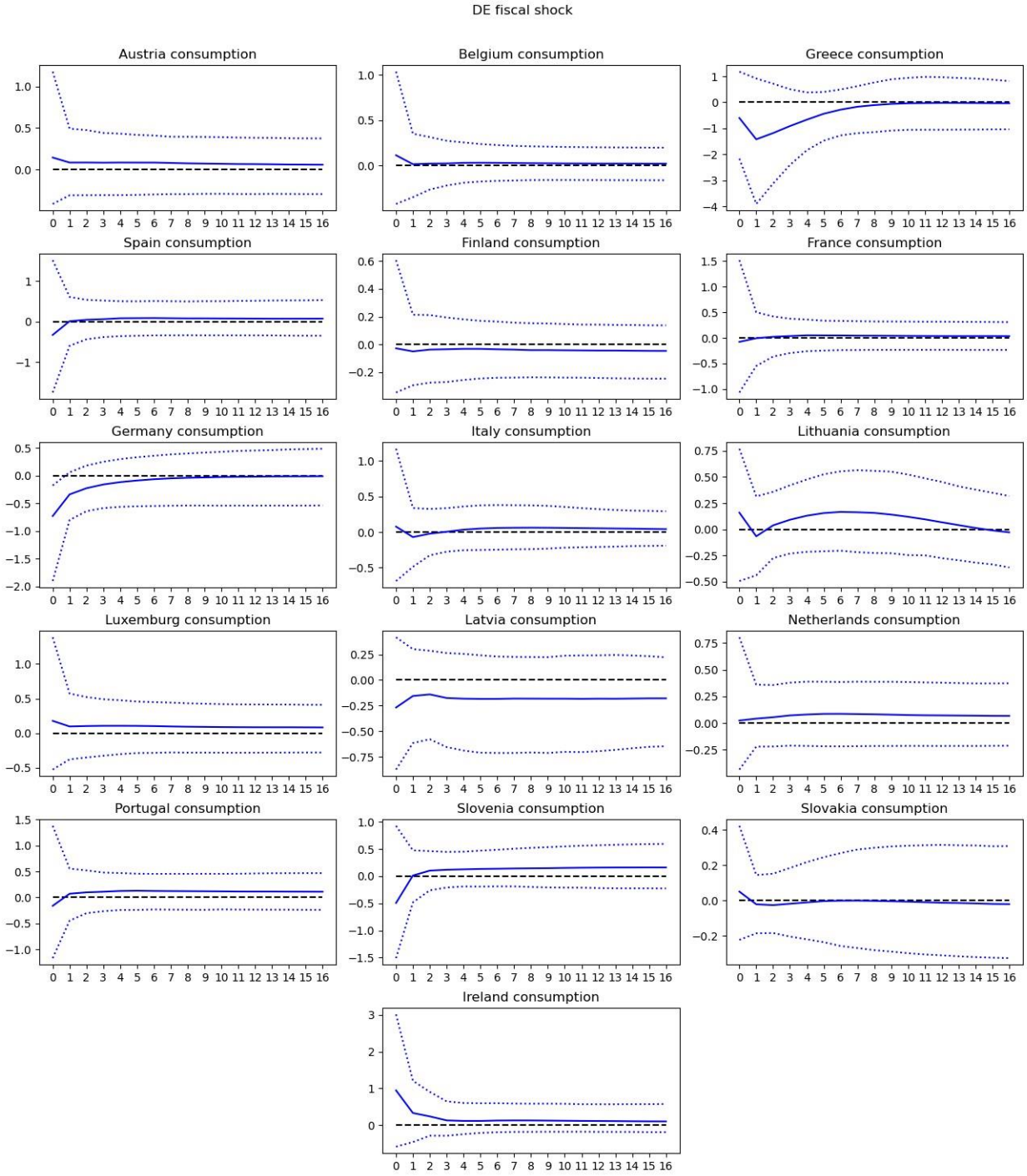

Figure OD1: GIRFs on private consumption of a DE budget balance shock. All values[58] are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

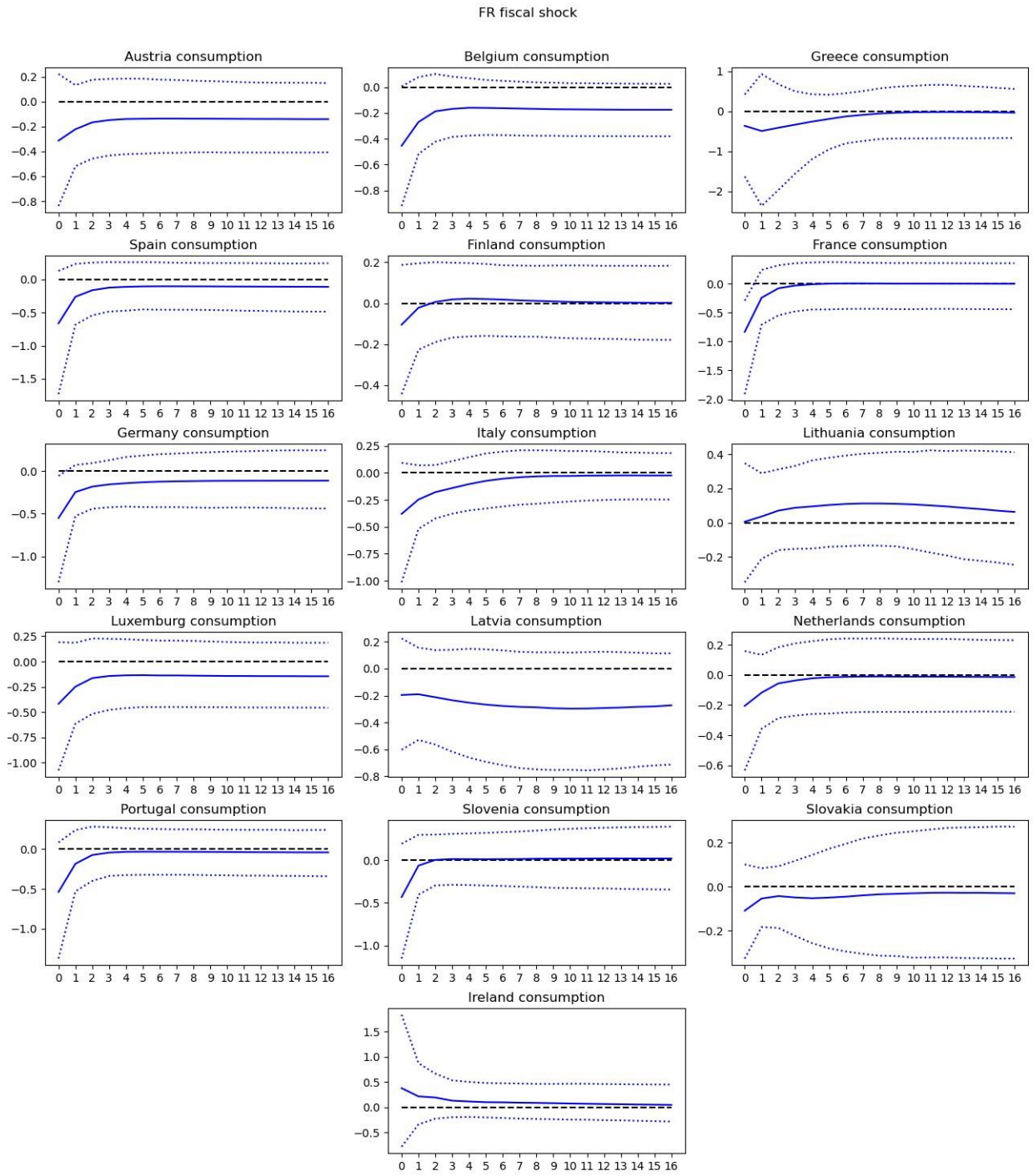

Figure OD2: GIRFs on private consumption of a FR budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

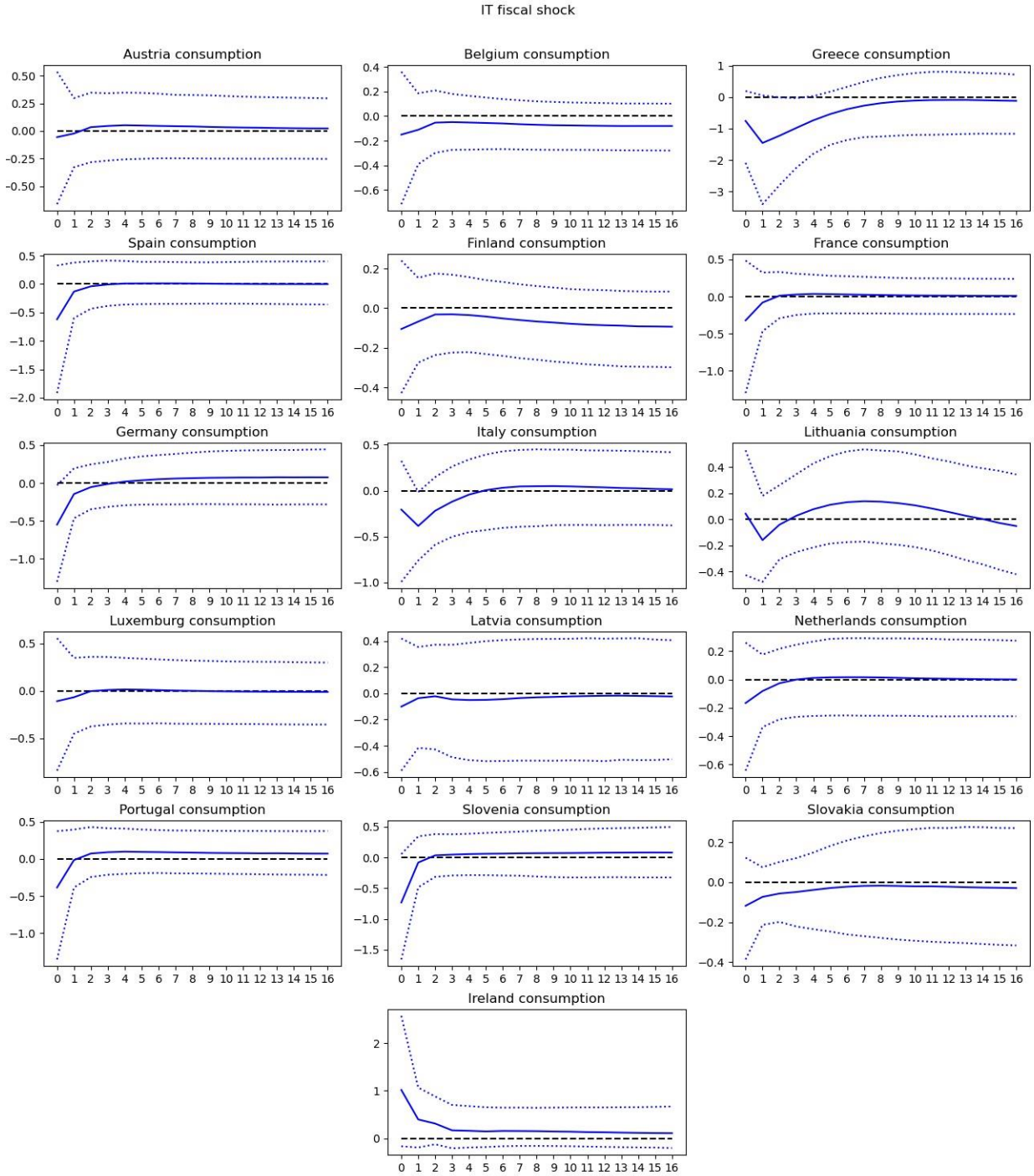

Figure OD3: GIRFs on private consumption of an IT budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

All

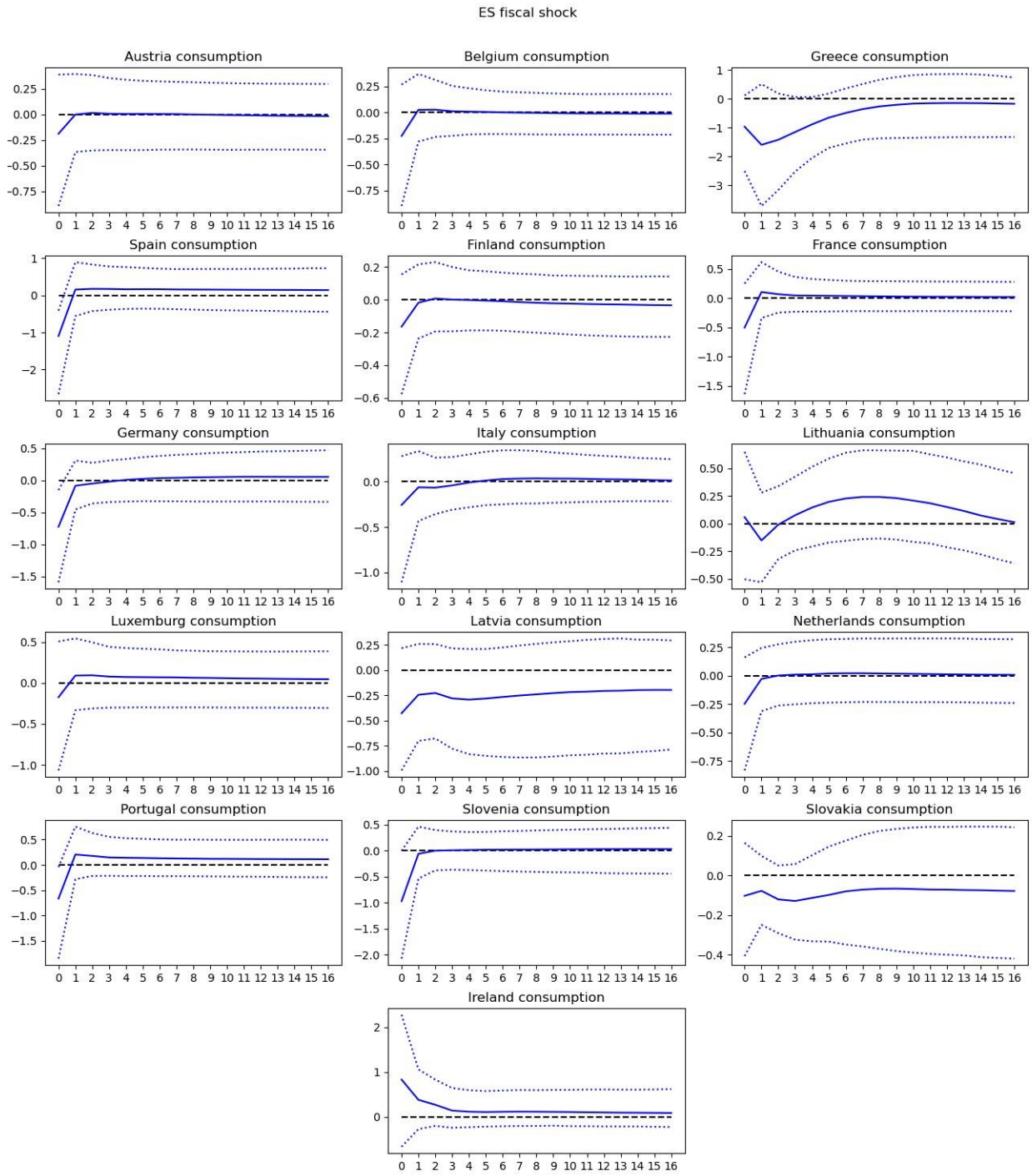

Figure OD4: GIRFs on private consumption of an ES budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

All

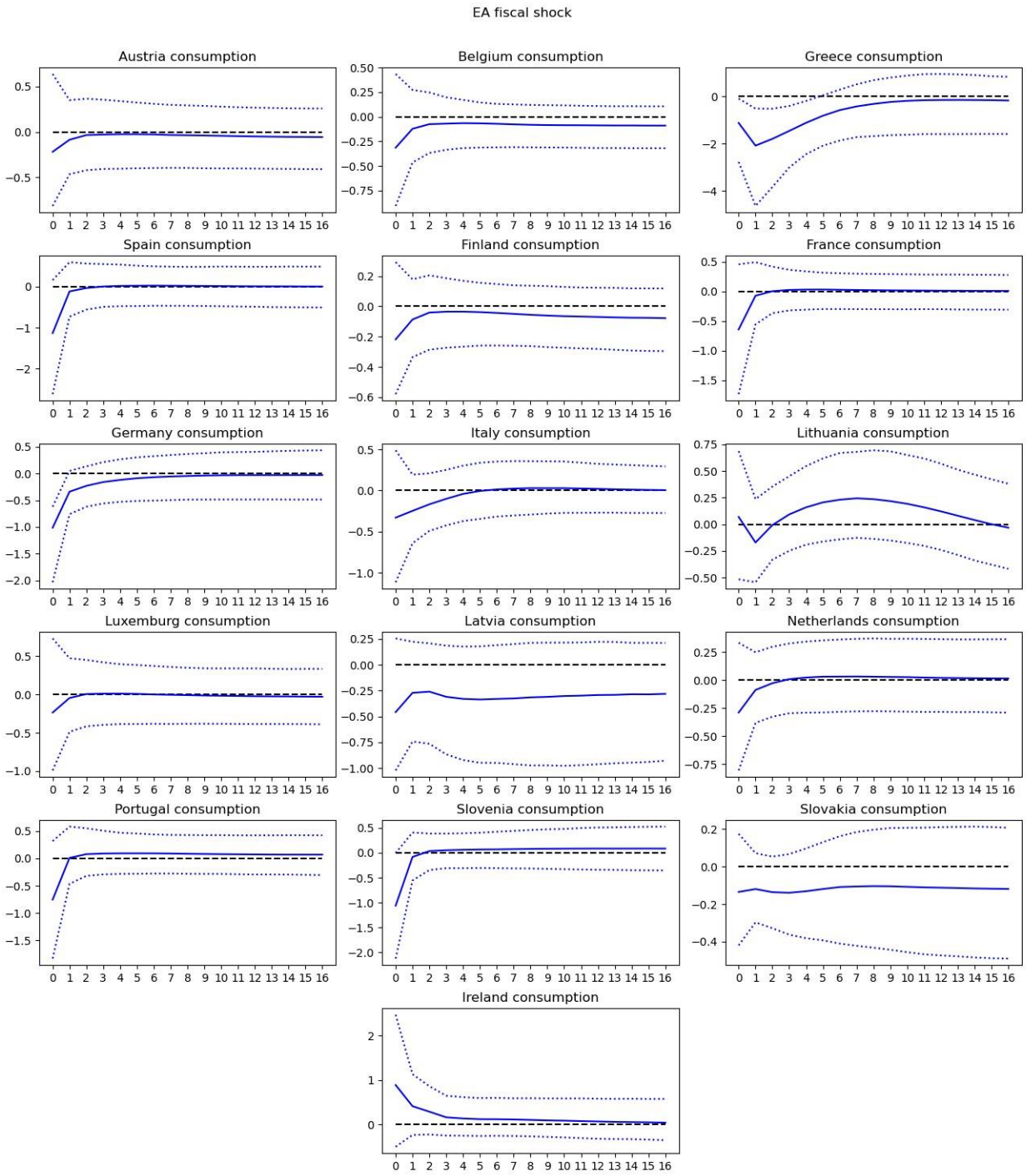

Figure OD5: GIRFs on private consumption of an EA budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

OE - GIRFs on private investment and confidence intervals

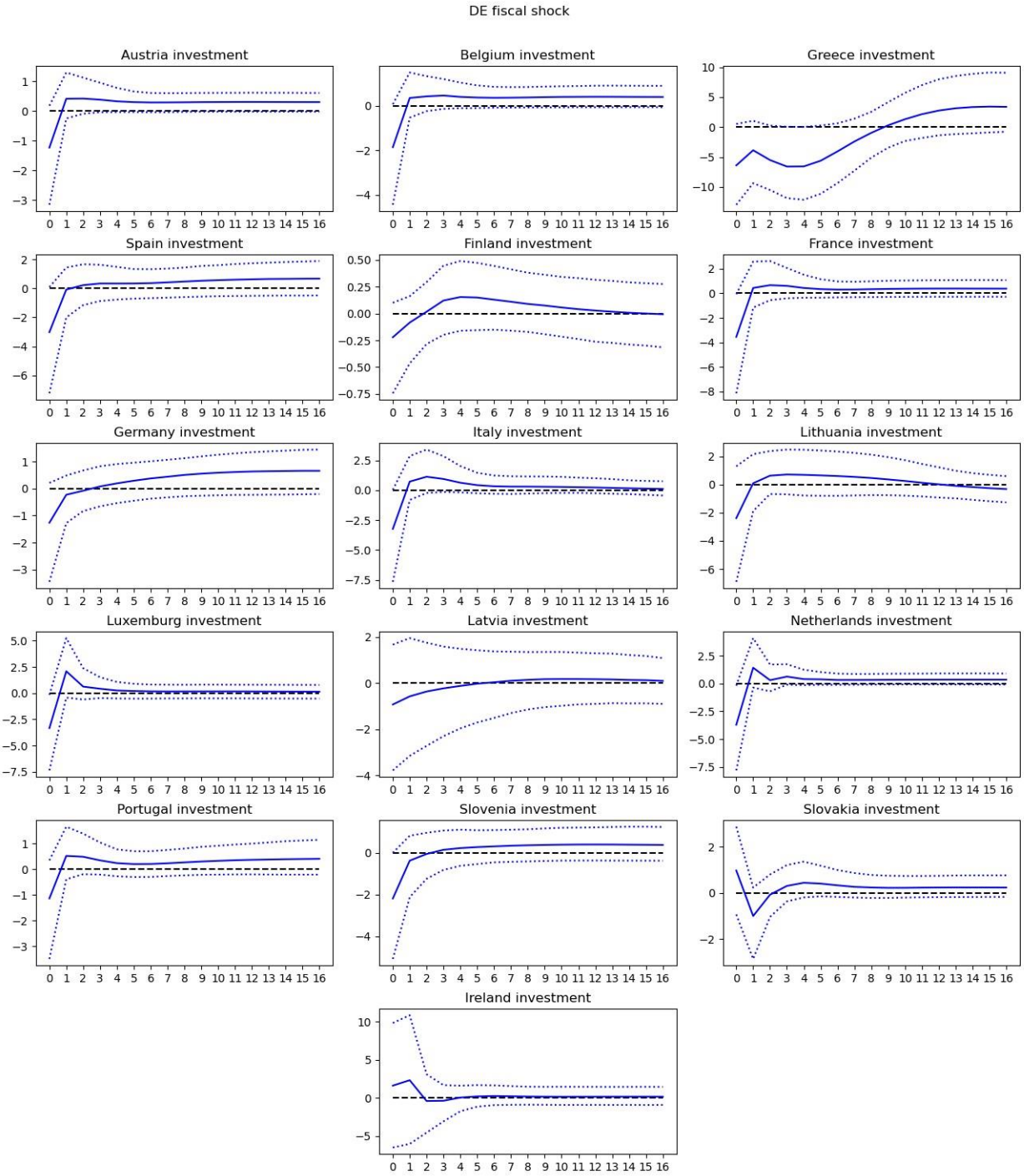

Figure OE1: GIRFs on private investment of a DE budget balance shock. All values[63] are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

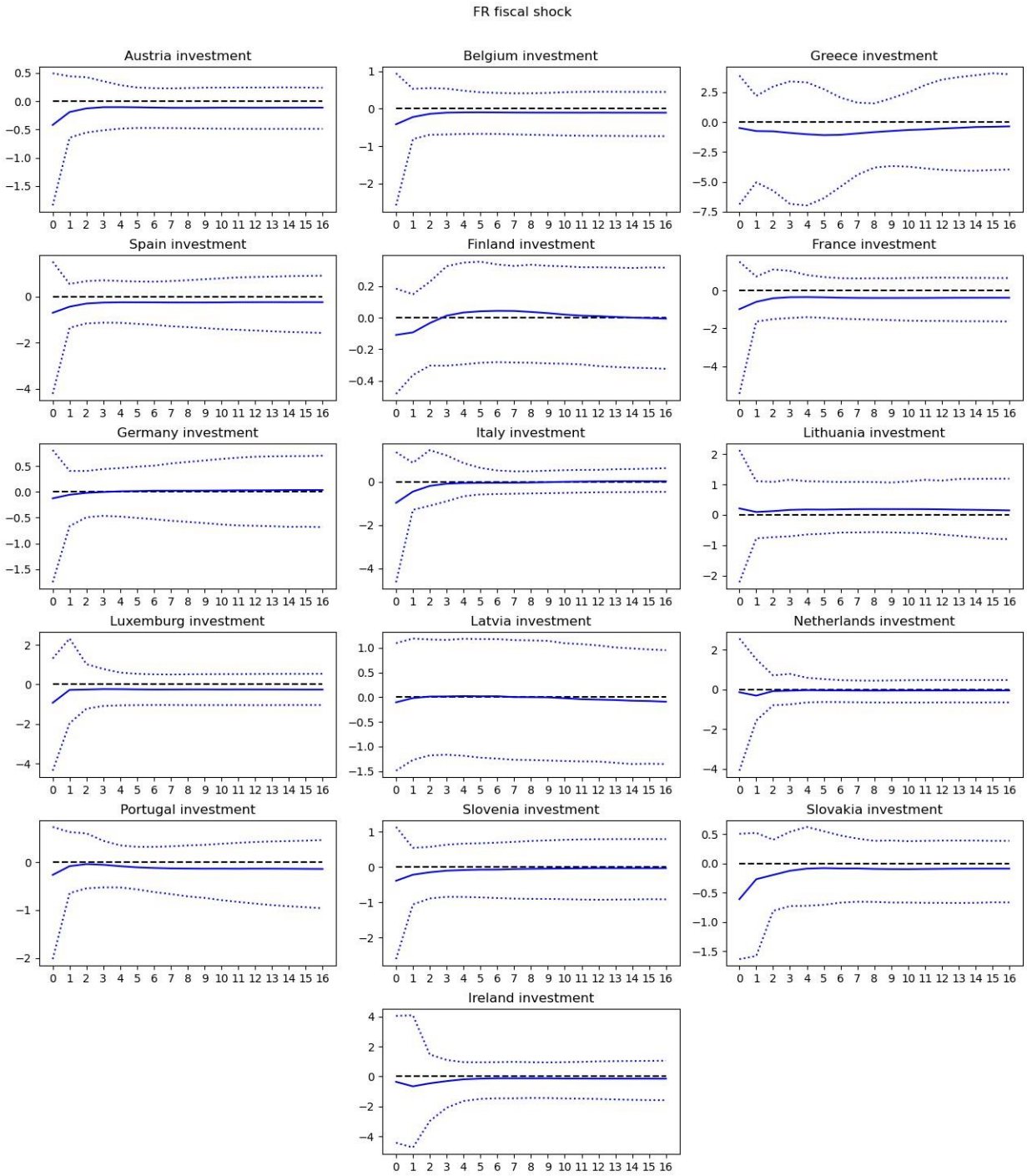

Figure OE2: GIRFs on private investment of a FR budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

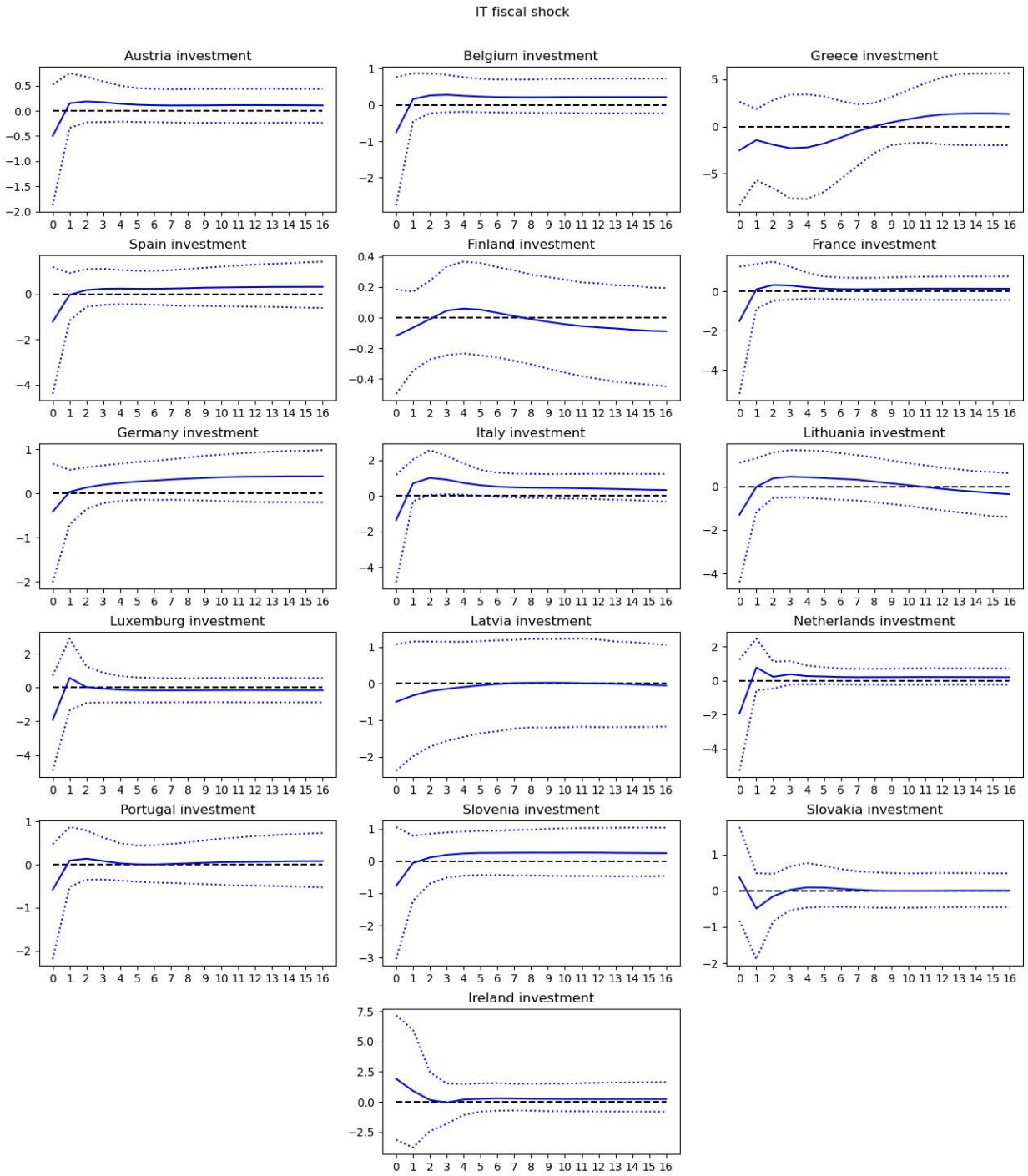

Figure OE3: GIRFs on private investment of an IT budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

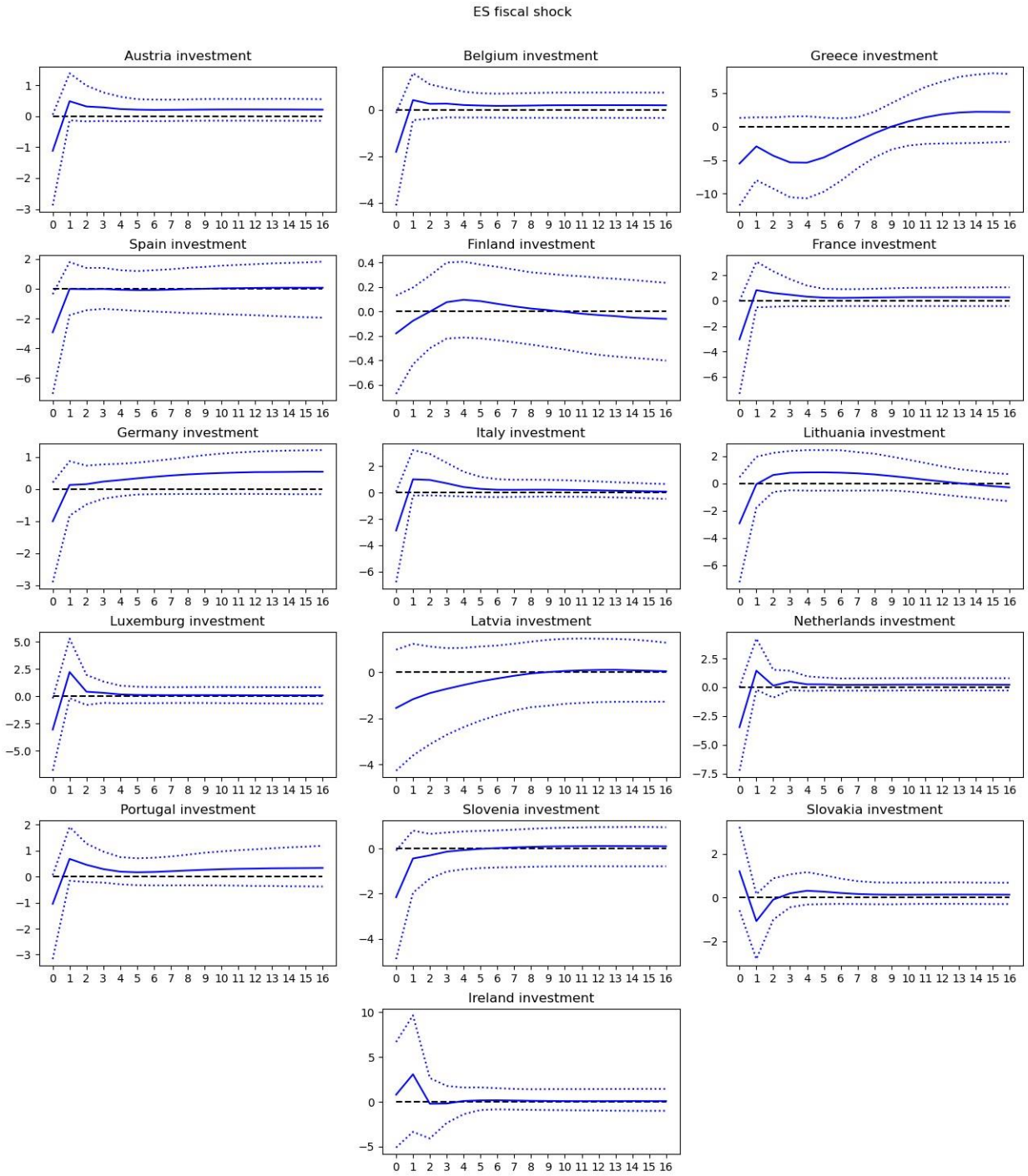

Figure OE4: GIRFs on private investment of an ES budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

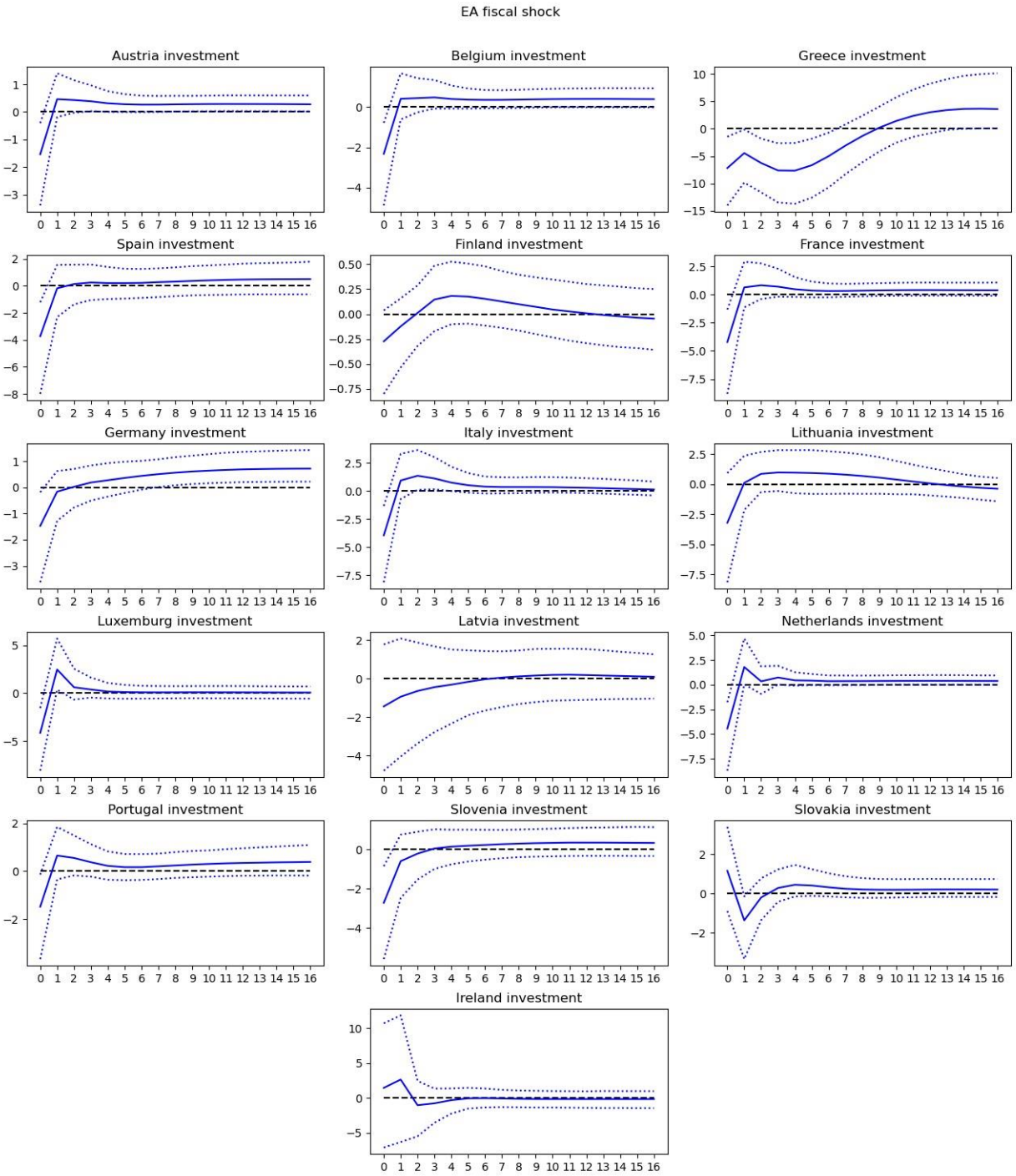

Figure OE5: GIRFs on private investment of an EA budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

OF - GIRFs on employment and confidence intervals

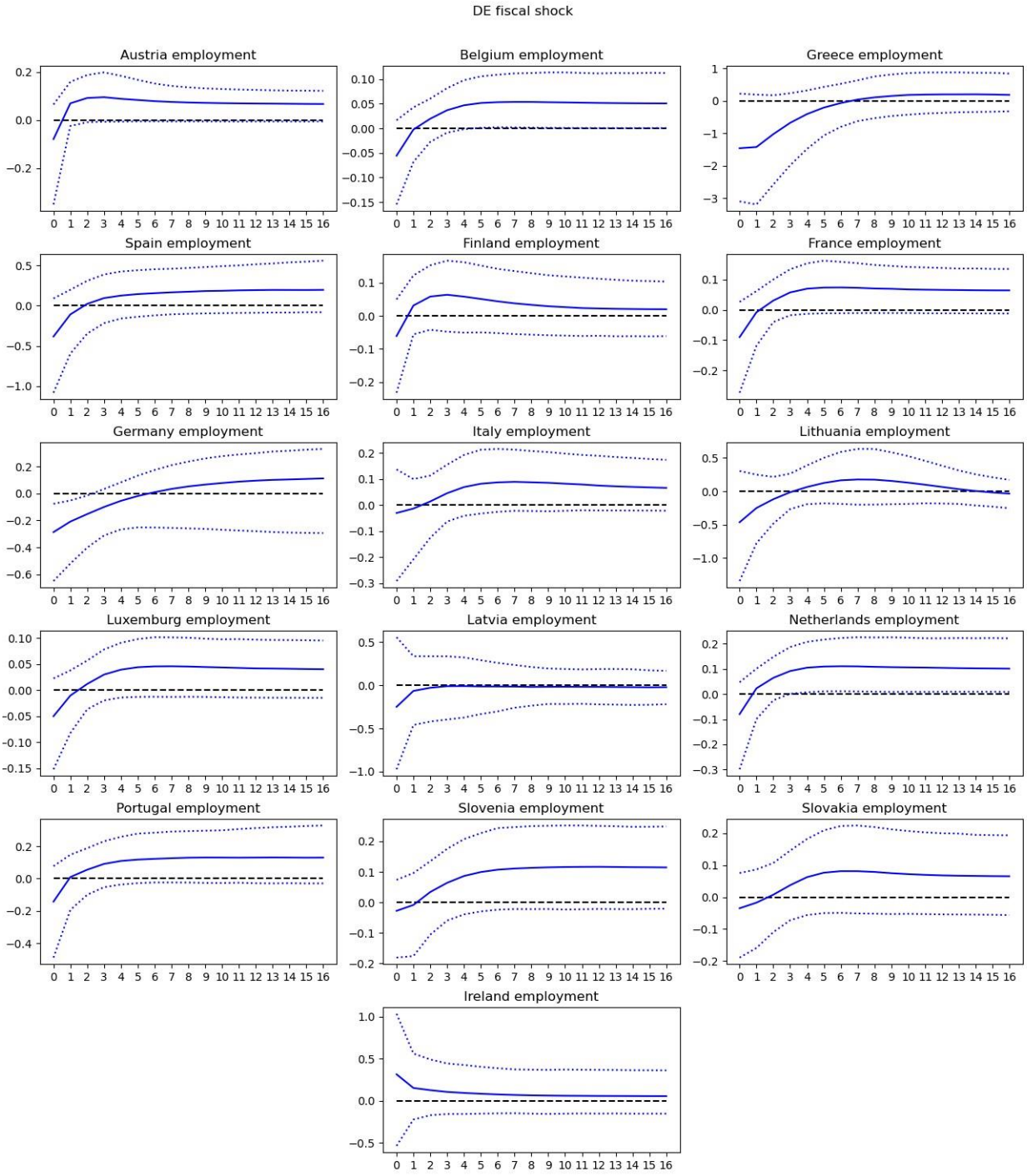

Figure OF1: GIRFs on employment of a DE budget balance shock. All values are[68] reported in percentage and correspond to the bootstrap estimates after 2500 replications.

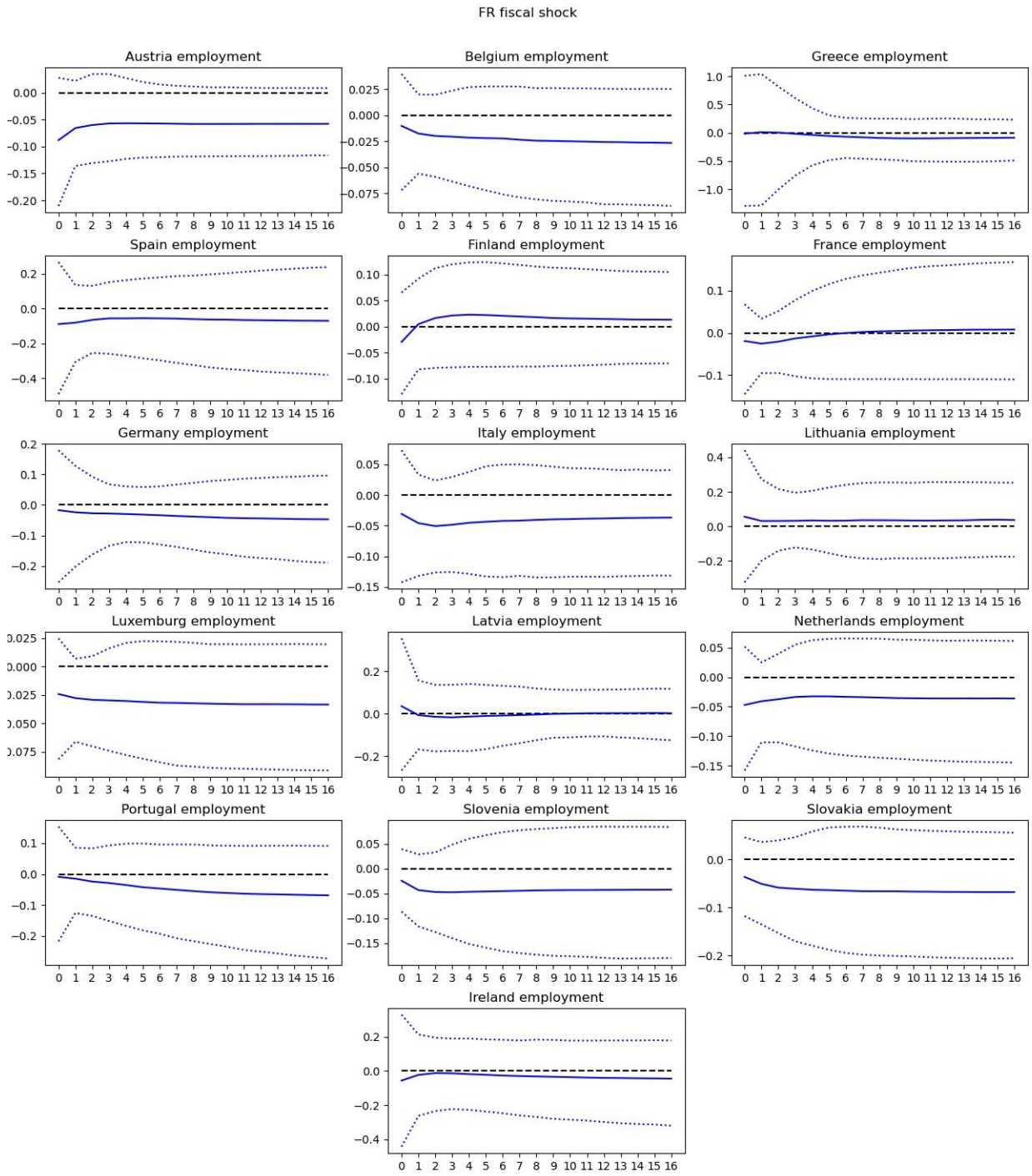

Figure OF2: GIRFs on employment of a FR budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

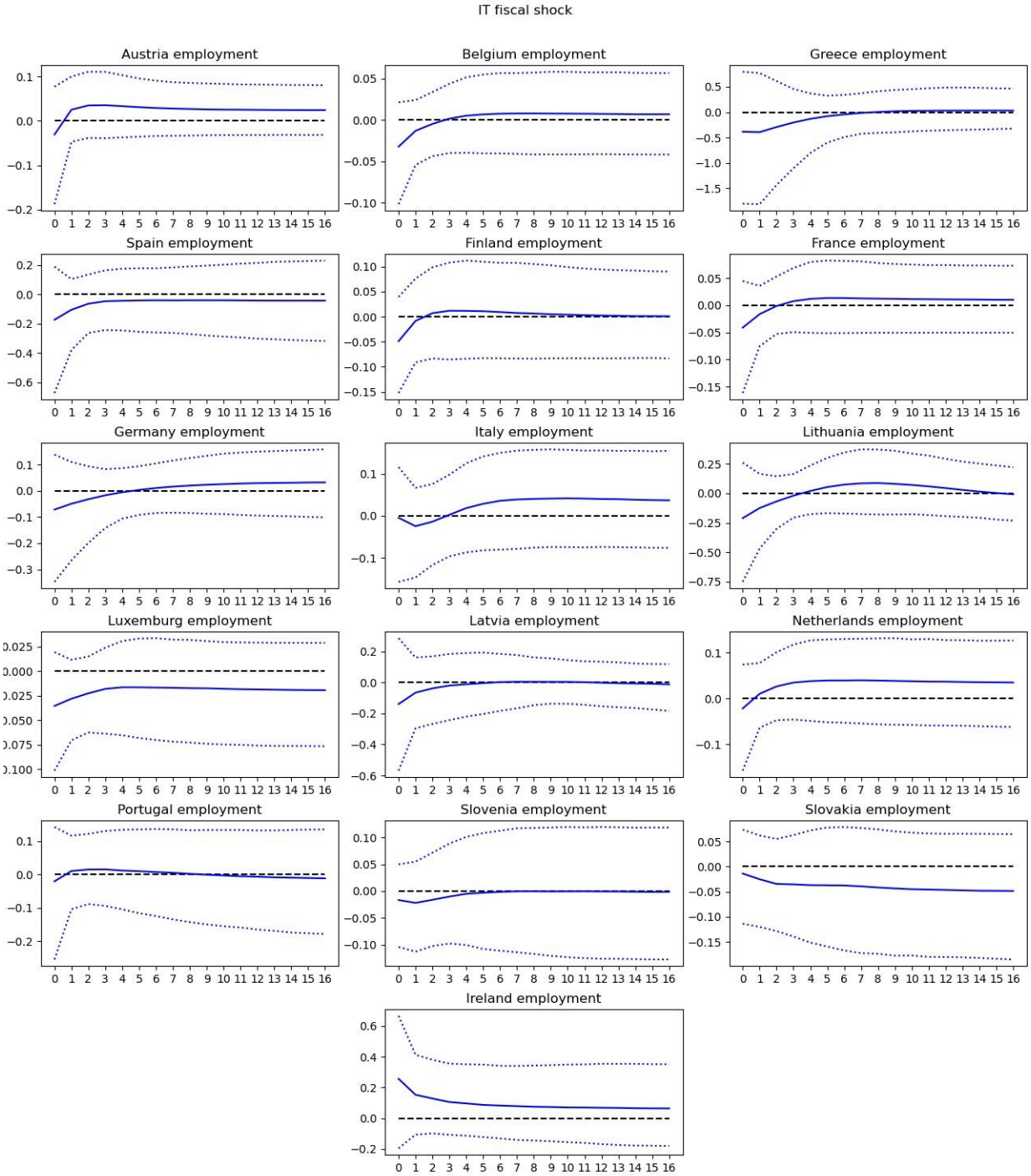

Figure OF3: GIRFs on employment of an IT budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

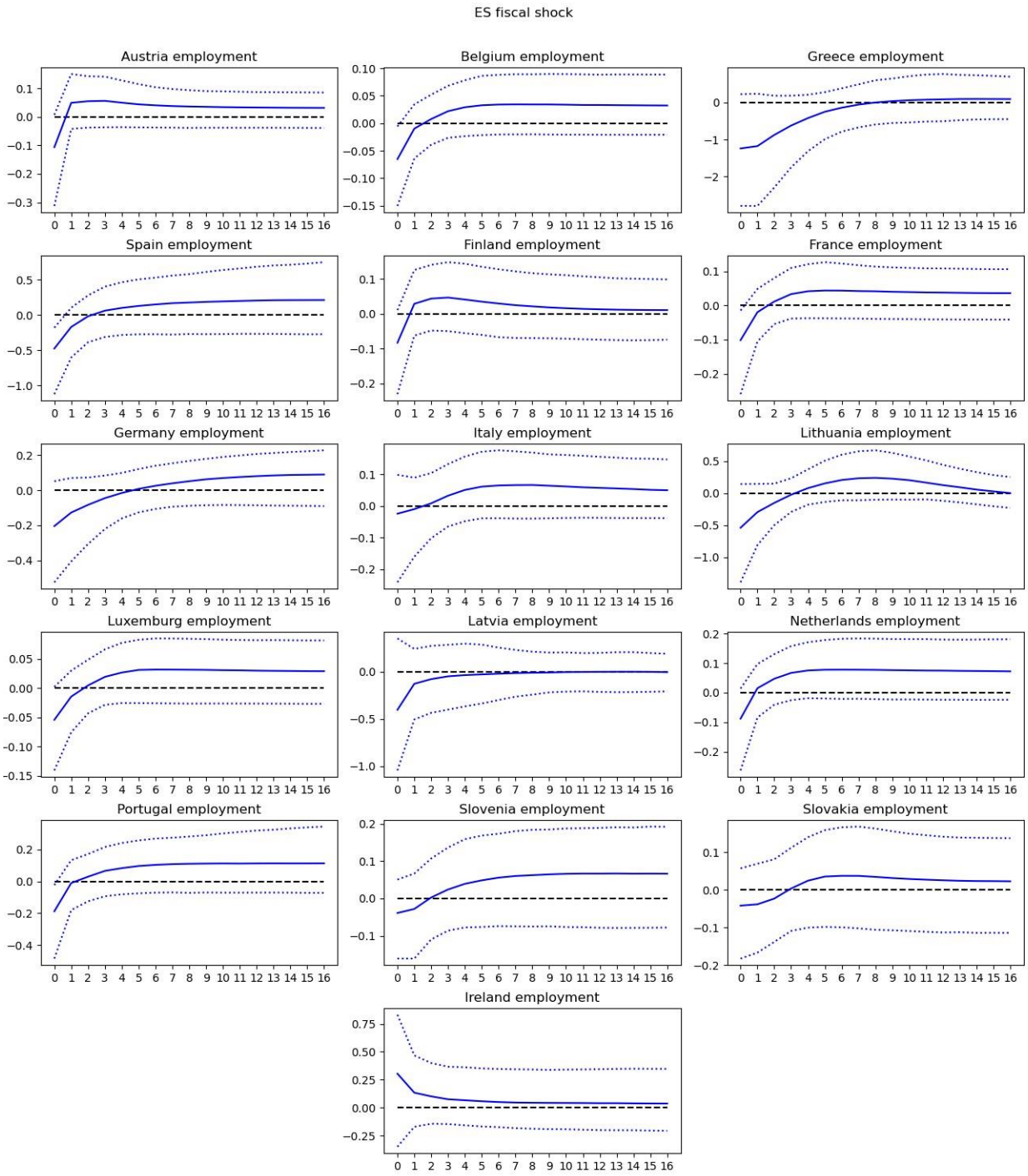

Figure OF4: GIRFs on employment of an ES budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

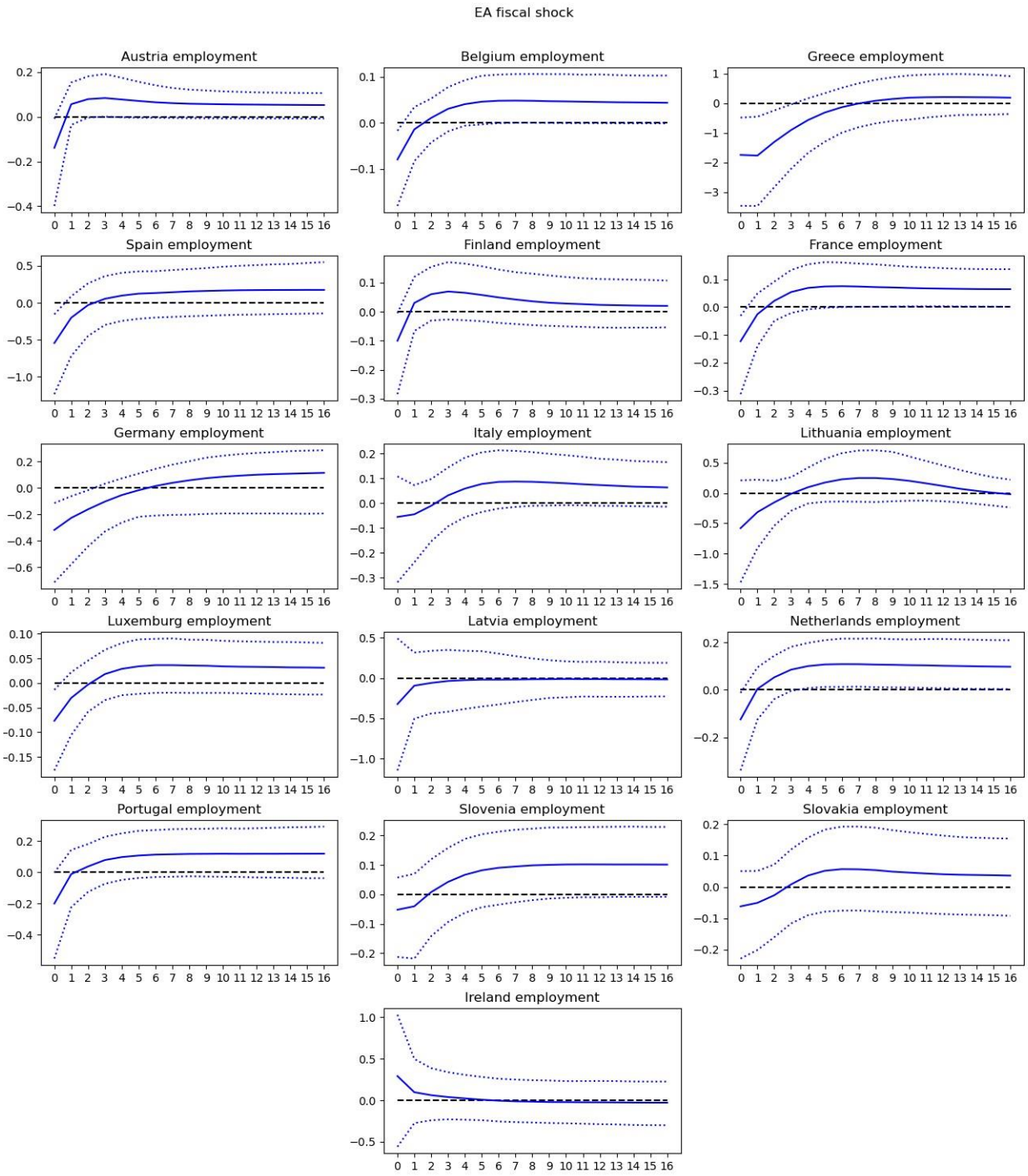

Figure OF5: GIRFs on employment of an EA budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

OG - GIRFs on income and confidence intervals

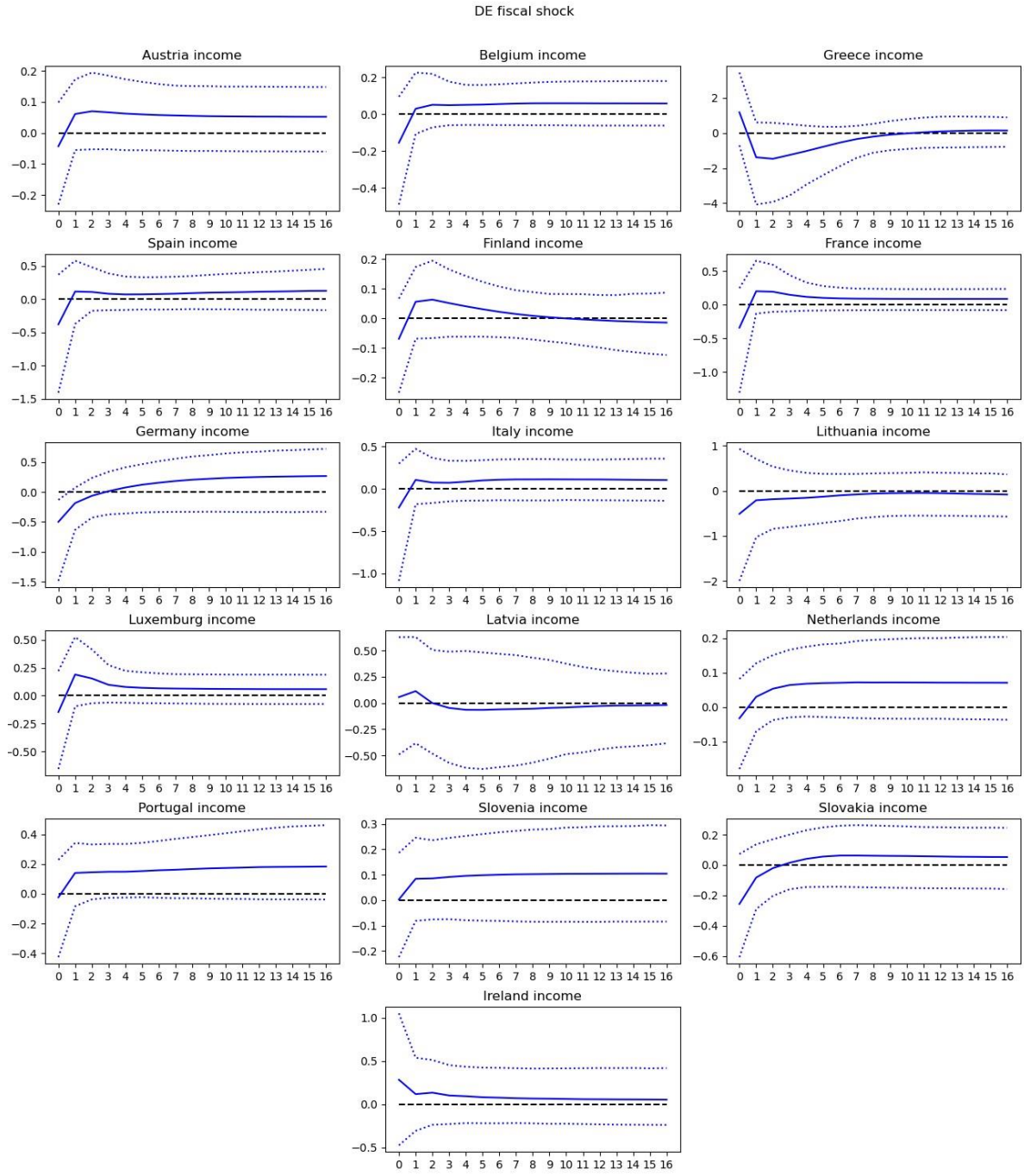

Figure OG1: GIRFs on income of a DE budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

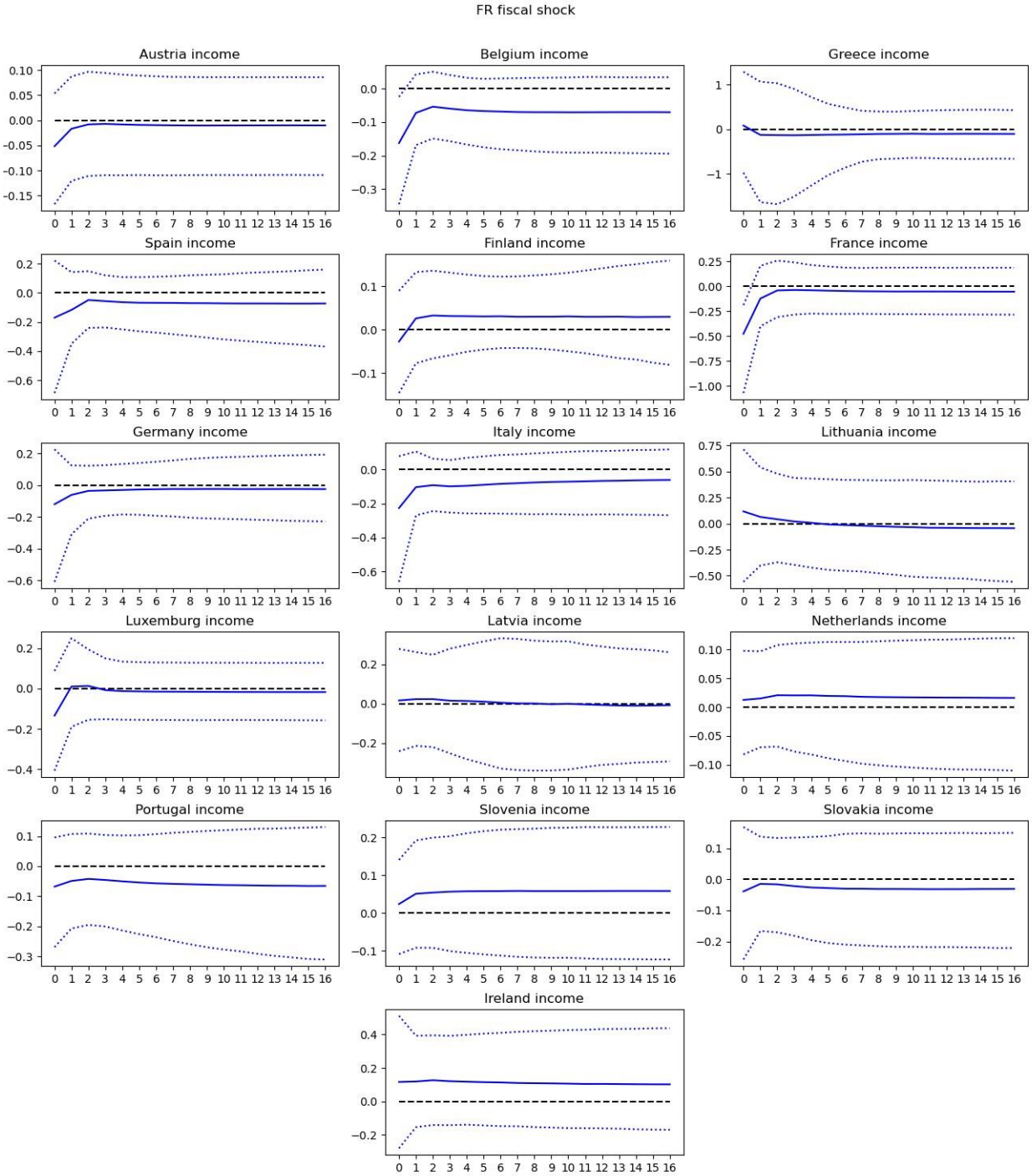

Figure OG2: GIRFs on income of a FR budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

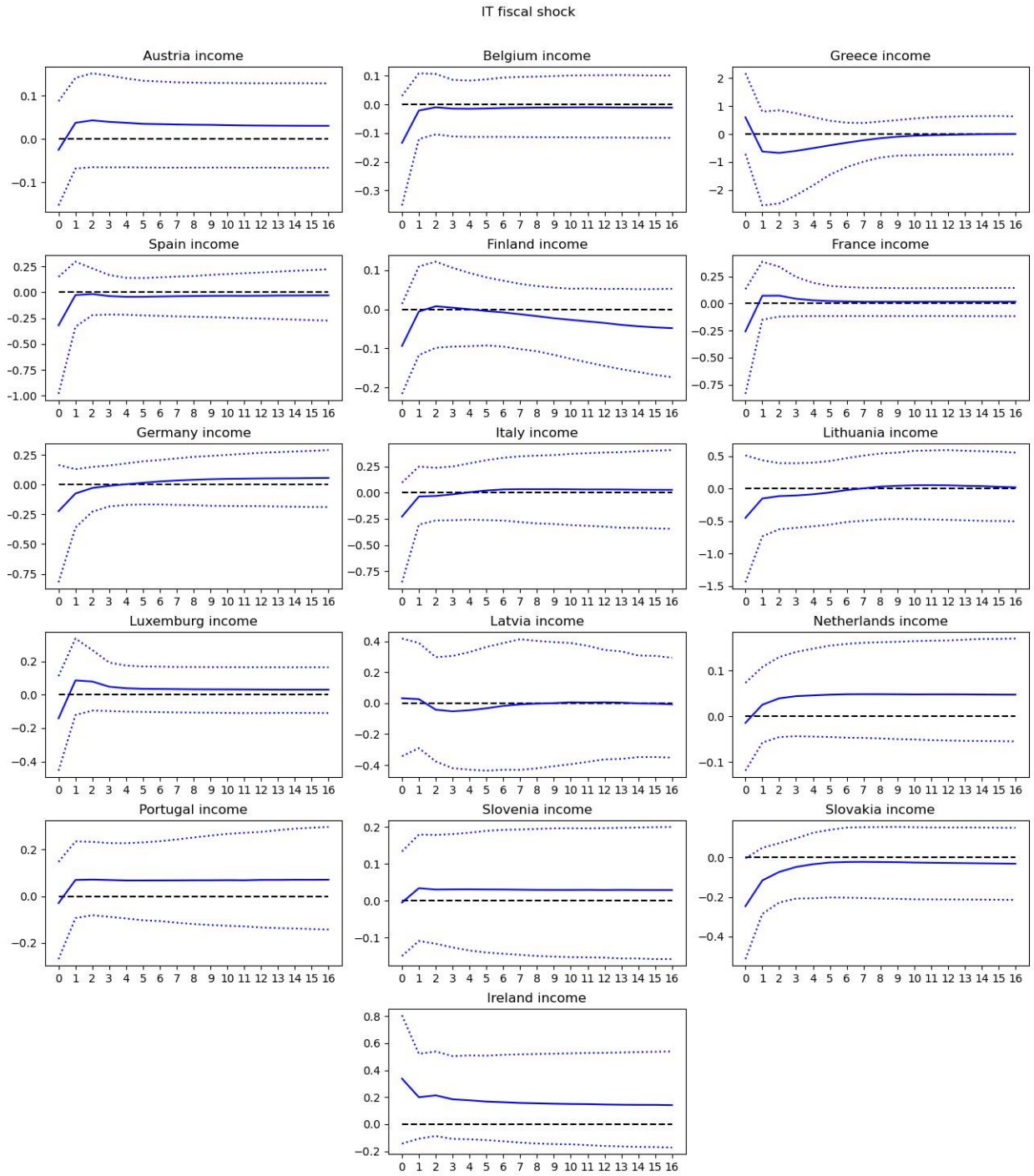

Figure OG3: GIRFs on income of an IT budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

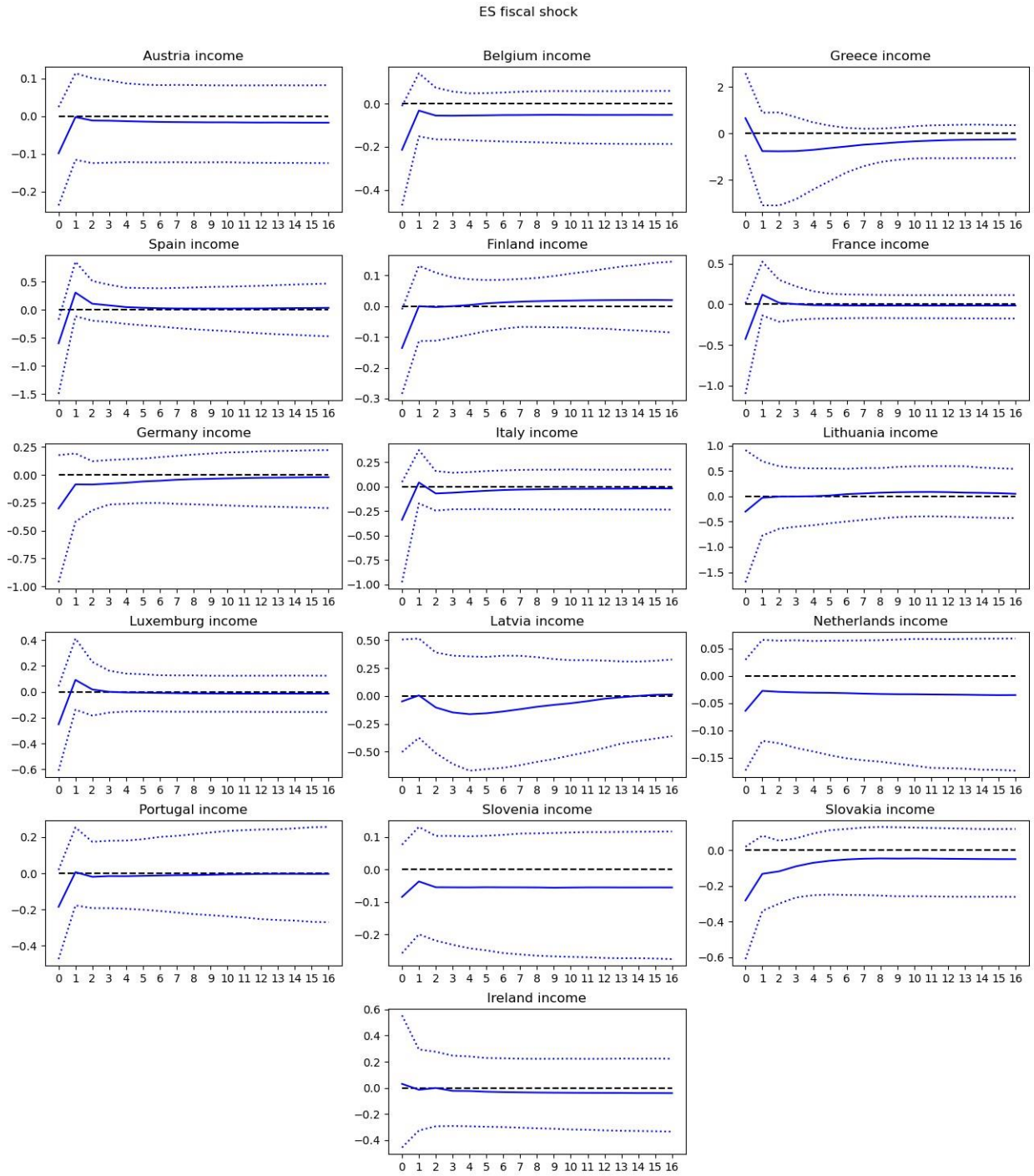

Figure OG4: GIRFs on income of an ES budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

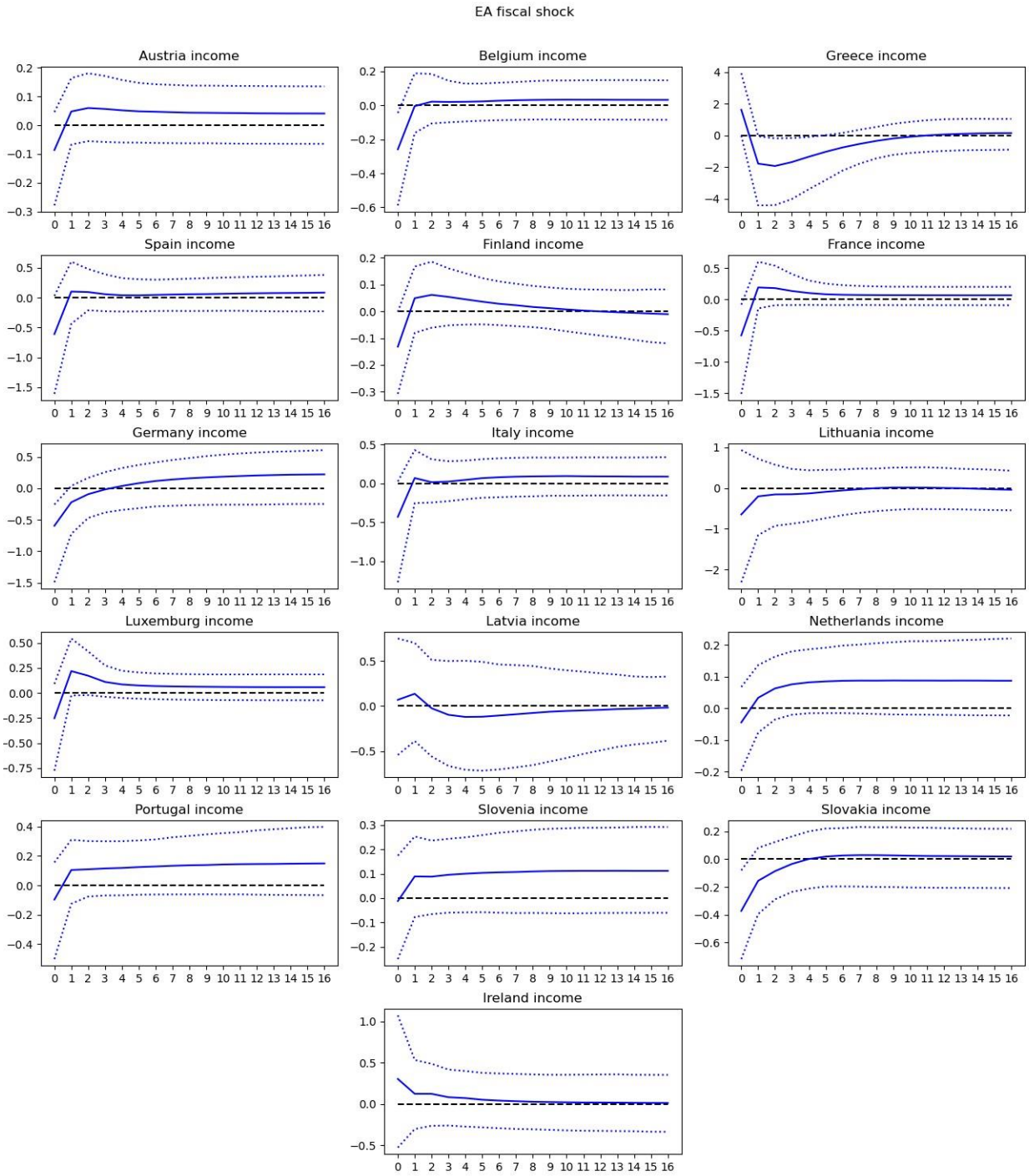

Figure OG5: GIRFs on income of an EA budget balance shock. All values are reported in percentage and correspond to the bootstrap estimates after 2500 replications.

OH - Alternative 1: GIRFs on output

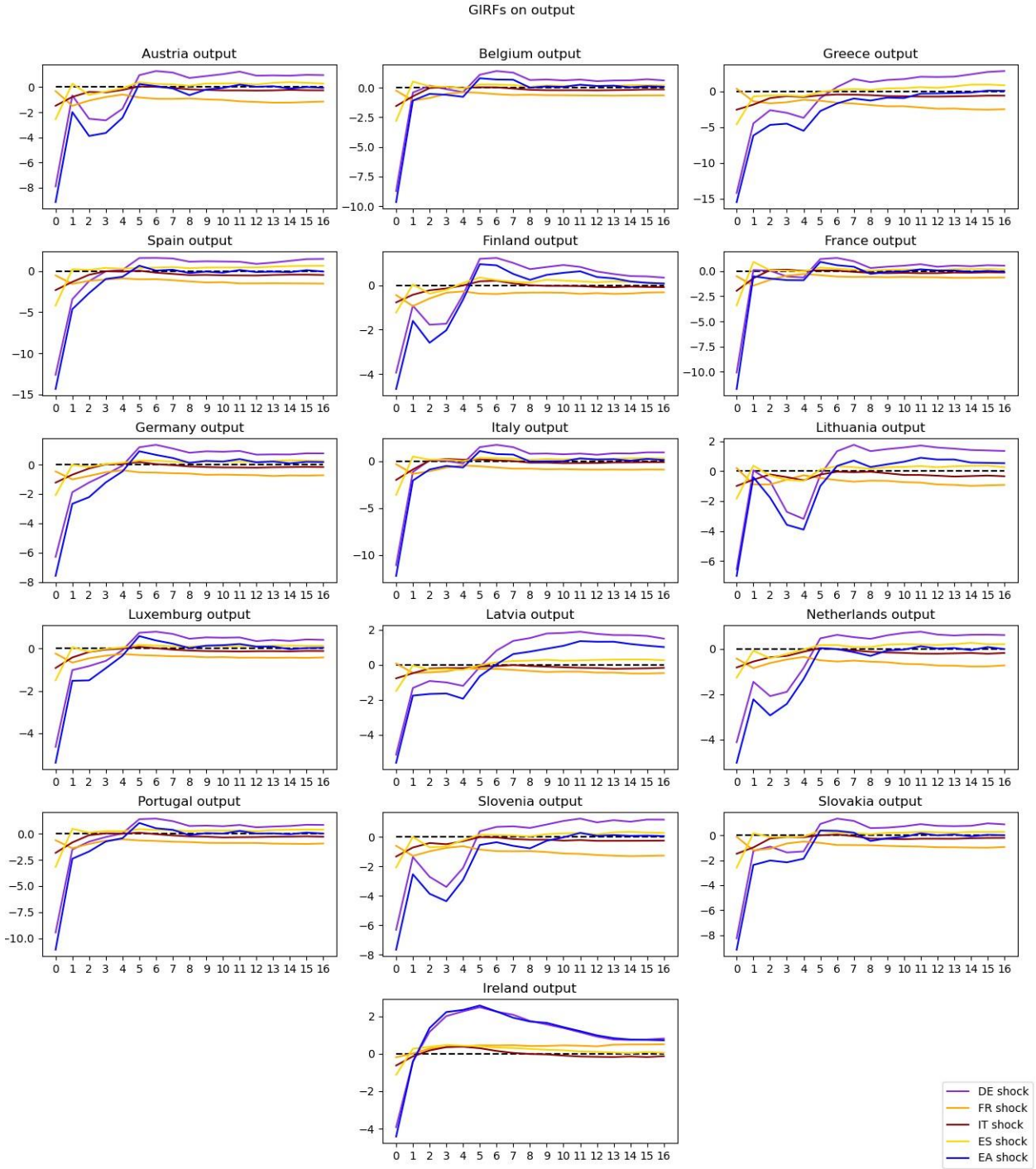

Figure OH1: Alternative 1: GIRFs on output. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

OI - Alternative 2: GIRFs on output, consumption, investment, employment, income

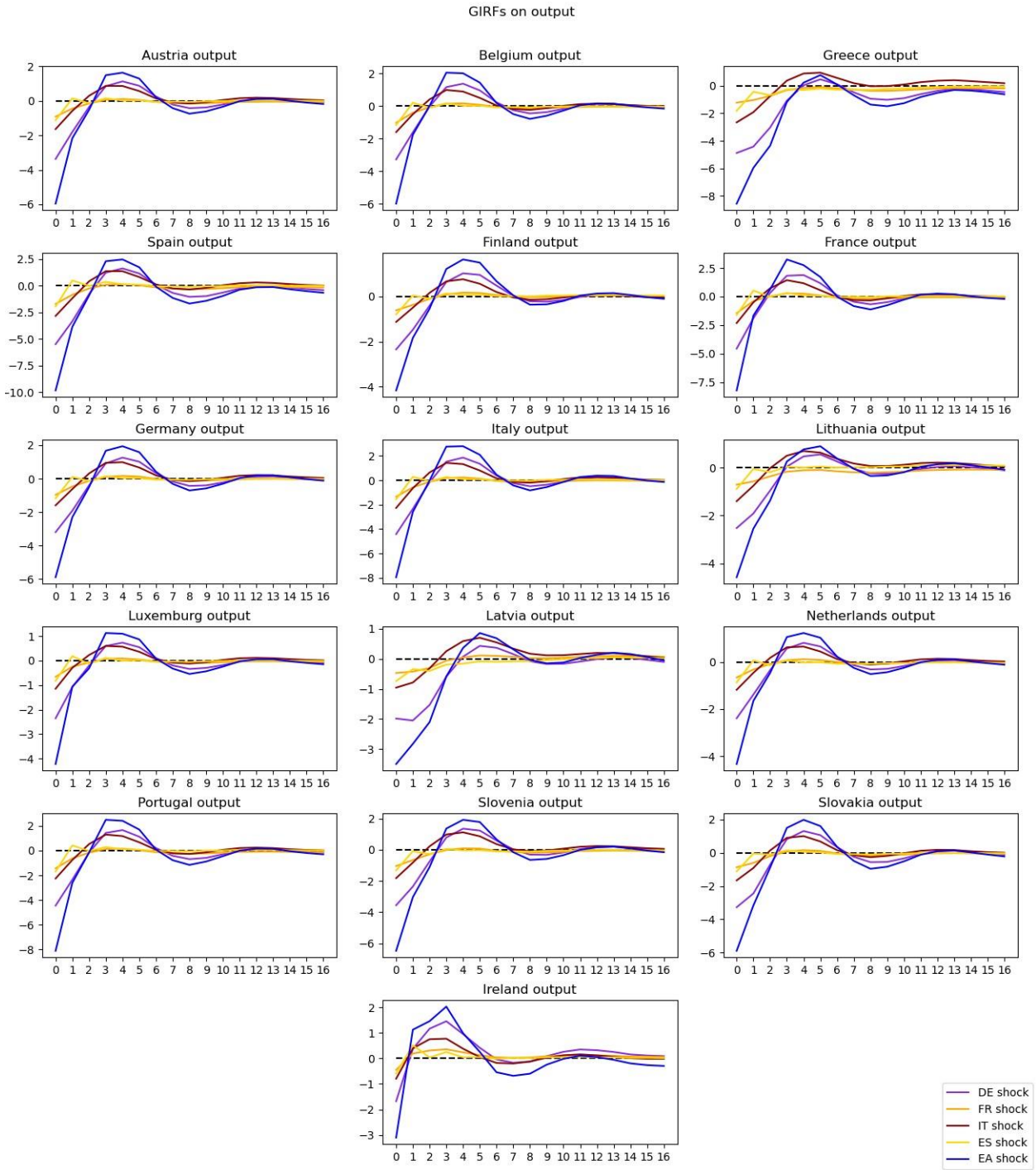

Figure OI1: Alternative 2: GIRFs on output. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

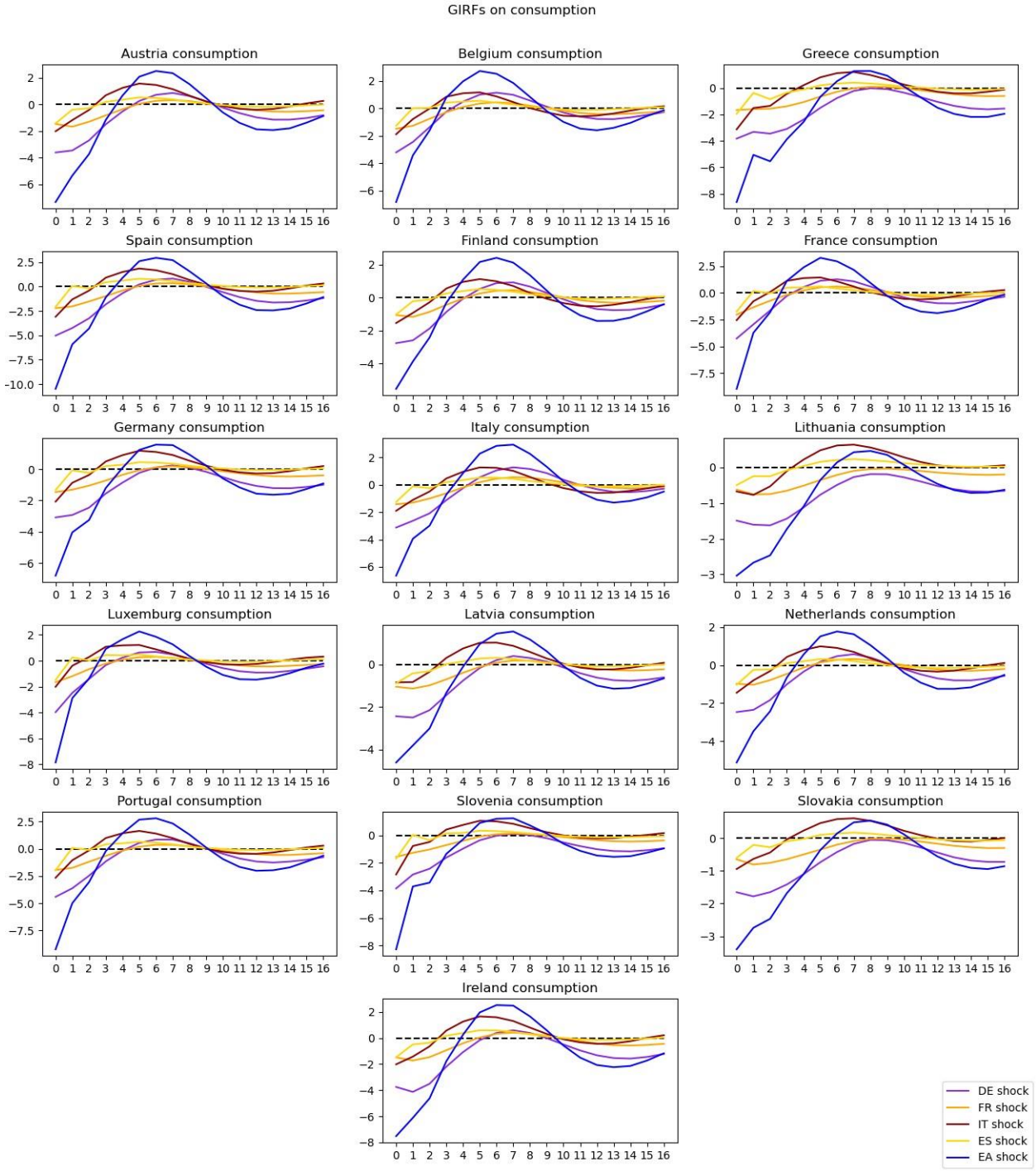

Figure OI2: Alternative 2: GIRFs on consumption. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

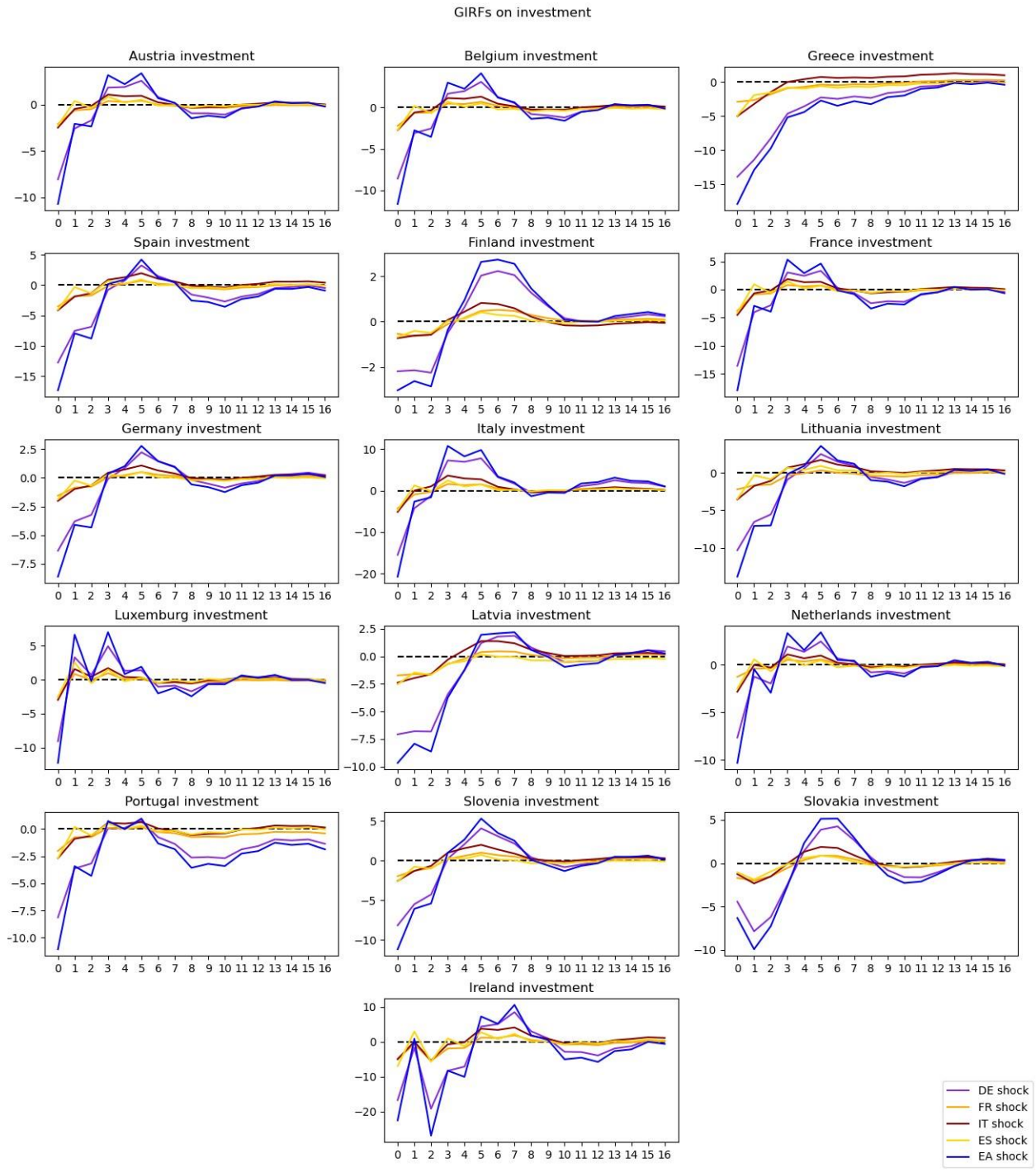

Figure OI3: Alternative 2: GIRFs on investment. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

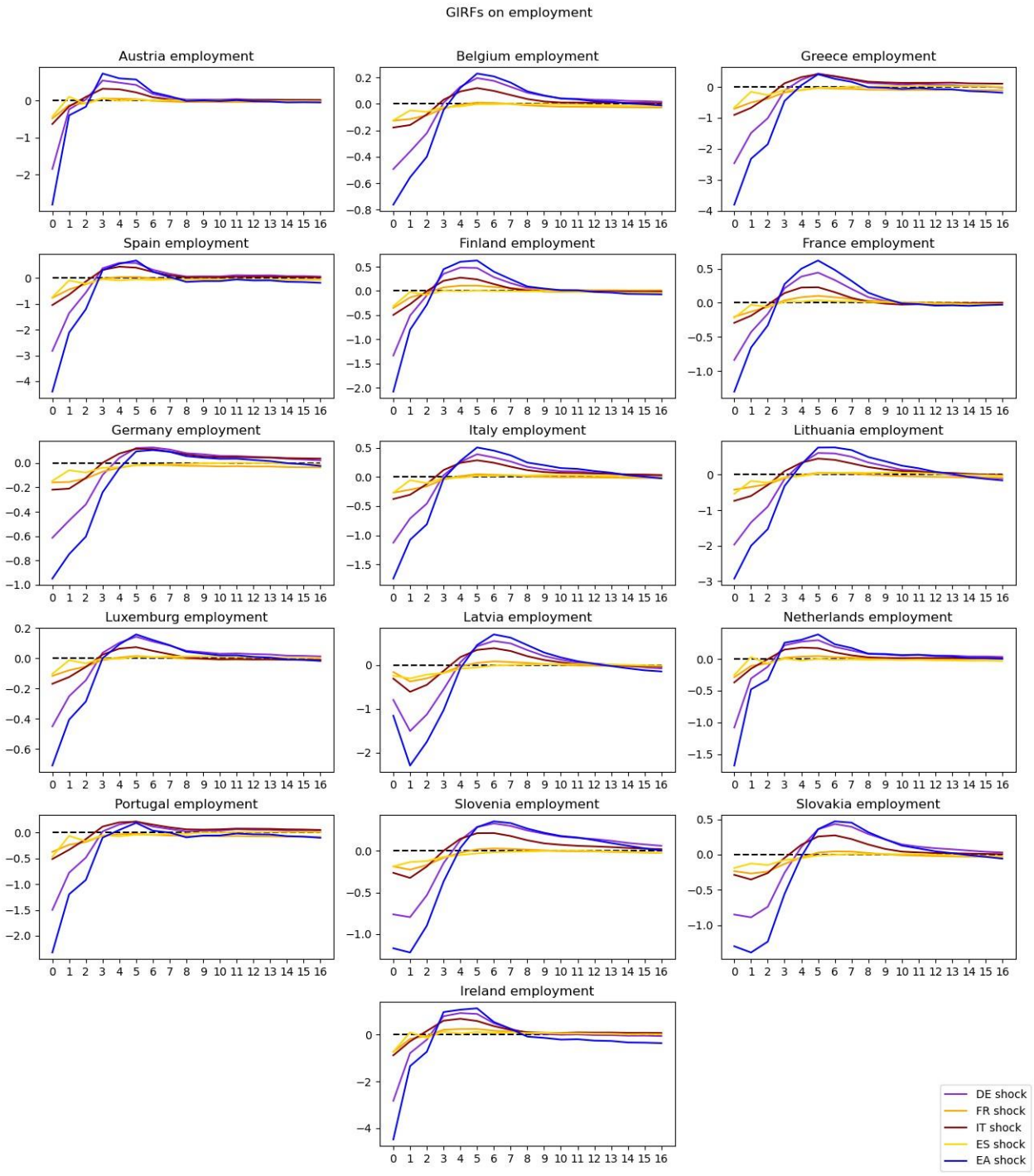

Figure OI4: Alternative 2: GIRFs on employment. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

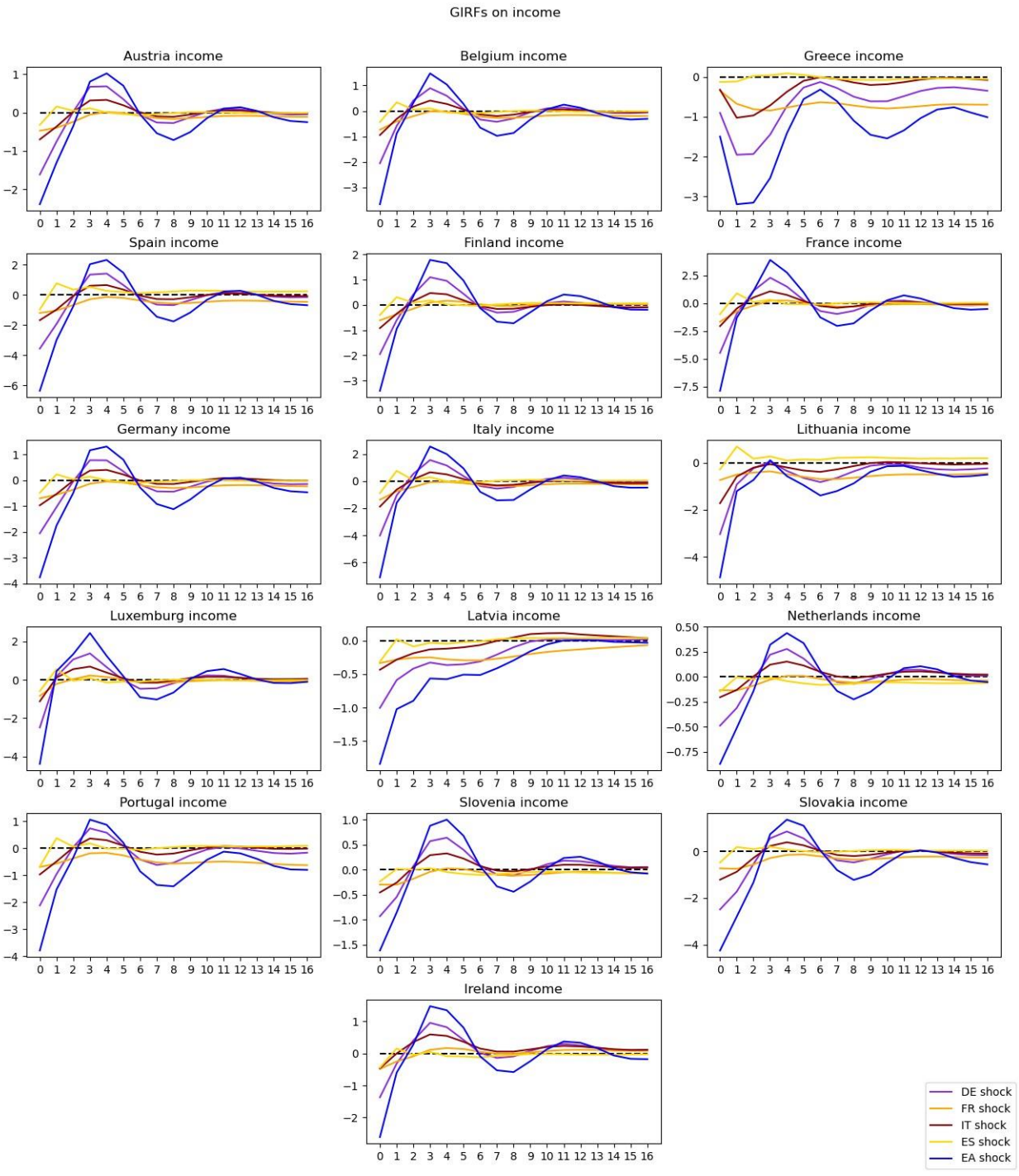

Figure OI5: Alternative 2: GIRFs on income. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.

OJ - Alternative 3: GIRFs on output

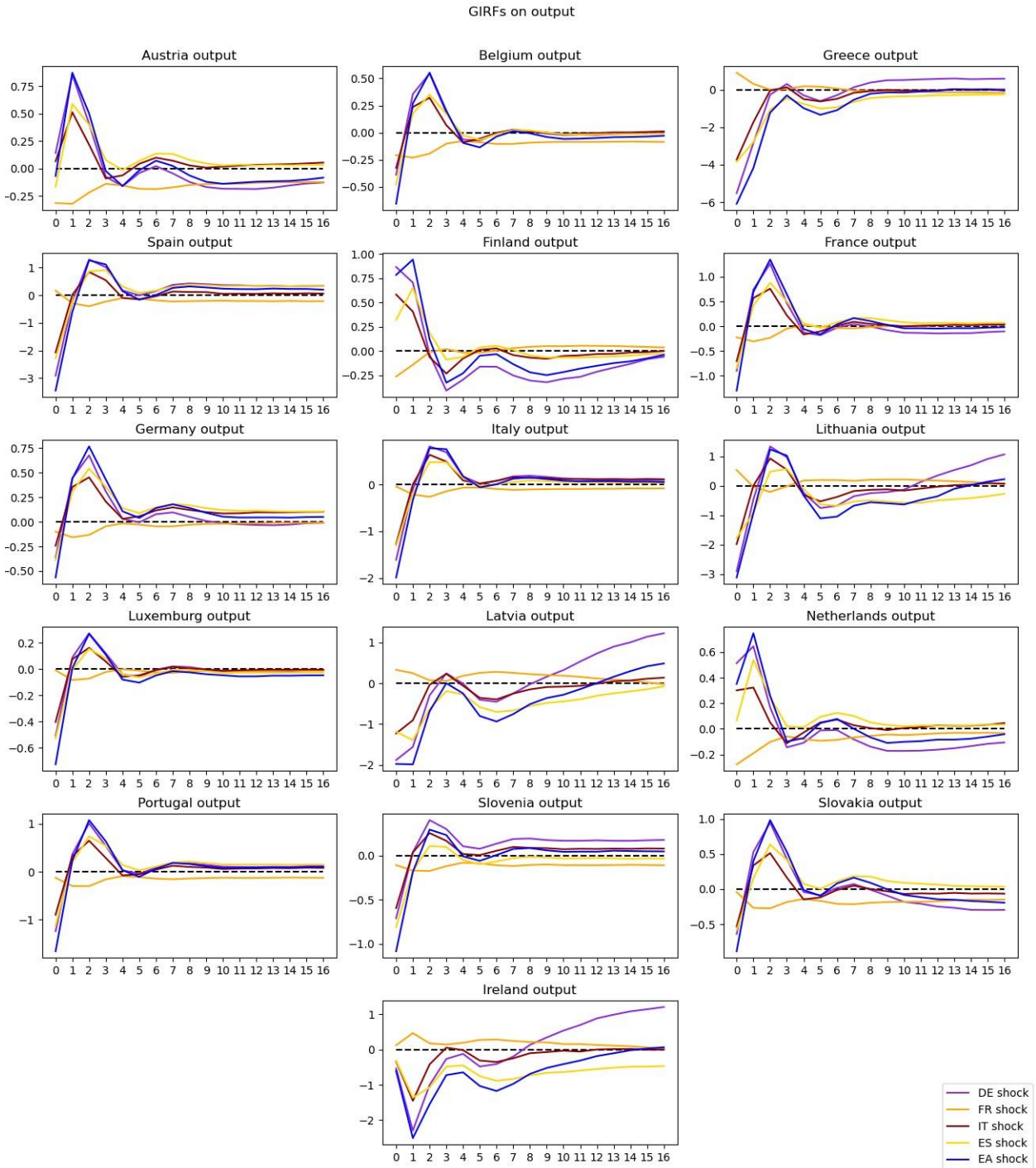

Figure OJ1: Alternative 3: GIRFs on output. All values are reported in percentage and correspond to the bootstrap median estimates after 2500 replications.