European Trade and Growth Imbalances: A Sign-Restriction GVAR Analysis*

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Abstract

The accumulated, persistent trade and economic imbalances between the South euro area (SEA) and the North euro area (NEA) countries brought about severe strains for the euro following the global financial crisis of 2008. This paper assesses alternative scenarios suggested to restore the trade imbalances within the euro area. We employ a structural Bayesian Global VAR in which theory-consistent long- and short-run restrictions are imposed. Empirical results show that a depreciation of the SEA real exchange rate and/or a reduction of the SEA unit labor cost can lead to an improvement of the SEA trade balance through an increase in exports. Evidence also emerges that a negative demand shock in the SEA can also ameliorate the SEA trade balance by boosting exports and reducing imports. Among the policies that could restore trade imbalances in the SEA, austerity is less painful in terms of adjustment to long-run equilibrium. Counterfactual analysis signal that if policies – improved competitiveness and/or austerity in SEA – were pursued prior to 2010 the European debt crisis could have been averted. Finally, a simple loss function exercise shows that a persistent contractionary demand shock in SEA will maximize the welfare of pan-European social-welfare planer-policy maker.

Keywords: European North-South Divide; Global VAR; Structural Impulse Response Analysis.

JEL Codes: C33; E27; F14

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1 Introduction

A notable aspect of the global financial crisis from 2008 onward was that it brought into focus the divergent external imbalances between euro area countries. With the creation of the single currency a decade earlier, economic developments, by contrast, had seemed more benign: per-capita income convergence had been facilitated by increased financial integration, the compression of risk premia, and capital flows from the richer more capital-abundant north euro area (NEA) to the south (SEA). Accordingly, savings-investment correlations fell significantly at the start of the monetary union (Blanchard and Giavazzi, 2002) and current account balances were positively correlated with per capita income. However, this catch-up and convergence proved not sustainable. Productivity growth did not sufficiently materialize in the south since much of the expansion seeped through to residential investment and wages at the expense of the tradeable sector (van Ark et al., 2013; Chen et al., 2013). Complicating matters further was the containment of unit labor costs in the north tradeables sector (see Bettendorf and León-Ledesma, 2019) which provided a further boost to NEA trade surpluses. Consequently, given these demand and supply asymmetries, euro area countries took quite different paths, with Germany and other NEA countries gaining competitiveness and accumulating external assets and the SEA falling behind.

Why should such asymmetries matter in a monetary union? One reason is that these individual outcomes pose a systemic risk to the *whole* euro area since imbalances not only increase the vulnerability of the affected countries but also represent a hazard for neighboring countries given economic linkages. Imbalances may also impede the efficacy and independence of the single monetary policy. Indeed, precisely such fears played out in the subsequent sovereign debt crisis (Lane, 2006, 2012) with financial contagion and negative demand spillovers and large financial assistance programs implemented. Accordingly many saw the global financial crisis, allied with the build up of these imbalances, as an existential threat to the euro.

These developments can be gauged from Figure 1a, which shows the diversity of global trade conditions in 2019: with Brazil, Canada, India and the US experiencing deficits in contrast to Australia, China and Germany. Regarding the euro area, there is something of an even split with Austria, Belgium, Finland, Netherlands and (notably) Germany in surplus while Spain, Italy, Greece and Portugal in deficit. In addition, Figure 1b shows the recent adjustment in the euro area where we observed that all SEA countries have positively improved while there is a current account deterioration in Ireland.[1] Table 1 also shows the stark evolution of unit labor costs (ulc) and accumulated inflation across countries.

[1]More formally, Italy, Spain and Portugal have a current account surplus while Greece has deficit which however is lower than the deficit prior to 2008.

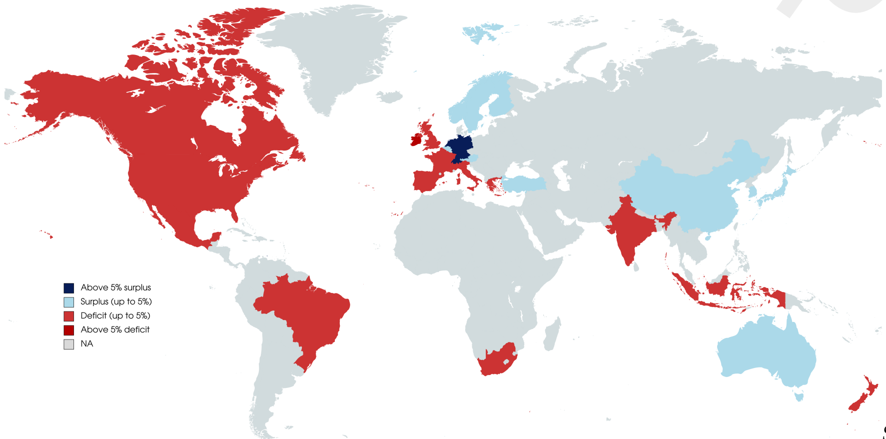
TABLE 1: Cumulative current account balances, unit labor costs and inflation, 1999-2012

Country	△ ulc	Infl.	Country	△ ulc	Infl.	Country	△ ulc	Infl.
Austria	−1.5	26.4	Netherlands	4.2	30.3	Belgium	8.0	29.9
Ireland	−22.5	32.1	Finland	−19.9	26.4	Italy	28.5	30.9
France	2.4	24.5	Portugal	11.1	35.1	Germany	1.4	21.8
Spain	24.8	38.4	Greece	54.9	43.4			

Source: IMF WEO for CPI inflation, OECD MEI for unit labor costs (denoted △ ulc).

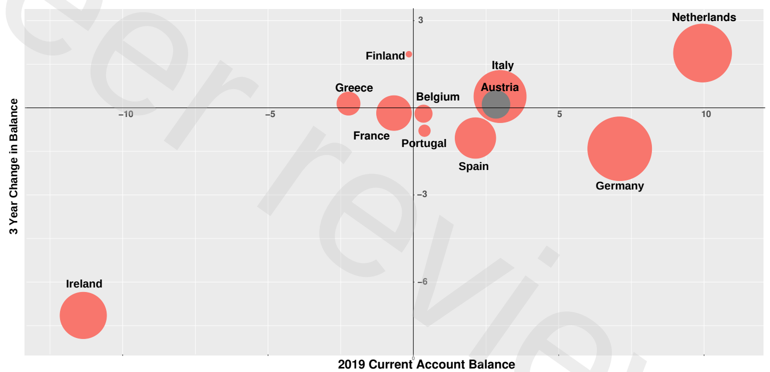
FIGURE 1: Current Account Balance, 2019

(A) Current Account Balance, 2019



Source: OECD, current account balance as percentage of the GDP. Countries marked in **dark blue** (**dark red**) exhibit a current account **surplus** (**deficit**) greater than 5% of their GDP.

(B) Euro area Current Account Balance Adjustments: 2016-2019



Source: IMF WEO.
Notes: The vertical axes shows the 3-year change in net exports (2016-2019). The horizontal axis shows the net exports in 2019. The countries are ranked by their share to global imbalances (in absolute value) in 2019. The size of the bubble is based on the aforementioned ranking.

Need less to say, the financial crisis and the subsequent sovereign debt crisis incited a lively debate in academic and policy circles on how to address these deep-rooted trade imbalances. Notably, though, little attempt has been made to evaluate remedial policies by linking them closely to an underlying open economy macroeconomic model (OEM). For example, policy recommendations made by Jaumotte and Sodsriwiboon (2010) and Chen et al. (2013) were driven by empirical results based on an econometric exercise rather than testing the policy implications of an OEM. Even the macroeconomic imbalance procedure, introduced by the European Commission in 2011, aimed to identify and prevent potentially harmful macroeconomic imbalances, was based on judgment from several indicators rather than on rules implied by a theoretical model. This certainly does not detract from their analyses, but it does suggest that there exists a gap in the literature as regards a more structural complementary analysis of the topic.

And yet theory has an important role to play in the debate. Indeed arguably the development of persistent trade imbalances within the euro area could be explained by, and attributed to, two distinct growth models. On the one hand, SEA countries such as Greece, Portugal, Spain and Italy rely more on domestic consumption as a mechanism of economic growth. Alternatively, NEA countries like Germany, Austria, Belgium, Finland and Netherlands adopted policies that promote export led growth, which led to increase savings and lending.[2] Evidence of the TFP decline in the SEA between 2000-2008 and the persistence of nominal rigidities, however, raises questions about the coexistence and sustainability of those two growth models in the monetary union.[3] Although, productivity in SEA declined after 2000 and prior to the financial crisis, Chen et al. (2013) show that an over-valuation of the nominal exchange rate (ner) was a key factor behind the downturn of exports in SEA.[4] However, country-specific ner depreciation is not an available instrument in a monetary union and *real* exchange rate depreciation tends to be a protracted and economically costly process.[5]

Accordingly, we contribute to the discussion of the euro area current account adjustment mechanism by evaluating the view that positive demand shocks in the NEA accompanied by improvements in competitiveness in SEA can be used as an instrument to smooth trade imbalances across the two regions. We also assess the suggestion that contractionary demand shocks in SEA can be used to restore trade imbalances.

Our study differs from the existing literature in three main respects. First, unlike that literature, which largely set aside the multi-country dimension, we explicitly adopt a framework which accounts for both

[2]Camarero et al. (2021) show that German fiscal policy has spillover effects on other European countries such as France and Spain.

[3]Giavazzi and Spaventa (2011) argue that empirical evidence do not fit the story portrayed by the classical convergence model where capital flows financing current account deficits of countries with expected rising GDP growth driven by soaring productivity. More formally, the declining TFP in three out of four cohesion countries – Greece, Portugal, Spain and Italy – was a signal of curtailed future GDP growth and living standards.

[4]Chen et al. (2013) argue that while trade shocks would have required the *real* exchange rate depreciation to restore long-run trade sustainability, intra-euro area capital inflows allow deficit countries to maintain an appreciating real effective exchange rates, which were driven mainly by nominal appreciation of euro.

[5]Jaumotte and Sodsriwiboon (2010) argue that a current account deficit, in a monetary union, generated by loss of competitiveness can be re-established by an automatic build-in-adjustment process known as competitiveness channel: lengthy recessionary forces that help restoring competitiveness via lower inflation.

the inter-linkages across regions and the global unobserved macroeconomic factors.[6] More formally, we use a Bayesian structural Global VAR (**GVAR**) which allows us to account for spillover effects of structural shocks emanating from both regions: NEA and SEA (28 countries).[7] Moreover, the BVAR, compared to say maximum likelihood, makes estimation easier when there are non-linearities in the data. Another advantage is that it explicitly accounts for parameter uncertainty, and using the stochastic search variable selection (SSVS) method (described below), also accounts for model uncertainty.[8]

Second, we disentangle *structural* shocks by imposing theory consistent long- and short-run restrictions. In particular, based on the characteristics of each region, we impose the long-run restrictions implied by the Export- and Import-Led Growth Hypotheses. We also impose short-run restrictions implied by Corsetti and Müller (2006) and Corsetti et al. (2008). These imply sign restrictions to account for the income and substitution effects pursued by a depreciation/appreciation of the real exchange rates (rer).[9] Third, we account for the impact of and inherent uncertainty of the financial crisis by allowing the importance of the variables to change across time. We do so by using the aforementioned SSVS approach suggested by George et al. (2008). This is natural since clearly the shocks at play were unusually large and asymmetric.

We simulate numerous scenarios using structural IRF analysis (see summary Table 2). These structurally-identified shocks are not intended to represent corrective policy packages per se, but more to understand the underlying mechanisms by which identified shocks impact trade imbalances and macroeconomic stability. *First*, we investigate the role of a **positive supply shock in the NEA** as an adjustment mechanism of euro area trade imbalances. The aim being to assess the view that a positive supply shock in the NEA accompanied by a subsequent depreciation of the SEA rer can alleviate SEA trade deficits.[10] *Second*, we examine the view that **a positive demand shock in the NEA** can lead to a symmetric adjustment of trade imbalances between the NEA and the SEA (using a positive NEA real import shock to proxy a NEA demand shock).

In a *third* scenario, we simulate the impact of a **SEA** rer **depreciation** shock. In doing so, we intend to evaluate the argument that accumulated current account deficits in the SEA were the byproduct of a loss of competitiveness.[11] Note that a depreciation of the rer can be achieved either via a depreciation of the ner or a reduction of unit labor costs (ulc). To disentangle the role of ulc from the impact of ner on trade balance, we compute the effects of rer shocks without accounting for the importance of ulc. We call this

[6]For example, Chinn and Prasad (2003) used panel regressions ignoring any static and dynamic interdependence across the countries included in their analysis.

[7]Chisiridis et al. (2022) and Bussière et al. (2012) also use a GVAR approach but their impulse response function (IRF) analysis were based on reduced form models. The seminal text on the GVAR framework is di Mauro and Pesaran (2013).

[8]Koop and Korobilis (2010) and Korobilis (2013) demonstrated the use of SSVS as an efficient dynamic model average approach in a forecasting framework.

[9]Corsetti and Müller (2006) and Corsetti et al. (2008) shows that a positive output or expansionary demand shock can lead to a depreciation of the rer. See also Bussière et al. (2021).

[10]Corsetti et al. (2008) show that a positive supply shock and home bias of domestic consumption can initially generate an appreciation of the rer, which in the long-run will switch to a depreciation.

[11]Giavazzi and Spaventa (2011) show that prior to the financial crisis, there was a declining TFP in Spain, Italy, Portugal, and Ireland.

restricted model. Then, we extent the model by adding the ulc (the unrestricted model) and simulate the influence of ulc on the trade balance conditional on the rer. In doing so, we can infer the effect of ner changes on trade balance by comparing the responses of rer and ulc to a shock emanated from RER. We also consider the role of a negative – i.e., a fall – SEA ulc shock as a means to boost SEA competitiveness and ameliorate trade imbalances in euro area. *Finally*, we assess the suggestion that a contractionary (fiscal) policy is needed, especially in a monetary union, in countries with low public savings, which was the case for the SEA countries prior to the financial crisis. We do so by considering a **negative SEA import shock** and imposing the restrictions implied by Corsetti and Müller (2006): a negative demand shock will lead to a depreciation of the rer; decline of investment; increase of exports; and reduction of imports.

TABLE 2: Summary of examined scenarios

#	Scenario
I.	Positive supply shock in NEA
II.	Positive demand shock in NEA
III.	Depreciation in SEA real exchange rate
IV.	Negative unit labor cost shock in SEA
V.	Negative import shock in SEA

The analysis is conducted using quarterly data from the 1980Q1 to 2019Q4, on the Bayesian structural GVAR framework. Our results provide five main policy implications.

First, a depreciation of the SEA rer, part of which is driven by a reduction of ulc, can lead to a persistent increase of exports without having any substantial impact on imports.[12] Alternatively, a fall of the SEA ulc can also lead to improvement of the trade balance by increasing exports.

Second, there is strong (i.e., a highly persistent and quantitatively large) evidence that a negative demand shock in the SEA leads to a fall of ulc and depreciation of the rer, which in turn increases exports and reduces imports. Therefore, our results suggest that both a depreciation of the rer and/or a contractionary demand (fiscal) shock can be used as a means to restore trade imbalances in SEA sustainably.[13]

Third, there is evidence that among the policies that could restore trade imbalances in the SEA, austerity is less painful in terms of adjustment to long-run equilibrium. More formally, analysis of persistence profiles show that the speed of adjustment of variables to their long-run equilibrium following a negative demand shock is quicker than the speed of adjustment of any other shock considered in our analysis.

Fourth, a simple loss-function exercise is consistent with the view that a persistent contractionary demand

[12] This reflects the substitution and income effects explained by Corsetti et al. (2008). The former will switch demand from foreign to domestically produced goods while the latter will lead to lower relative domestic income, which in turn will reduce domestic demand for foreign goods

[13] The second result is consistent with the suggestion of Jaumotte and Sodsriwiboon (2010).

shock in SEA will maximize the "welfare" of pan-European policy maker. There is also evidence that expansionary import shock in SEA can maximize the pan-European welfare. However, in the later case, trade imbalances in SEA will be ameliorated only through a country-specific depreciation of the ner, which is not a feasible instrument in a monetary union.[14]

Finally, a counterfactual analysis shows that if policies that improve competitiveness or control demand in SEA had been pursued before 2010, the European debt crisis could potentially been averted.

Organization Section 2 presents the econometric methodology behind our use of GVAR modeling and the means of identifying structural shock using theory-consistent sign restrictions. Section 3 discusses the data, the empirical restrictions in the model and motivates the simulation choices. Section 4 discusses empirical results. Finally, we conclude. Additional material is in the appendices.

2 Econometric methodology

A fundamental problem to analyze spillover effects of shocks in a multi-country framework is the curse of dimensionality. As such, we employ a GVAR model which allows to examine the spatial propagation and the time dynamics of structural shocks.[15] We do so, by identifying structural shocks using theory-consistent sign restrictions extracted from Corsetti and Müller (2006) and Corsetti et al. (2008).

Although the inclusion of foreign variables in the GVAR soothes the curse of dimensionality, the number of parameters can increase quickly by including more variables in the country-specific VARX* or/and increasing the cross-sectional units. Furthermore, a GVAR builds on the estimation of homogeneous country-specific submodels.[16] However, our research question aims to investigate the key differences across the euro area countries. Therefore, it is imperative to *relax* the assumption of homogeneity and account for individual country characteristics. Here, we take into account the uncertainty about the variable included into country-specific model by using Stochastic Search Variable Selection (SSVS) approach introduced by George et al. (2008).[17] Furthermore, we adopted a framework suggested by Dovern et al. (2016) and estimate a GVAR where the variance covariance matrix of country-specific error term is non constant. More formally, we follow

[14] We did observed that while in the restricted model – without ulc – a positive NEA import shock improved the trade balance of SEA, once the ulc is introduced the SEA trade balance remained unresponsive to NEA import shock. This implies that an appreciation of NEA ner followed by a positive demand shock was offset by a reduction of NEA ulc.

[15] FAVAR and panel VAR (PVAR) models have been suggested in the literature to account for cross-sectional dependence. However, while PVAR models do not account for dynamic cross-sectional heterogeneity and FAVAR models summarize the information of large number of variables in a small number of factors, which is difficult to identify. Furthermore, Pesaran (2015) argues that FAVAR can not be estimated consistently when the cross-sectional dimension is large.

[16] The literature of GVAR tends to assume, driven by data availability, that submodels are homogeneous concerning the variables included in the model. Note that some papers such as Georgiadis (2015) depart from this and specify VARs somewhat differently across countries.

[17] However, unlike the traditional SSVS prior suggested by George et al. (2008), we followed Dovern et al. (2016) and adopt a conjugate SSVS specification, which either includes or excludes a given explanatory variable in all equations of a specific country-model. In doing so, we preserved the observed heterogeneity between SEA and NEA economies.We also consider the heterogeneity between the euro area countries and the rest of the countries included in our analysis.

Carriero et al. (2012) and Huber (2016) and assume that the error terms follow a stochastic volatility process. In doing so, we use a general framework which accounts both for model uncertainty and for non-linearities associated with large shocks typically observed in period of financial and debt crisis.[18,19]

2.1 GVAR model

The GVAR, first put forward by Pesaran et al. (2004) and extended substantially by Dees et al. (2007) consists of two steps. The first takes into account cross-sectional heterogeneity by estimating individual VARX$^*(p,q)$ models for each country included in the global model.[20] In the second step, the individual country models are stacked into a global model that can be used to trace dynamic propagation of shocks emanated by an individual country to the rest of the model.

We consider the general case of VARX$^*(p_i,q_i)$ for the country i where $i = 0, 1, ..., N$, where $i = 0$ stand for the numeraire country:

$$x_{it} = a_{i0} + a_{i1}t + \sum_{j=1}^{p_i} \Phi_{ij} x_{i,t-j} + \sum_{j=0}^{q_i} \Lambda_{ij} x^*_{i,t-j} + \sum_{l=0}^{1} \delta_i d_{t-l} + u_{it} \tag{1}$$

where x_{it} is a $k_i \times 1$ vector of country-specific endogenous variables and x^*_{it} is a $k^*_i \times 1$ vector of country-specific foreign variables. Specifically, x^*_{it} are given by:

$$x^*_{it} = \sum_{j=1}^{N} w_{ij} x_{jt}$$

where the trade weights $w_{ij} \geq 0$ represents the share of country j to the total trade of country i such that $\sum_{j=1}^{N} w_{ij} = 1$, $w_{ii} = 0$ and $w_{ij} \geq 0$. Furthermore, in (1), a_{i0} and a_{i1} are $k_i \times 1$ vectors of intercept terms and trend coefficients, respectively. Φ_{ij} are the matrices of coefficients for the lagged values of the endogenous variables associated with country i. Λ_{ij} denote the matrices of coefficients for the foreign variables. d_t is a vector of global variables (i.e. oil price) and δ_i a $k_d \times 1$ vector of their respective coefficients. The white noise process $u_{it} \sim \mathcal{N}(0, \Sigma_{it})$ is the vector of country-specific shocks. Based on Carriero et al. (2012) and Huber (2016) we consider the following stochastic volatility model:

$$\Sigma_{it} = \exp(h_{it}) \times \Sigma_i$$
$$h_{it} = \mu_i + \rho_i(h_{it} - \mu_i) + \eta_i \ \text{ with } \ \eta_{it} \sim \mathcal{N}(0,1)$$

[18]The use of SSVS has been widely used in forecasting literature to address issues of model uncertainty, while stochastic volatility used to model external uncertainty due to large shocks materialized during period of crisis

[19]Sims and Zha (2006) show that neglecting changing volatility will lead to a model with time-varying parameters.

[20]Note that a PVAR imposes cross-sectional homogeneity.

where h_{it} is the country-specific volatility, μ_i is the unconditional variance, ρ_i is an auto-regressive parameter and η_i is the variance of the log volatility.[21] In addition, we assume that $E(u_{it}u_{js}) = \Sigma_{ijt}$ for $t = s$ and $E(u_{it}u_{js}) = 0$ for $t \neq s$. We implement a Bayesian version of the GVAR as introduced by Cuaresma et al. (2016) and modified by Dovern et al. (2016).[22]

For prior implementation, it is convenient to write (1) in a compact form:[23]

$$X_{it} = \Gamma_i Z_{it} + u_{it}$$

where $Z_{it} = (1, t, x'_{i,t-1}, x^{*\prime}_{i,t}, x^{*\prime}_{i,t-1}, d_{t-1})'$ is a K_i-dimensional vector, where $K_i = 2 + k_i + 2k_i^* + k_d$ and $\Gamma_i = (a_{i0},\ a_{i1},\ \Phi_{i1}, \Lambda_{i0},\ \Lambda_{i1}, d_1)$ is a $k_i \times K_i$ matrix of coefficients, which is vectorized as $\Psi_i = vec(\Gamma_i)$. Implementation of stochastic volatility it is straightforward by dividing x_{it} and Z_{it} by $\exp(\frac{h_{it}}{2})$. We denote the normalized matrices as $\widetilde{x}_{it}$ and $\widetilde{Z}_{it}$. Following Carriero et al. (2012), we respectively impose a multivariate Gaussian prior on Ψ_i and a Wishart prior on Σ_{ui}^{-1}:[24]

$$\Psi_i|\Sigma_{ui}^{-1}, \gamma_i \sim \mathcal{N}(\underline{\Psi}_i, \Sigma_i \otimes \underline{V}_{\Psi_i})$$

$$\Sigma_{ui}^{-1} \sim \mathcal{W}(\underline{\nu}_i, \underline{S}_i)$$

where $\gamma_i = (\gamma_{i1}, \gamma_{i2}, \ldots, \gamma_{iK_i})'$ is a vector of binary variables such as the elements of diagonal matrix $\underline{V}_{\Psi_i}$ are given by

$$v_{ij} = \begin{cases} \tau_{0,ij} & \text{if} \quad \gamma_{ij} = 0 \\ \tau_{1,ij} & \text{if} \quad \gamma_{ij} = 1 \end{cases}$$

assuming that $\underline{\Psi}_i$ is a vector of zeros, the SSVS impose a mixture of Normals on each coefficient j of Ψ_i :

$$\Psi_{ij}|\gamma_{ij} \sim (1 - \gamma_{ij})\mathcal{N}(0, \tau_{0,ij}) + \gamma_{ij}\mathcal{N}(0, \tau_{1,ij})$$

where $\tau_{0,ij}$ and $\tau_{1,ij}$ are prior variances such as $\tau_{0,ij} < \tau_{1,ij}$. If γ_{ij} equals zero then Ψ_{ij} is drawn from the first distribution and and if it equals one it is drawn from the second. By choosing $\tau_{0,ij}$ to be 'small', the variable j is constrained to be excluded from all equations of country i while the choice of large value for $\tau_{1,ij}$ implies a relative non-informative prior for the corresponding coefficient. The posterior distribution is built from a sample of $25,00$ draws as follows. First, we use $5,000$ burn-in draws and then we build the posterior sample from $25,000$ replications by keeping every 10$^{\text{th}}$ draw.[25]

[21]Dovern et al. (2016) show that to identify the model is sufficient to set $h_{it} = 0$.

[22]Cuaresma et al. (2016) assume that variance covariance of u_{it} is constant.

[23]Here to enhance clarity in the algebra, we restrict formulas to VARX*(1,1). In practice we employ a VARX*(2,1).

[24]Dovern et al. (2016) and Cuaresma et al. (2016) also use the same priors.

[25]We assess convergence of the Markov chains by using the test proposed by Geweke (1992). The results indicate that after $5,000$

Next, the $N+1$ country-specific models are stacked to derive the global model. Equation (1) is transformed into:

$$A_{i0}z_{it} = \sum_{l=1}^{p} A_{ij}z_{i,t-j} + \phi_{it} + u_{it} \tag{2}$$

where $p = \max(p_i, q_i)$, $z_{it} = (x'_{it}, x^{*\prime}_{it})'$ is a $k_i + k^*_i$ dimensional vector, $A_{i0} = (I_{ki}, -\Lambda_{i0})$, $A_{ij} = (\Phi_{ij}, \Lambda_{ij})$, $\phi_{it} = a_{i0} + a_{i1}t + \sum_1^{l_i} \delta_i d_{t-1}$.[26] Note that by using the $(k_i + k^*_i) \times k$ link matrix $W_i = [E'_i, \widetilde{W}'_i]$, where E_i and $\widetilde{W}_i$ are $k \times k_i$ and $k \times k^*_i$ dimensional selection matrices respectively, we can write z_{it} in terms of a k-dimensional global vector $x_t = (x'_{0t}, x'_{1t}, \ldots, x'_{Nt})'$ where $k = \sum_{i=0}^{N} k_i$

$$z_{it} = W_i x_t : i = 0, \ldots, N$$

This allow us to write (2) as

$$A_{i0}W_i x_t = \sum_{l=1}^{p} A_{il}W_i x_{t-l} + \phi_{it} + u_{it} \tag{3}$$

Stacking each country-specific model in (3) leads to:

$$G_0 x_t = \sum_{l=1}^{p} G_l x_{t-l} + \phi_t + u_t \tag{4}$$

where $u_t = (u'_{0t}, u'_{1t}, \ldots, u'_{Nt})'$, $\phi_t = (\phi'_{0t}, \phi'_{1t}, \ldots, \phi'_{Nt})'$ and $G_l = \left[(A_{0l}W_0)', (A_{1l}W_1)', \ldots, (A_{Nl}W_N)'\right]$ for $l = 0, 1, 2, \ldots, p$. If G_0 is invertible, then we pre-multiply (4) by G_0^{-1} to obtain the GVAR model

$$x_t = \sum_{l=1}^{p} F_l x_{t-l} + \psi_t + \varepsilon_t \tag{5}$$

with $F_i = G_0^{-1}G_l$, $\psi_t = G_0^{-1}\phi_t$, $\varepsilon_t = G_0^{-1}u_t$ and $\Sigma_\varepsilon = G_0^{-1}\Sigma_u G_0^{-1\prime}$. Therefore, it is easily seen that G_0 reflects the contemporaneous effects across countries. The GVAR model (5) is solved recursively and used for the IRF analysis.

2.2 Identification of structural GVAR shocks

The reduced form residuals ε_t are associated with structural shocks v_t through the transformation $\varepsilon_t = G_0^{-1}B^{-1}v_t$.[27] Finding the structural shocks boils down to identifying the impact matrix B. We follow Eickmeier and Ng (2015) and Feldkircher and Huber (2016) and proxy B^{-1} by a $k \times k$ block diagonal

iterations the chain reached the stationary distribution. Thinning is used to account for auto-correlation among draws. Several sensitivity analyses were performed. First, we increased the number of burn-in draws. Second, we increased the size of posterior sample. Finally, we increased the thinning interval (the number of draws was also increased as to retain the same posterior sample size as the main model). The results remain qualitatively the same in all cases. The MCMC diagnostics are implemented for each variables available and for the shake of brevity, we do not present them but they are available on request.

[26] Define $\Phi_{il} = 0$ for $l > p_i$ and $\Lambda_{il} = 0$ for $l > q_i$.

[27] Note that we have used the reduced form residuals $u_{it} = B_i^{-1}v_{it}$, where B reflects the contemporaneous interaction among the endogenous variable: the impact matrix.

matrix $P = \text{diag}(P_0, P_1, \ldots, P_N)$, where P_i is the Cholesky factor of the variance-covariance matrix u_{it} for $i = 0, 1, \ldots, N$; $\text{Var}(u_{it}) = \Sigma_{ui} = P_i P_i'$.[28]

We set $i = 0$ to represent the numeraire country/region: in our case $i = 0$ is NEA or SEA. The IRF of the structural shock, at horizon H, will be given by $\Psi^H = \Phi^H G_0^{-1} P$ where Φ^H is obtained from the moving average representation of

$$BG_0 x_t = \sum_{l=1}^{p} BG_l x_{t-l} + B\phi_t + Bu_t$$

$$BG_0 x_t = \sum_{l=1}^{p} \widetilde{F}_l x_{t-l} + \widetilde{\phi}_t + v_t$$

where $\widetilde{F}_l$ is a matrix of structural parameters, v_t is a k-vector of orthogonal shocks with variance covariance matrix $\Sigma_v = \text{diag}(I_{k0}, \Sigma_{u1}, \ldots, \Sigma_{uN})$ and $B = \text{diag}(B_0, I_{k_1}, \ldots, I_{k_N})$.[29]

For the numeraire county/region, we identify the structural shock v_{0t} by multiplying P_0 by a randomly drawn $k_0 \times k_0$ orthogonal rotation matrix Q_0 such as the selected impulse matrix $B_0^{-1} = P_0 Q_0$ satisfies the theory consistent sign restrictions. To obtain a candidate rotation matrix, we draw Q_0 using the algorithm of Rubio-Ramirez et al. (2010). For each posterior draw, we consider 5000 tries to search for a rotation matrix that fulfills the set of sign restrictions.[30] However, Fry and Pagan (2011) show that sign restrictions do not lead to a unique identification of a shock, in the sense that a variety of models (i.e., Q_0) will satisfy the sign restrictions. Here, apart from the median response, we also use the 'Median Target' (MT) approach suggested by Fry and Pagan (2011) and we select among all qualified models the one which gives rise to the impulse response with the smallest distance to the median.

3 Data

Our empirical analysis is based on data from 1980Q1 to 2019Q4 for 28 countries. In line with our objectives, we divide the euro area countries into two regions: the NEA countries (Austria, Belgium, Finland, Germany and the Netherlands) and SEA countries (Greece, Italy, Portugal and Spain). The distinction between SEA and NEA is based on empirical regularities: the SEA countries experience higher inflation, over the convergence period, higher government debt and current account deficits. We choose not to include France and Ireland in any of the two regions because both countries are characterized by features that are present in both. Although, Ireland promoted export-led growth policies, domestic demand growth was the main driving

[28] Georgiadis (2015) accounted for immediate cross-country spillover effect by allowing the off-diagonal matrices of Σ_u to be non-zero. Although this setting is more general the channels of spillover effects become more complicated.

[29] Note that Σ_u has a block diagonal structure, which implies that immediate spillover effects across-countries are modest. This assumption can be justified by the quarterly frequency of the data. Recall that $\Sigma_\varepsilon = G_0^{-1} \Sigma_u G_0^{-1\prime}$. Therefore, we do not restrict the immediate spillover effects to be zero.

[30] For each shock we obtain 3000 rotation matrices on average.

force of government debt prior to the financial crisis. Alternatively, France enjoyed surpluses over the period 2000-2005 and deficits afterwards (Gros, 2012). All other countries in our sample are treated as separated entities. Therefore, our GVAR model includes 21 entities (see Table 3), which account for 80% of global GDP. The data sources for all variables used in the analysis are reported in Table B3 (see also Appendix B).

TABLE 3: Countries and regions in the GVAR model

NEA	SEA	Other
Austria	Greece	Australia, Brazil, Canada, China, France
Belgium	Italy	India, Indonesia, Ireland, Japan, South Korea
Finland	Portugal	Mexico, Norway, New Zealand, South Africa
Germany	Spain	Sweden, Switzerland, Turkey, UK, US
Netherlands		

In comparison to the existing literature on European trade imbalances, we increase the number of countries and the number of the endogenous variables. In particular, we construct a VARX* model including six endogenous variables: real output (y_{it}), real gross capital formation (gcf_{it}), real exports and imports (ex_{it}, im_{it}), the real exchange rate (rer_{it}) (defined as the ratio of domestic over foreign prices, with an increase showing an appreciation) and unit labor cost (ulc_{it}). We also consider four foreign variables (y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}) and one exogenous variable: the real oil price ($poil_t$).[31] We exclude imports (im^*_{it}) and exports (ex^*_{it}) from the foreign variables from the individual model due to the problem of multi-collinearity.[32] Therefore, the vectors of country specific and foreign variables are given by:

$$\boldsymbol{x}_{it} = (y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it})' \quad \text{and}$$
$$\boldsymbol{x}^*_{it} = (y^*_{it}, gcf^*_{it}, rer^*_{it}, poil_t)'$$

$\forall i = 1, \ldots, N-1$.

We treat the SEA/NEA as the numerate country (where $i = 0$) and following Dees et al. (2007) we treat oil prices as endogenous variables. We construct the foreign variables using fixed weights based on the trade shares of foreign countries in total export and imports over the period 2012-2019. The regional variables (NEA and SEA) were constructed based on a weighted average scheme for each individual country.[33] Table 4

[31] Note that the US vectors of domestic and foreign variables are:

$$\boldsymbol{x}_{0t} = (y_{0t}, gcf_{0t}, ex_{0t}, im_{0t}, rer_{0t}, poil_t)' \, and$$
$$\boldsymbol{x}^*_{\mathbf{0t}} = (y^*_{0t}, gcf^*_{0t}, rer^*_{0t})$$

See Table B1 for a detailed description of the variables included in all country-specific VARX models.

[32] Greenwood-Nimmo et al. (2012) point out that in a model that takes into account the majority of the world trade it holds that $ex_{it} = im^*_{it}$ (and vice-versa).

[33] Following the relevant literature, we employed average PPP-GDP weights over the period 2012-2019.

reports the trade weights used for the construction of the foreign variables and Table B2 (also Appendix B) reports the PPP-GDP weights used for the construction of regional variables.

Table 4: Trade weights of the GVAR Model

Country/Region	China	France	Japan	NEA	SEA	Sweden	UK	USA
China	.	0.01	0.08	0.23	0.02	0.00	0.02	0.36
France	0.01	.	0.08	0.44	0.22	0.01	0.07	0.08
Japan	0.04	0.02	.	0.09	0.02	0.00	0.02	0.27
NEA	0.00	0.14	0.30	.	0.17	0.08	0.11	0.19
SEA	0.06	0.15	0.01	0.43	.	0.01	0.07	0.06
Sweden	0.00	0.05	0.01	0.46	0.07	.	0.07	0.07
UK	0.01	0.25	0.01	0.27	0.07	0.01	.	0.12
USA	0.17	0.02	0.03	0.09	0.02	0.00	0.03	.

Notes: Trade weights based on data from the IMF's Direction of Trade Statistics. Each line of the table presents the trade share of foreign countries in the domestic country's trade (exports and imports) over the period 2016-2019. We do no report trade weights for all countries.

3.1 Identification of long-run relationships in the GVAR

We adopt the approach suggested by Garratt et al. (2012) and estimate (1) flexibly within a VECMX* framework:

$$\mathbf{\Delta x}_{it} = \mathbf{c}_{i0} - \alpha_i \beta_i' [\mathbf{z}_{i,t-1} - \mathbf{d}_{i,t-1} - \gamma_i (t-1)] + \mathbf{\Gamma}_i \mathbf{\Delta x}_{i,t-1} + \mathbf{\Lambda}_i \mathbf{\Delta x}^*_{it} + \delta^*_{i0} \mathbf{\Delta d}_t + \delta^*_{i1} \mathbf{\Delta d}_{t-1} + \mathbf{u}_{it} \quad (6)$$

where α_i is a $k_i \times r_i$ matrix of rank r_i and $\beta_i = (\beta'_{ix}, \beta'_{ix^*}, \beta'_{id})'$ is a $(k_i + k_i^* + m_d) \times r_i$ matrix of rank r_i. In this set up, we can impose and identify theory-consistent long-run relationships.[34] In particular, we identify long-run relationships that are consistent with the two growth models adopted in NEA and SEA respectively: Export-Led Growth Hypothesis (ELGH) and Import-Led Growth Hypothesis (ILGH).[35]

Assuming a log-linear production function that depends on both imported goods and exports, we can test for the presence of ELGH in the cointegration space:[36]

$$y_{it} = c_i + c_{1i} gcf_{it} + c_{2i} ex_{it} + c_{3i} im_{it} \quad (7)$$

[34] Garratt et al. (2012) argue that although there is a degree of consensus regarding the long-run relationships implied by economic theory there is less agreement on how to model short-run dynamic adjustments.

[35] Proponents of ELGH such as Balassa (1978) and Feder (1982) among others argue that export-oriented policies can promote economic growth due to high productivity of tradeable sector, economies of scales, greater utilization of resources and expanded base of aggregate demand. Alternatively, advocates of ILGH argue that the ELGH overlooks the impact of imports on economic growth. For example, Rivera-Batiz and Romer (1991) and Esfahani (1991) show that imports of intermediate goods and of technologies can boost domestic economic growth.

[36] For further details concerning the form of production function and the derivation of ELGH and ILGH see Esfahani (1991) and Feder (1982).

If condition (7) is rejected by the data, we also test for the Enhanced Trade Equation (ETE) suggested by Bussière et al. (2012). The ETE extends the traditional import and export volume equations, which feature only demand and relative prices terms by also including foreign output and rer. The ETE accounts for the role that imports play on the production of exports (i.e. imported goods can be used as intermediate inputs for the production of exported goods) and vice versa (i.e., exports could be part of the imported goods because part of the exported goods are outsourced abroad). Therefore, ETE implies a cointegration among exports, imports and the traditional demand and relative prices variables. We also examine the presence of cointegration between the volumes of exports and imports. Table 5 presents the cointegrating relationship considered in our GVAR model.

TABLE 5: Long-run relationships in the GVAR analysis

Relation:	
Export-Led-Growth Hypothesis:	
$y_i - c_{1_i} gcf_i - c_{2_i} ex_i - c_{3_i} im_i$	$\sim I(0)$
Exports equation (ETE):	
$ex_i - a_{1_i} im_i - a_{2_i} y_i^* - a_{3_i} rer_i$	$\sim I(0)$
Imports equation (ETE):	
$im_i - b_{1_i} ex_i - b_{2_i} y_i - b_{3_i} rer_i$	$\sim I(0)$
Stationarity of Trade Balance:	
$ex_i - im_i$	$\sim I(0)$

Identification of the cointegrating vector has important implications for the stability of GVAR, IRF and the shape of persistent profiles (PPs). We account for possible misspecification of cointegrating vectors by following the three-step parsimonious approach suggested by Bussière et al. (2012).[37] In the first step, we estimate the number of cointegrating vectors based on the full-VARX* model. In the second step, only a selected subset of country-specific variables are estimated jointly.[38] In the third and final step, we impose only those cointegrating relations that satisfy certain criteria: they are consistent with the underlying long-run restrictions of our analysis; exhibit satisfying PPs; and the likelihood-ratio test (LR) accepts the over-identified restrictions.[39]

Table 6 presents the imposed cointegrating vectors along with the likelihood results of over-identification restrictions. We observed that the null hypothesis of all the imposed over-identification restrictions have

[37]Bussière et al. (2012) show that for high dimensional VAR – VAR(9) – the number of cointegrating vectors is sensitive to the order of lags.

[38]For example, we test for stationarity of trade balance in a one-variable system.

[39]The PPs show the time profile of the effects that a system wide or variable-specific shock has on the cointegrating relations in the GVAR. The value of these PPs is unity on the impact and converge to zero as the forecast horizon increases, if the imposed cointegrating vector is valid.

Table 6: Over-identified long run restrictions in the GVAR model

Country/ Region	Imposed Restrictions	LR	Vectors Identified
Australia	$y - \underset{(0.0793)}{1.53}gcf - \underset{(0.0989)}{0.47}ex + \underset{(0.1280)}{0.92}im$	24.57^{***}	1
Canada	$ex - im$	80.32^{***}	2
China	$ex - im$	33.90^{***}	2
France	$y - \underset{(0.0908)}{1.47}gcf - \underset{(0.0592)}{0.28}ex - \underset{(0.0936)}{0.84}im$	17.54^{***}	1
Indonesia	$ex - \underset{(0.0488)}{0.85}im - \underset{(0.0892)}{0.30}y^* + \underset{(0.0892)}{0.47}rer$	5.42^{***}	1
India	$ex - im$	46.80^{**}	1
Ireland	$y - \underset{(0.2048)}{0.53} - \underset{(0.6963)}{0.93}ex + \underset{(0.0070)}{0.76}im$	25.14^{***}	1
Korea	$ex - im$	33.55^{***}	1
North Europe	$y - \underset{(0.1946)}{0.26}gcf - \underset{(0.0989)}{2.37}ex + \underset{(0.3646)}{2.82}im$	104.08^{***}	3
Norway	$ex - im$	41.26^{***}	1
New Zealand	$ex - \underset{(0.1633)}{0.88}im - \underset{(0.2009)}{0.62}y^* + \underset{(0.1341)}{0.51}rer$	32.09^{***}	1
South Europe	$im - \underset{(0.2315)}{0.72}ex - \underset{(0.2057)}{0.46}y - \underset{(0.0411)}{1.13}rer$	67.55^{***}	2
Turkey	$y - \underset{(0.0638)}{0.23}gcf - \underset{(0.1238)}{2.15}ex + \underset{(0.1181)}{1.67}im$	46.95^{***}	2
United Kingdom	$im - \underset{(0.0447)}{0.22}ex - \underset{(0.0784)}{1.76}y - \underset{(0.1027)}{0.82}rer$	47.39^{***}	1
USA	$ex - \underset{(0.1140)}{0.52}im - \underset{(0.2398)}{0.73}y^* + \underset{(0.5642)}{1.45}rer$	113.31^{***}	3

Notes: ***,** denotes significance at the 1% and 5% significance level, respectively. LR stands for the likelihood ratio test. Standard errors in parentheses

not been rejected. It is worth noting that for NEA and France, the estimated cointegrating vectors provide support of the ELGH while for the SEA and the UK cointegrating vectors are consistent with the import equation. In particular, there is significant evidence that in the NEA while exports and investment have positive impact on the steady state value of real output, import affect output negatively. Alternatively, in the SEA, imports, exports and rer have positive long-run relationship. Therefore, an appreciation of the rer and increase of foreign output will increase imports in the long-run.[40]

We provide further validation of the imposed cointegrating vectors by presenting in Figure A1 (Appendix A) the PPs of a system wide shock corresponding to the long-run restriction displayed in Table 5. The PPs show the speed at which the equilibrium errors return to zero after a shock. All PPs are well

[40] If the import equation is normalized with respect to exports then an appreciation will have a negative impact on exports.

behaved reassuring that the imposed long-run restrictions are valid. In particular, figure A1 shows that in all countries variables return to their long-run equilibrium within four to five years, although in many cases return to equilibrium is much quicker, often taking less than ten quarters.[41]

3.2 Identification of short-run relationship using sign restrictions

We impose sign restrictions based on the general equilibrium model of Corsetti et al. (2008) who focus on the international transmission mechanism of supply shocks. They show that under the assumption of incomplete asset markets, a positive shock to domestic output has income and substitution effects (respectively, IE and SE) on the demand of domestically produced goods via a depreciation of the terms of trade:

$$\frac{\partial C_H}{\partial \zeta_t} = SE(Y_{_H}, \alpha_{_H}, \omega, \zeta_t) - IE(Y_{_H}, \alpha_{_H}, \omega, \zeta_t) \tag{8}$$

where C_H is consumption of domestically produced goods from domestic consumers; $Y_{_H}$ is domestic output; $\zeta = \frac{P_F}{P_H} > 0$ is the terms of trade defined as the relative price of foreign goods (P_F) in terms of home goods (P_H); $\alpha_{_H} \in (0, 1)$ is the share of domestically produced goods in domestic consumption; and $\omega \geq 0$ is the elasticity of substitution between domestic and foreign trade-able goods. The negative income effect in (8) is driven by the fall in the value of Home output $Y_{_H}$ in the world economy following a depreciation of the terms of trade ζ. Alternatively, a depreciation will lead to a positive substitution effect by switching demand from foreign to relatively cheaper domestic goods. Consumption of 'home goods' C_H can either increase or decrease in response to a depreciation of the terms of trade depending on the relative strength of the two effects. For high values of $\omega > 1$, the substitution effects will outweigh the income effects. Therefore, a depreciation will increase the world demand for domestic goods. The reverse is true for $\omega < 1$, where a depreciation will lead to a lower demand for domestic goods. Alternatively, a depreciation of the terms of trade will increase foreign consumption for domestic goods (i.e., C_H^*) because of positive substitution and income effects:

$$\frac{\partial C_H^*}{\partial \zeta_t} = SE(Y_{_F}, \alpha_H, \omega) + IE(Y_{_F}, \alpha_{_H}, \omega) > 0$$

Corsetti et al. (2008) also show that:

$$rer = \frac{2\alpha_{_H} - 1}{1 - 2\alpha_{_H}(1 - \omega)}(\widehat{Y_{_H}} - \widehat{Y_{_F}}) \tag{9}$$

and

$$\zeta_t = \frac{\widehat{Y_{_H}} - \widehat{Y_{_F}}}{1 - 2\alpha_{_H}(1 - \omega)} \tag{10}$$

[41] The USA, NEA, China, Japan and Ireland display the highest persistence while the UK displays the lowest persistence.

and for values $\omega > \frac{2\alpha_H - 1}{2\alpha_H}$ both the terms of trade and the rer will depreciate in response to a positive home supply shock: $\frac{\partial rer}{\partial Y_H} > 0$. Therefore, (8)-(10) show that for $\omega > 1$ a positive shock to domestic output will increase world demand for domestic goods.

Next, Corsetti et al. (2008) introduce, into their model, an international bond market allowing agents to smooth consumption. They show that a positive output shock can initially lead to an appreciation of the rer, followed by a depreciation. The main idea was that agents in anticipation of higher future income will increase consumption of domestic goods beyond supply. This will lead, in the short-run, to an appreciation of the rer. However, over time as the supply of domestic goods increases to meet demand, the rer appreciation switches to a depreciation. Therefore, the sign of the positive output shock on rer varies across time: negative in the short-run, but positive in the medium to long-run.

Corsetti et al. (2008) focus on the international transmission mechanism of supply shocks. In our analysis, besides the supply shocks, we are also concerned about the impact of demand shocks. We use the theoretical implication of Corsetti and Müller (2006) to identify the international transmission mechanism of demand shocks. They argue that if goods are not homogeneous and there is a home bias, a persistent fiscal expansion will fall on domestically produced goods causing an appreciation of the terms of trade, which in turn will increase the real return of domestic investment.[42,43] This effect on the rate of return will counteract the negative impact of fiscal expansion on investment via a rise in the domestic interest rate. The relative strength of both effects depends on the degree of openness and the persistence of fiscal shocks. In a relative open economy, a fiscal expansion will lead to an appreciation of the rer without affecting the real interest rate. Therefore, a fiscal expansion will deteriorate the current account by increasing investment and decreasing exports. Furthermore, the more persistent are expansionary fiscal shocks the more long-lasting will be the appreciation of the rer, and thus the more persistent will be the increase of domestic investment and the deterioration of trade balance.

We simulate numerous scenarios based on the short-run restrictions of Corsetti and Müller (2006) and Corsetti et al. (2008): we investigate the impact of a positive NEA real output and import shocks; a depreciation of SEA rer; a decline of SEA ulc; and a negative SEA import shock. More concretely, for a positive real output shock emanating from the NEA we impose the following restrictions on the response of NEA variables: real output will increase (positive response), the rer will appreciate (positive response), which will lead to an increase of investment (positive response), exports will decline due to the real exchange appreciation (negative response) and imports will increase (positive response). Alternatively, in SEA, real

[42]This is so because the present discounted value of output from domestic investment rise relative to the price of investment.

[43]Corsetti and Müller (2006) show that the return to investment in real terms is given by:

$$\text{Real Return to investment} = (\text{Marginal product in terms of domestic goods}) \times \frac{P_D}{P}$$

where P_D denotes the price of domestic consumption and P_D/P indicates the terms of trade. Therefore, an increase of the term of trade will raise the real return of domestic investment.

output will increase due to spillover effects (positive response), the rer will depreciate (negative response), we leave the response of investment unrestricted, exports will increase due to real exchange depreciation and imports will fall. To account for the case where real exchange initially appreciates following a positive output shock but in the medium to long run depreciates we leave the response of export and imports unrestricted.[44]

Next we consider a positive demand shock proxied by an increase of imports in the NEA. The response of the NEA variables will be the following: real output will increase; the rer will appreciate due to home bias in domestic consumption; the response of investment is unrestricted due to countervailing effect that an expansionary demand shock has on investment; exports will decline and imports will increase due to rer appreciation. The response of SEA variables mirror those of the NEA with the exception of imports which are left unrestricted.

We proceed with the analysis of the role of the SEA rer depreciation as a mechanism of current account adjustment. We restrict the responses of both NEA and SEA variables such as: the NEA rer will appreciate; NEA export will decrease and imports will increase as the byproduct of the rer appreciation. The response of real output and investment in NEA remain unrestricted. Alternatively, we restrict the responses of SEA exports and imports to a SEA rer depreciation shock to be positive and negative respectively. We do not impose any restriction on real output and investment. We also examine the impact of a negative SEA ulc shock. We do so because a depreciation of SEA rer will require either a depreciation of the euro ner or a decline of ulc. However, the former option within a monetary union is rather difficult to be implemented. Therefore, a realistic option for the SEA to improve competitiveness is through an internal devaluation: reduction of ulc. We impose on the decline of SEA ulc shock the same sign restrictions as those imposed on the deprecation of SEA rer shock. Finally, we investigate the impact of a negative SEA demand shock as reflected by a declined of SEA imports. We impose the reverse sign restrictions imposed on the positive NEA import shock. See summary Table 7.

4 Empirical results

In what follows, we examine the time profile of the following scenarios (as highlighted earlier in Table 2): i) the impact of a positive non-export real output shock to the NEA on SEA variables; ii) the effects of a positive shock to real imports of the NEA; iii) the response of SEA variables to a SEA rer depreciation shock; iv) the response of SEA to a decline of SEA ulc shock; and v) the response of SEA variables to a negative (contractionary) SEA import shock. To guide the reader we first provide an overall summary.

[44] Results from these model re-enforce evidence from the restricted model. Therefore, we do not present these results here but they are available upon request.

TABLE 7: Identification of shocks through sign restrictions

Scenario/Variables	y	gcf	ex	im	rer
Positive Shock to NEA y					
Response of NEA variables	+	+	−	+	+
Response of SEA variables	+	**u**	+	−	−
Positive Shock to NEA im					
Response of NEA variables	+	**u**	−	+	+
Response of SEA variables	+	**u**	+	−	−
Negative Shock to SEA im					
Response of NEA variables	−	**u**	−	+	+
Response of SEA variables	−	**u**	+	−	−
Negative Shock to SEA rer					
Response of NEA variables	**u**	**u**	−	+	+
Response of SEA variables	**u**	**u**	+	−	−

Notes: In all cases, ulc is left unrestricted. + and − denote a positive and negative impulse response, respectively. **'u'** denotes no sign restriction on the variable, i.e., the variable is (u)nrestricted. The restrictions are imposed on the impact effect, and left unrestricted afterwards.

4.1 Summary

Empirical results provide four findings concerning the adjustment mechanism of European trade imbalances.

First, the IRF analysis suggests that the adjustment of trade imbalances will be achieved by contractionary demand shocks in SEA: a negative SEA import shock. Results show that a depreciation of SEA rer leads to a persistent increase of SEA exports while imports remain largely unresponsive. This can be achieved either by depreciation of the ner or a reduction of ulc. However, the former option (a region-specific depreciation) is not available within the EMU (for an individual country). Therefore, we also test for the impact of a negative SEA ulc on trade imbalances. Empirical results reinforce evidence from the depreciation of SEA rer deprecation. In particular, it is rather remarkable that the increase of SEA exports following a negative SEA ulc is larger and more persistent than that following a depreciation of SEA rer. Finally evidence from a contractionary SEA import (demand) shock provides support to the view that trade imbalances in debtor countries can be adjusted by fiscal policies that promote an increase of savings. More formally, we notice that there is a persistent increase of SEA exports following a negative SEA import shock.[45]

Second, among the policies that effectively ameliorate the trade imbalance of SEA, a negative demand shock in SEA is least painful in terms of speed of adjustment to long-run equilibria. In particular, evidence

[45]The positive response of SEA exports is probably driven by depreciation of SEA rer and a reduction of SEA ulc following a contractionary demand shock in SEA.

from the persistence profile shows that after a negative SEA import shock, all variables return to their long-run equilibrium within two years. For all other shocks return to equilibrium takes longer.

Third, a simple welfare exercise shows that a persistence negative demand (import) shock in SEA will maximize the welfare of a pan-European policy maker. There is also evidence that the social welfare planner can maximize some measure of pan-European welfare by a positive NEA import shock. However, this will be feasible only through a depreciation of the ner of euro, which is not an available instrument within the EMU.

Finally, a counterfactual analysis shows that if austerity and/or depreciation of SEA rer was pursued prior to European debt crisis then the later could have been averted.

4.2 The Posterior Inclusion Probabilities of the NEA and SEA regions

One of the merits of a GVAR model is that it accounts for spillover effects through foreign variables. Note that the correlation of the foreign variables with the errors terms is very low, which implies that foreign variables are essentially exogenous. It is therefore of interest to see which foreign variables are more strongly linked to domestic equations. The Posterior Inclusion Probabilities (PIP) generated by the SSVS model in the estimation step shows the probability of a particular variable to be included in a particular equation of domestic economy.[46] Thus a $PIP = 0(1)$ denotes that the variable is completely insignificant (fully significant).[47]

Table 8 and Table 9 respectively present the PIP of the NEA and SEA model. For visual convenience we highlight values above ≥ 0.5 in gray. First, we observe that the PIP attached to the first own lag of each domestic variable is high.[48] Table 8 shows that the role of foreign variables as control variables in NEA model is consistent with the ELGH. More formally, we observed that PIP of foreign investment; foreign rer are very high in the NEA export equation.[49] This implies that variables which affect the competitiveness of the NEA traded goods play an important role in the export equation. In the same vein, variables that might affect the production of the NEA output seem to be salient in the output equation: the PIP of foreign output; foreign rer; foreign ulc and oil price exceed 0.5.[50]

[46]The SSVS accounts for model uncertainty and has been extensively used in forecasting literature for Dynamic Model Average, see for example Koop and Korobilis (2016) and Korobilis (2017). See also Dees and Güntner (2014) for forecasting in a European and panel VAR context.

[47]Significance here is related to the concept of model uncertainty, in the sense that the relevant variable is completely certain to be included or exclude in the estimated model

[48]A natural default choice both for the prior and for posterior inclusion probability is 0.5. For further details see Koop and Korobilis (2010).

[49]Note that the cumulative effect of foreign ulc is above 0.5

[50]An exception to this is the PIP of the rer which is very close to 0.5.

Table 8: Posterior Inclusion Probabilities across NEA

	y	gcf	ex	im	rer	ulc
y_{t-1}	1.000	0.225	0.329	0.495	0.155	0.770
gcf_{t-1}	0.291	1.000	0.716	0.889	0.360	0.388
ex_{t-1}	0.835	0.116	1.000	0.207	0.235	0.184
im_{t-1}	0.211	0.794	0.525	1.000	0.388	0.166
rer_{t-1}	0.198	0.084	0.998	0.308	1.000	0.664
ulc_{t-1}	0.206	0.054	0.418	0.352	0.290	1.000
y_{t-2}	0.807	0.057	0.264	0.424	0.117	0.458
gcf_{t-2}	0.330	0.553	0.578	0.567	0.466	0.494
ex_{t-2}	0.394	0.072	0.350	0.399	0.385	0.286
im_{t-2}	0.160	0.090	0.262	0.316	0.531	0.198
rer_{t-2}	0.411	0.055	0.226	0.141	0.860	0.336
ulc_{t-2}	0.103	0.066	0.210	0.133	0.167	0.996
y_t^*	0.555	0.193	0.337	0.880	0.171	0.120
gcf_t^*	0.164	0.983	0.994	1.000	0.240	0.320
rer_t^*	0.480	0.068	0.531	0.177	0.308	0.353
ulc_t^*	0.586	0.062	0.252	0.254	0.249	0.545
$poil_t$	0.737	0.064	0.998	0.913	0.250	0.306
ulc_{t-1}^*	0.152	0.043	0.157	0.252	0.144	0.367
y_{t-1}^*	0.289	0.102	0.245	0.206	0.153	0.150
gcf_{t-1}^*	0.156	0.629	0.576	0.473	0.168	0.149
rer_{t-1}^*	0.267	0.050	0.321	0.168	0.173	0.327
$poil_{t-1}$	0.243	0.116	0.240	0.187	0.246	0.184
constant	0.257	0.377	0.221	0.895	0.144	0.170
trend	0.940	0.059	0.953	0.993	0.124	0.220

Notes: PIP values above 0.5 are marked in gray for visual convenience.

Table 9: Posterior Inclusion Probabilities across SEA

	y	gcf	ex	im	rer	ulc
y_{t-1}	1.000	0.152	0.168	0.254	0.221	0.128
gcf_{t-1}	0.982	1.000	0.156	0.342	0.318	0.983
ex_{t-1}	0.319	0.275	1.000	0.902	0.194	0.586
im_{t-1}	0.414	0.675	0.215	1.000	0.147	0.404
rer_{t-1}	0.235	0.167	0.156	0.974	1.000	0.552
ulc_{t-1}	0.180	0.121	0.188	0.325	0.438	1.000
y_{t-2}	0.255	0.391	0.768	0.318	0.077	0.063
gcf_{t-2}	0.179	0.208	0.482	0.376	0.078	0.096
ex_{t-2}	0.184	0.166	0.305	0.482	0.088	0.080
im_{t-2}	0.548	0.452	0.592	0.362	0.100	0.100
rer_{t-2}	0.177	0.150	0.244	0.195	0.755	0.157
ulc_{t-2}	0.128	0.068	0.082	0.092	0.084	0.982
y_t^*	0.809	0.623	0.467	0.234	0.346	0.396
gcf_t^*	0.258	0.398	0.236	0.210	0.240	0.229
rer_t^*	0.281	0.282	0.154	0.367	1.000	1.000
ulc_t^*	0.267	0.366	0.185	0.304	0.303	0.422
$poil_t$	0.332	0.246	0.206	0.246	0.340	0.726
y_{t-1}^*	0.181	0.260	0.199	0.153	0.312	0.201
gcf_{t-1}^*	0.361	0.313	0.218	0.224	0.312	0.324
rer_{t-1}^*	0.244	0.403	0.132	0.285	1.000	1.000
ulc_{t-1}^*	0.238	0.110	0.067	0.166	0.111	0.190
$poil_{t-1}$	0.756	0.970	0.859	0.228	0.242	0.187
$Cons$	0.331	0.228	0.598	0.262	0.138	0.272
$Trend$	0.771	0.326	0.228	0.524	0.123	0.397

Notes: PIP values above 0.5 are marked in gray for visual convenience.

Table 9 shows that the foreign output and the lag of oil price has a strong impact on the equations of SEA output, investment and exports.[51] This suggests that the productivity spillover from foreign economies and exogenous production costs might have been influential factors for the SEA current account.[52] We also observe that the sum of PIP of foreign rer and foreign ulc in the equation of SEA imports exceeds 0.5. Therefore, the improvement of competitiveness in SEA might ameliorate trade deficits through the reduction of imports.[53]

4.3 NEA real output shock

Figure 2a indicates the response of the NEA and SEA variables to a NEA real output shock.[54] The response of SEA variables to a NEA real output shock shows that there is evidence of strong long-lasting increase of output while the response of investment is weak.[55] The continued positive response of output is due to an increase of external demand as this is reflected by the significant positive response of exports (around 0.2% per quarter), facilitated by a depreciation of SEA rer; the SEA real exchange depreciated for six quarters following a NEA output shock. The response of imports is rather frail as the credible set includes zero across all out of sample period. Therefore, we observed an improvement of SEA trade balance, which is mainly driven by positive wealth effects due to an increase of exports and output, which in turn might be the byproduct of the positive response of NEA imports to a NEA output shock.[56]

Although, in Figure 2a, there is evidence that the improvement of SEA trade balance was facilitated by a SEA rer depreciation following a positive NEA output shock, we now extend our model to account for the impact of ulc on trade balance. In doing so, we control for the impact of ulc on rer. We have not imposed any sign restriction on the response of ulc. This is because the response of a restricted rer will provide some insights about the impact of ulc on rer. For example, if there is both a depreciation of the rer and a decline of ulc, we can conclude that part, if not all, of the depreciation of the rer is generated by the reduction of ulc.[57] The responses of the NEA variables in the first row of Figure 2b are similar to those from the restricted model.[58] The second row of Figure 2b shows that although both SEA rer and ulc decline for

[51] The PIP of foreign output and the lag of oil price in the equations of SEA output, investment and exports is relatively high.

[52] For example, the productivity differential between the NEA and SEA might have a negative impact on both SEA exports and imports.

[53] An appreciation of SEA rer will have negative income effects, which in turn will have negative effects on imports.

[54] The Figures indicate the median response, the Mean Target (MT) suggested by Fry and Pagan (2011) and the 68 percent credible set. The concept of Credible set corresponds to a confidence interval in classical statistical inference. However, the confidence interval and credible set can be different. Conceptually, the former shows that the constructed confidence interval include the true parameter with probability 95 percent. The latter specifies the region where the 95 percent of the probability mass of the posterior distribution is concentrated. For details see Kilian and Lutkepohl (2017) and Koop (2003).

[55] Albeit the response of output is only marginally significant in the sense that the lower limit of credible set is just above zero through out the out-of sample period.

[56] The responses of NEA show that output and investment increase while trade balance deteriorates due to an increase of imports and weak response of exports: the credible set of exports includes zero

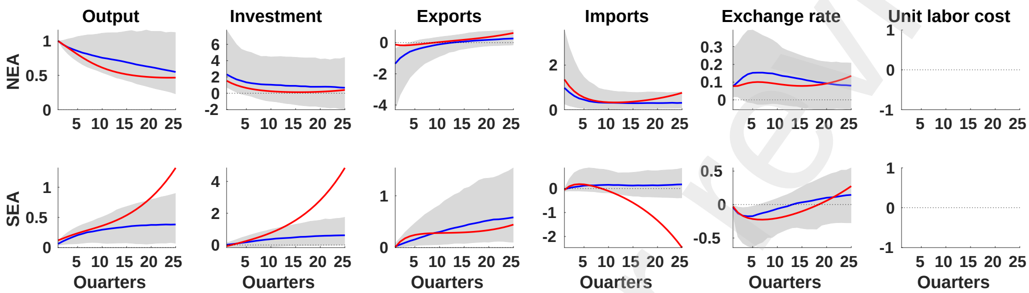
[57] Alternatively, a weak response of the rer might be due to a decline of ulc, which offsets an appreciation of ner.

[58] There is a positive and significant response of real output and investment; trade balance deteriorates due to an increase of imports while the response of exports is not different from zero; and the rer and ulc do not response to the real output shock.

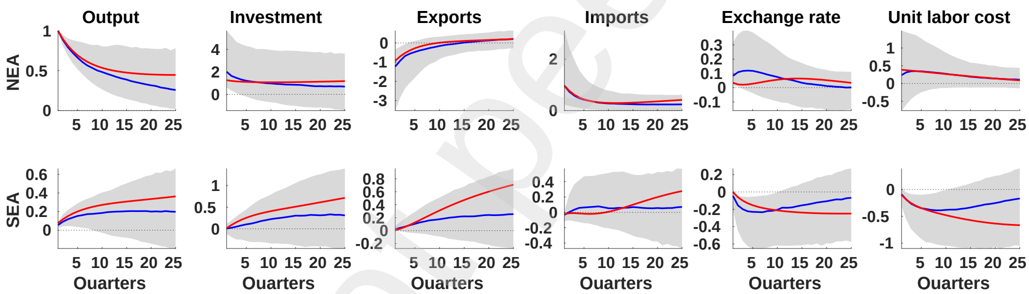
two years following the NEA output shock the responses of exports and imports are weak. Note that while ulc decline on average by 0.3% per quarter over the first eight quarters, the rer has depreciated by only 0.1%. Therefore, part of the reduction of ulc has been crowded out by an appreciation of ner. To that end, the feeble depreciation of SEA rer was not adequate to boost exports and improve the trade balance.[59]

FIGURE 2: Impulse responses of the NEA (top) and SEA (bottom) to a shock in NEA output.

(A) Unit labor cost is not included.



(B) Unit labor cost is included.



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set.

4.4 Positive NEA Demand Shock (NEA import shock)

We now consider the impact of a positive NEA demand shock, proxied by an increase of the NEA imports. The top row of Figure 3a depicts the impulse responses of the NEA variables to a standardized (i.e. one unit increase) positive NEA import shock for the restricted model. There is evidence of positive and strong response of real NEA output for almost two years afterwards.[60] We also observed a deterioration of the trade balance generated by an increase of imports, which remains above 0.5% per quarter for more than five quarters following the NEA import shock. Alternatively, the response of exports is weak. The mirror response of the deterioration of the NEA trade balance following a positive NEA import shock is the increase

[59] Furthermore, while there is an increase of output, the response of investment appears not significant.

[60] Assuming that imports reflect a demand shock, the positive response of real output mirrors that output is demand determined.

of SEA exports while SEA imports remain unresponsive to a NEA import shock.[61] Therefore, there is an improvement of SEA trade balance due to a positive demand (imports) shock in NEA. However, it is worth noting that the improvement of SEA trade balance is demand-driven, since the response of the rest of SEA variables – real output, investment and rer – was weak in the sense that zero is within the credible set of these responses. In particular, there is no evidence of depreciation of the SEA rer, which might lead to an increase of exports (due to substitution effects) and decline of imports (due to negative wealth effects) following the depreciation of the rer. Therefore, the positive response of SEA exports to a positive NEA import shock is demand-determined.

In Figure 3b, we extend our model by including ulc. The aim of this exercise is to check whether the weak response of the SEA rer was the byproduct of an appreciation of SEA ner, which cancels out the effects of a negative response of SEA ulc. Figure 3b shows that, with the exception of the NEA real output and imports, the rest of the variables, in both regions, remain unresponsive to a positive NEA import shock. The weak impact of a demand shock emanated by NEA might reflect imperfections of euro area labor market such as real wage rigidities. Alternatively, it might reflect productivity differences across the two regions. Note that a proxy of ulc is the ratio of nominal wages divided by labor productivity. The productivity gap between NEA and SEA will require a depreciation of SEA rer. However, given labor market rigidities in euro area,this can only be achieved through a depreciation of ner, which is rather an impossible task within the monetary union. Therefore, labor market rigidities and productivity gaps among the member countries of the EMU will neutralize the impact of demand-driven shocks.

4.5 SEA real exchange rate shock and unit labor cost shock

Next, we investigate the view that a rise of SEA competitiveness could be used as a tool to restore trade balance within the euro area. To that end, we consider two alternative shocks that reflect improvement of competitiveness in SEA: a depreciation of SEA rer and a decline of SEA ulc. We focus only on the unrestricted model because results from the restricted model (the model excluding ulc) were similar.[62] Furthermore, we only present the impulse responses of SEA variables. This is because besides real output the rest of NEA variables remain unresponsive to a SEA rer and ulc shock.

Figure 4 (top row) depicts the responses of SEA variables to one unit negative (depreciation) SEA rer shock. The depreciation of the rer lasts six quarters before becoming zero (i.e. the credible set includes zero). Although the depreciation of the rer is relatively brief the response of exports is positive and long-lasting.[63] Alternatively, the response of imports is short-lasting and debilitate: both the MT and the median responses

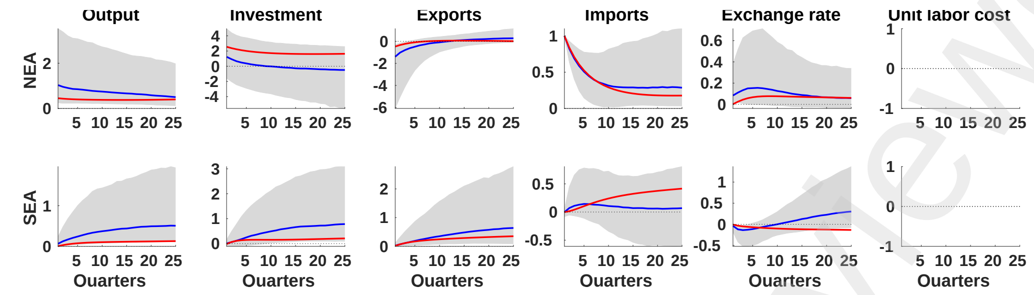
[61] More formally, the bottom row of Figure 3a shows that the SEA exports increase on average by 0.25% for the whole out of sample period.

[62] Results from the restricted model are available on request.

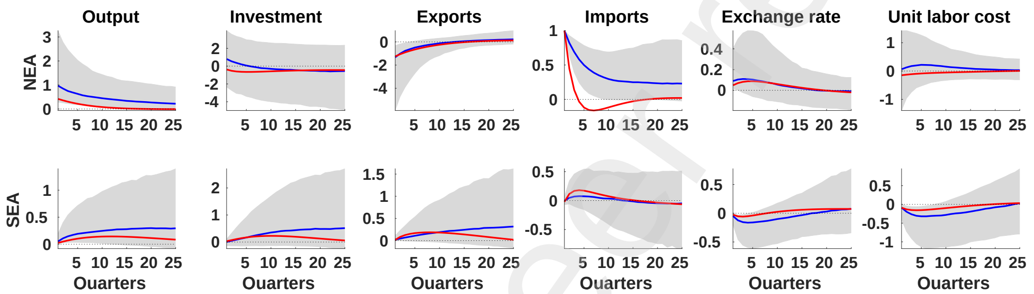
[63] We observe that exports increase by 1.5 percent, on average, per quarter and remain positive for the whole out-of-sample period.

FIGURE 3: Impulse responses of the NEA (top) and SEA (bottom) to a shock in NEA imports.

(A) Unit labor cost is not included.



(B) Unit labor cost is included.



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set.

are negative and very close to zero.

Finally, there is no evidence that the depreciation of the rer was driven by a fall of ulc since zero is within the creditable set of ulc response. This implies that the depreciation of the rer was the byproduct of a depreciation of ner.[64] Therefore, the argument that the euro area current account adjustment can be achieved by reducing production cost (i.e., real wages) in SEA might not be true.[65]

The bottom row in Figure 4 presents the impulse responses of SEA variables to a negative SEA ulc shock. Although there is a decline of ulc, the response of real output is not different from zero while investment declines for a year following the shock.[66] It is also worth stressing that the reduction of ulc fails to generate a depreciation of the rer, which in turn could advance the competitiveness of SEA countries. The frail response of the rer is essentially due to an appreciation of the nominal euro exchange rate, which crowds out the effects of ulc, see also Chen et al. (2013). Despite the weak response of SEA real exchange, we observe that a decline of SEA ulc has positive and persistent effect on SEA exports while imports remain unresponsive. Therefore, there is an improvement of SEA trade balance following a reduction of ulc but such

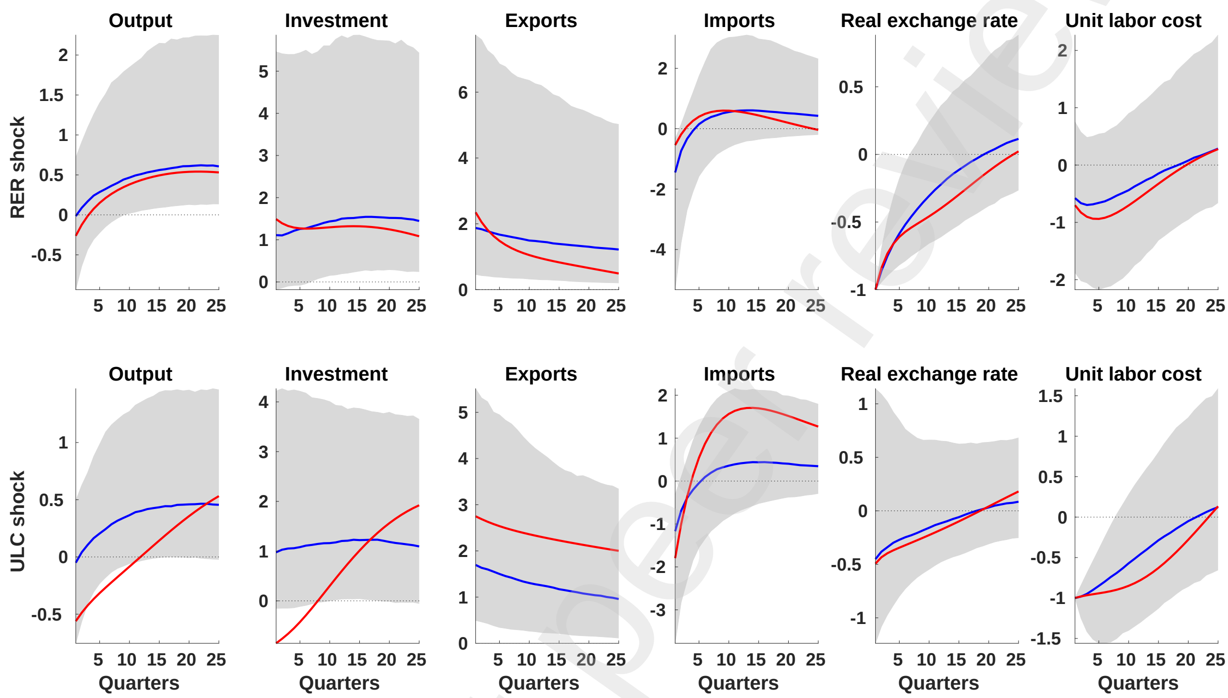
[64] The euro nominal effective exchange rate has depreciated after 2015.

[65] Our results are consistent with the evidence presented by Chen et al. (2013) who show that appreciation of euro ner was a major factor for the generation of the current account deficits in SEA countries.

[66] The negative response of investment reflects both inefficient capital markets and labor market rigidity, which hinder the efficient allocation of capital and labor. For a detailed analysis of capital misallocation and labor market rigidity in SEA see Gopinath et al. (2017).

an improvement can be reverse in the long-run if output and investment remain muted. This is so because labor market rigidity and low level of capital deepening in SEA will undermine economic growth as this has been reflected by the feeble response of both real output and of investment.

FIGURE 4: Responses of SEA to negative shocks in SEA rer (top) and SEA ulc (bottom).



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set. In the last row, the shock in imports lasts for six quarters.

4.6 A negative SEA import shock

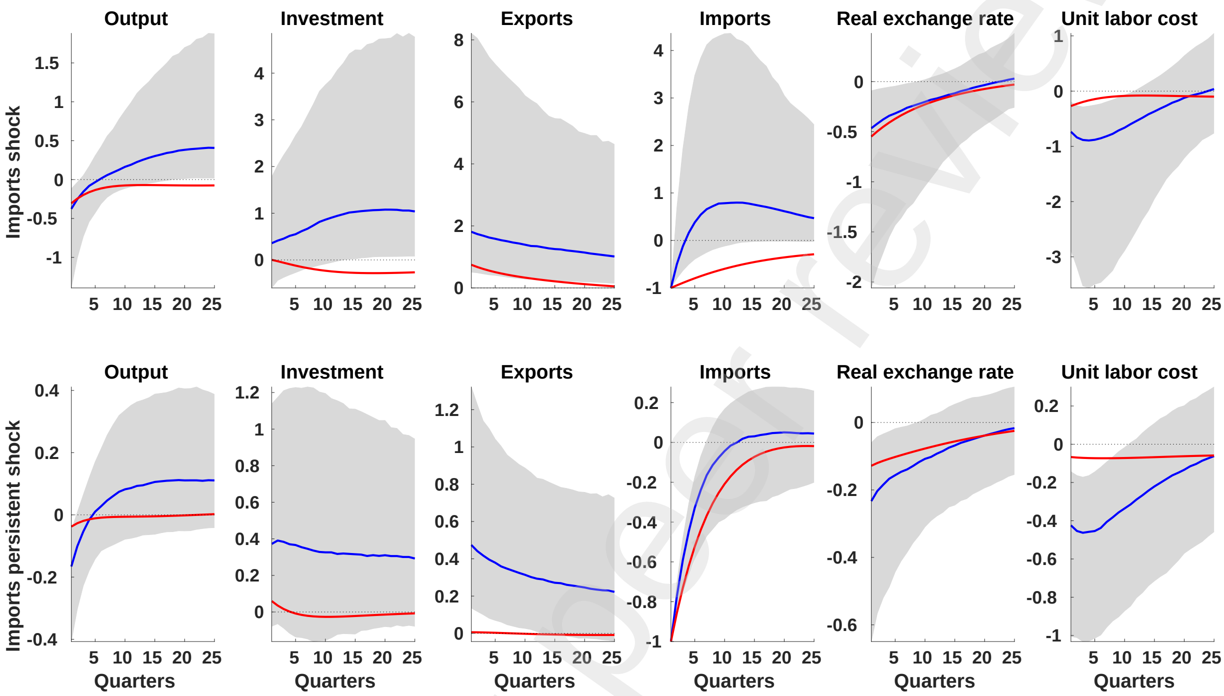
Next we investigate the suggestion by Jaumotte and Sodsriwiboon (2010) that a contractionary demand (fiscal) shock seems appropriate for the SEA countries to reverse their current account deficits. We proxy contractionary demand shock by a negative SEA import shock. Figure 5 (first row) shows that there is a long-lasting improvement of trade balance driven by a persistent positive response of exports while imports also become significantly negative: the credible set of of SEA import response does not include zero; albeit only on impact.[67] The positive response of exports might be driven by a depreciation of the rer, which lasted for eight quarters following the shock.[68] There is also evidence that a large part of the rer depreciation is

[67]In particular, exports increase on average by 0.5% per quarter for the first three years following the shock and remain positive for the whole out of sample period. Note that the mean-target (MT) response is negative and lies outside the credible set, which implies that the decline of imports might have been persistent.

[68]Note that the upper limit of of credible set is marginally bellow zero.

due to a decline of ulc, which fall for more than eight quarters after the negative import shock.[69] It is worth noting that real output decline for two quarters while investment remain unresponsive to a negative import (demand) shock.

FIGURE 5: Responses of SEA to negative shocks in SEA imports (top) and a persistent SEA imports (bottom).



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set. In the last row, the shock in imports lasts for six quarters.

Evidence that a short-lasting negative demand shock led to an improvement of SEA trade balance raises the question whether a long-lasting contractionary policy will accelerate the adjustment of SEA trade imbalances. Therefore, we impose an additional negative SEA import shock which lasts at least for six quarters (by which we define a "persistent" shock).[70] Figure 5 (second row) shows that although contractionary policy is more persistent, the improvement of trade balance is mainly driven by a fall of imports. The response of exports is positive and different from zero but less responsive compared to the case of a momentary negative shock in SEA imports. Furthermore, there is a strong negative response of ulc, which declines persistently for more than 0.6% per quarter. Note that the deprecation of the rer was significant -zero is not included in the creditable set- but smaller in absolute terms than the fall of ulc. Our results show that a deprecation of the rer through a depreciation of nominal rate might be less painful and more effective in restoring trade imbalances than a reduction of ulc.

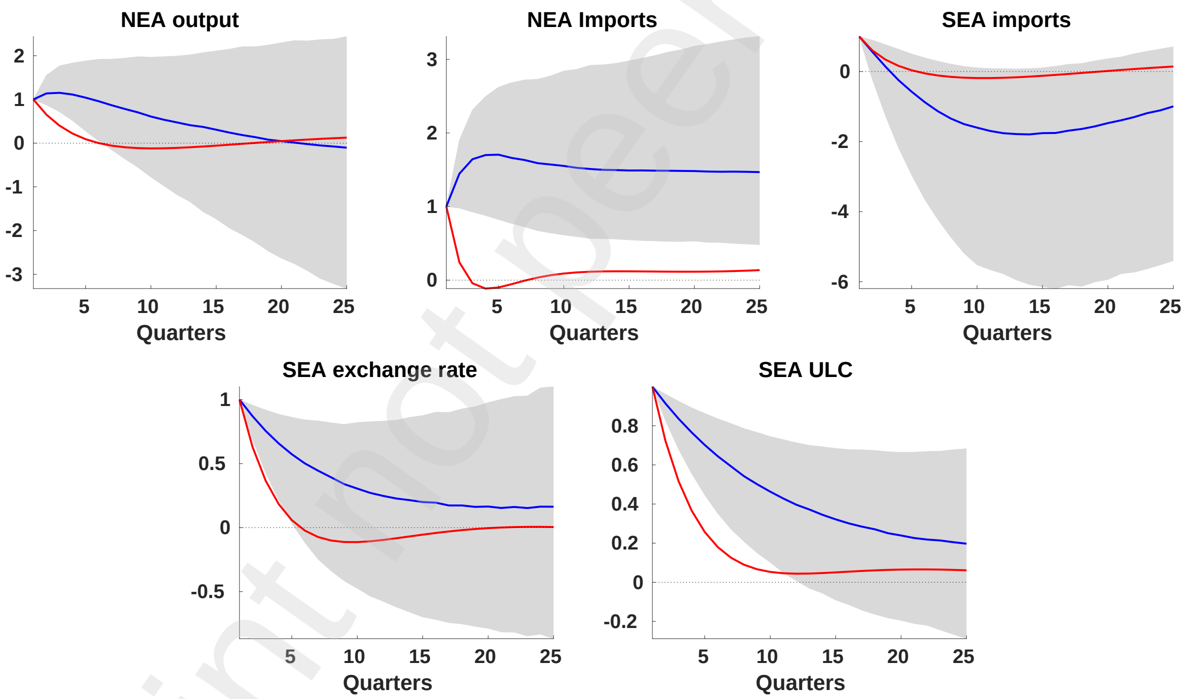
[69] In particular, we observe that while the SEA rer depreciate, on average, by 0.3% per quarter two years following the shock the ulc fall by 0.17%.

[70] We have restricted imports to remain negative for six quarters following the shock.

4.7 The persistence profiles

While the analysis of long-run relationships – identification of cointegrating vectors and the PPs of system-wide shocks – provide valid evidence that the NEA and the SEA adopted policies are consistent with the ELGH and ILGH respectively, the impulse response function analysis shows that the adjustment of trade imbalances between the two regions can be achieved either by improving competitiveness in SEA – depreciation of SEA rer or reduction of SEA ulc – or by adopting austerity policies in SEA. Here, we assess for the impact of the adjustment of trade imbalances on the long-run relationships presented in Table 6. More formally, we investigate the persistent profile of the variable-specific shocks used in the IRF analysis. Therefore, Figure 6 presents the PPs of a positive NEA output shock; positive NEA import shock; depreciation of SEA rer; negative SEA ulc shock; and negative SEA import shock.

FIGURE 6: Persistence profiles with respect to variable-specific shocks.



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set.

Evidence from the persistence profiles indicates that policies which aim to smooth trade imbalance within the euro area have only a short-run impact on long-run relationship. Figure 6 shows that while the median responses imply a slow speed of adjustment towards long-run equilibria, the mean target responses show that for any of the variable-specific shocks the equilibrium error returns to zero within ten quarters. We also observe that the speed of adjustment of a negative SEA import shock is faster than the speed of adjustment of any of the other shocks.[71] More formally, after a negative shock in SEA imports, variables return to their equilibrium within few quarters. This is probably due to the evidence from the IRF analysis that a negative SEA import shock leads both to a depreciation of SEA rer and a reduction of SEA ulc, which in turn facilitate the improvement of SEA trade balance: increase of SEA export and decline of SEA imports.

4.8 Counterfactual analysis

In this section we test whether evidence based on the full sample estimates could still hold for the period before the onset of European sovereign debt crisis in 2010. The aim of this exercise is to examine the effects of the purposed policies. Would those policies have been effective in smoothing the trade imbalances in the SEA and helped to avoid the debt crisis in 2010. In particular, we substitute the structural GVAR estimated coefficients for the full sample, which account for the impact of policies induced in the aftermath of debt crisis, in the period before 2010. In doing so, we test whether the SEA countries could have circumvented the debt crisis in 2010, if they had adopted policies, which promote public savings and competitiveness. Therefore, in what follows, using data up to 2010 and the estimated coefficients from the full sample, we examine the scenarios that can lead to an improvement of the SEA trade balance: i) the response of the SEA variables to a SEA rer depreciation shock; iv) the response of SEA to a negative SEA ulc shock; and v) the response of SEA variables to a contractionary SEA import shock.

Empirical results from the counterfactual analysis reinforces the evidence from the full sample estimates. For example, Figure 7 (first row) shows that a depreciation of the SEA rer leads to a large and persistent increase of SEA exports while the response of imports is not significant. More formally, although the response of exports based on the full sample estimates is larger for the first two years then declines towards zero while the response of exports based on the restricted sample not only becomes larger than the full sample response but it also has an increasing trend 10 quarters following the shocks.

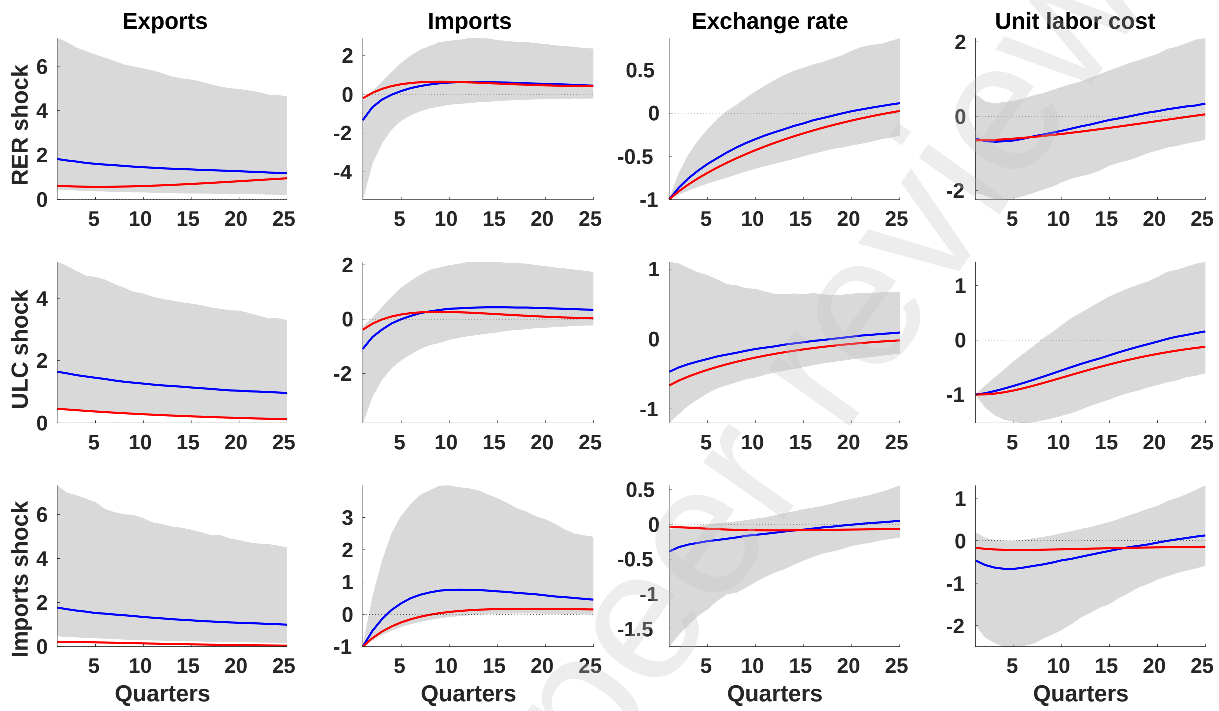
Results from a negative SEA ulc shock are also consistent with the full sample estimates. The second row of Figure 7 indicates a positive response of SEA exports while imports remain unresponsive to a negative SEA ulc shock. Finally, the last row of Figure 7 shows that a contractionary import shock improves SEA trade balance by reducing imports for more than two years following the shock while exports increase by more than 0.16 percent on average per quarter for the first three year and remain positive and significant for the full out of sample period. It is noteworthy that the fall of imports from the restricted sample is more persistent compared to the fall of imports observed in the full estimates.[72] There is also evidence that the SEA rer depreciates for 6 quarters after the shock. This implies that an improvement of SEA trade imbalance might be driven by a contractionary demand shock in SEA which in turn generates an improvement of

[71] Even the speed of adjustment of the median response to negative SEA import shock is less than five quarters.

[72] Estimates from the restricted sample show that imports remain negative for eight quarters following the shock while the fall of imports from the full sample estimates remain negative only on the impact.

competitiveness through a depreciation of the rer and increase of exports.

FIGURE 7: Counterfactual analysis. SEA responses to negative shocks in SEA real exchange rate (top), ulc (middle) and imports (bottom).



Notes: The blue and red lines are the Median and the Mean-Target responses, respectively. The shaded area is the 68% credible set.

4.9 A simple loss-function based analysis

Although the structural-shock analysis suggests that trade imbalances in SEA can be ameliorated either by a depreciation of the SEA rer or by a SEA contractionary demand-import-shock, these policies do not necessarily imply a welfare maximization for both regions. Therefore, to speak to that topic, we computed a simple loss function mimicking the social welfare planner of both regions:

$$\mathcal{L} = \mathbf{w}_x(X_{t+h} - X_{t+h|t})^2 - \mathbf{w}_y(y_{i,t+h} - y_{i,t+h|t})^2 \tag{11}$$

where $\mathbf{w}_x$ and $\mathbf{w}_y$ are the weights attached to the non-policy and policy variables respectively; $X_t = (\boldsymbol{x}'_{NEAt}, \boldsymbol{x}'_{SEAt})'$ and y_{it} is the policy variable of SEA or NEA that received a shock; and $X_{t+h|t} = X_{t+h} \times b_x$ and $y_{i,t+h|t} = y_{i,t+h} \times b_y$ are the forecasts of non-policy (i.e., those plotted in the charts) and policy variables for forecast horizon $h = 20$ (quarters).[73]

[73] Terms b_x and b_y are the median estimates of structural parameters: the parameters that satisfy the sign restriction.

The quadratic loss function implies that the conditional forecasts are optimal in the sense that they minimize the forecaster's loss function.[74] Table 10 presents estimates of $\mathbf{w}_x$ and $\mathbf{w}_y$ which minimizes $\mathcal{L}$ based on two grid search exercises. We experiment with three different types of grid search. Panel **A** presents estimates from a grid search where all values of $\mathbf{w}_x$ and $\mathbf{w}_y$ used to determine $\mathcal{L}$. More formally, we try all weight combinations in the range $\mathbf{w}_x, \mathbf{w}_y \in \{0.1, 0.2, \ldots 1\}$. In Panel **B**, we normalize with respect to $\mathbf{w}_y = 1$ and increase the value of $\mathbf{w}_x$ by 0.1 in the interval $[0.1,\ 1.0]$.

The key observation from both panels is that for *low* values of $\mathbf{w}_x$ – constituting a low weight on the deviation of non-policy variables from their target values – the "optimal" policy scenario is consistent with the view that trade imbalances will be restored by a persistent contractionary policy from the region which suffers from a loss of competitiveness: persistent negative import shocks in SEA.[75]

TABLE 10: Loss function analysis results for alternative policies.

	Panel A: Grid search						
Shock / $\mathbf{w}_x \mid \mathbf{w}_y = 1 - \mathbf{w}_x$	0.2	0.3	0.4	0.5	0.6	0.7	0.8
NE Y	9.314	8.853	8.828	11.500	14.780	18.900	24.234
NE IM	1.966	1.339	1.000	1.000	1.000	1.000	1.000
SE RER	59.952	66.009	71.537	98.349	131.225	172.601	226.109
SE ULC	40.897	44.194	47.438	64.838	86.193	113.026	147.752
SE IM	18.433	18.883	19.691	26.429	34.700	45.091	58.540
SE IM (persistent)	1.000	1.000	1.028	1.368	1.784	2.308	2.986
	Panel B: $\mathbf{w_y} = 1$						
Shock / $\mathbf{w}_x$	0.2	0.3	0.4	0.5	0.6	0.7	0.8
NE Y	9.550	9.141	8.904	8.749	8.640	9.116	9.951
NE IM	2.287	1.731	1.408	1.197	1.049	1.000	1.000
SE RER	56.854	62.227	65.345	67.382	68.817	74.431	82.814
SE ULC	39.212	42.136	43.833	44.941	45.722	49.316	54.756
SE IM	18.203	18.602	18.833	18.985	19.091	20.418	22.525
SE IM (persistent)	1.000	1.000	1.000	1.000	1.000	1.065	1.171

Notes:
i) In Panel A, we calculate the loss function $\mathcal{L}$ for all combinations of $w_x = 0.1, 0.2 \ldots 1$ and $w_y = 0.1, 0.2 \ldots 1$. In total, we consider one hundred different combinations. For brevity we only report the combinations of w's such that $w_x + w_y = 1$
ii) In Panel B, we impose $w_y = 1$ and calculate the loss function for $w_x \in [0.1, 1]$, by step 0.1. We do not report results for all pairs of weights.
iii) For each combination of the weights we normalize the results such that the lowest loss equals 1.
iv) the lowest loss is indicated in green.

[74] For further details concerning forecast evaluation accounting for decision-maker's loss function-forecast rationality - see Granger (1999) and Elliott and Timmermann (2015). Note that for $\mathbf{w}_x = \mathbf{w}_y = 1$, the loss function $\mathcal{L}$ is equivalent to a multivariate Mean Square Error.

[75] Note we use the word 'optimal' very loosely since in a fully structural micro-founded model, the loss functions weights would be potentially tied to the model coefficients, see Levine et al. (2008).

Alternatively, for more substantive, less extreme values of $\mathbf{w}_x$ (say $0.3 - 0.8$) the optimal policy is consistent with the view that adjustment of trade-imbalance in euro area should be symmetric, which implies that expansionary demand (imports) shock in NEA can be used as an instrument to alleviate trade imbalances. Recall that the analysis of the restricted model – i.e., the model without ulc – shows that a positive NEA import shock led to higher SEA exports without affecting SEA imports. However, the latter scenario is attainable through a depreciation of the rer, which in turn is driven by a depreciation of ner.[76,77] Therefore, within the monetary union, maximization of pan-European social welfare planner is not attainable through an expansionary NEA demand-import-shock.

We have also implemented a loss-function analysis for each region: SEA and NEA.[78] There is evidence that while for SEA welfare is maximized by an expansionary demand-import-shock in NEA, the maximum welfare for NEA is achieved by a persistent contractionary demand shock in SEA.[79] These results underlying the policy dilemma for a pan-European social planner: the adjustment of trade imbalance should be symmetric or deficit countries should follow policies that increase public saving and/or improve competitiveness.

5 Conclusion

The great financial crisis, coming barely ten years after the euro's inception, put the very existence of the single currency in doubt. The proximate cause was the accumulated current account deficits of SEA countries while during the same period the NEA countries built sizable trade surpluses. The development of such trade-imbalances within the euro area might be considered to be the byproduct of the co-existence of two growth models. On the one hand, NEA countries promoted export-led growth policies while SEA countries relied on domestic consumption as a mechanism of growth. However, evidence that the TFP of SEA countries declined during the period 2000-2008, while the euro nominal exchange rate was overvalued, raised questions about the continued co-existence of these growth models in the monetary union.

There was thus a lively debate on the policy front as to how to ameliorate intra-European trade imbalances. There is a view supported by the US Treasury (2017) and Krugman (2013) among others, that current account adjustment should be symmetric: the NEA surpluses should shrink along with SEA deficits. Alternatively, Jaumotte and Sodsriwiboon (2010) argue that for countries that lost competitiveness, the policy options to restore trade balance are: fiscal policies that promote an increase of public savings, improvement of competitiveness through a reduction of ulc and financial policies that control credit expansion.

Our paper contributes to this important debate by evaluating the view that an expansionary (demand-

[76] Recall, that once we introduce ulc, there is not a response of the SEA rer and of SEA export to a positive NEA import shock.

[77] Note that ulc in Germany has fallen by 16 percent from 2000 to 2008. Therefore, an appreciation of euro ner has been offset by a reduction of ulc in NEA.

[78] Therefore in equation (11) $X_{it} = \mathbf{x}_{it}$

[79] For brevity, we do not present results for individual country-block exercises. Results are available upon request

driven) policy in NEA accompanied by an improvement of competitiveness in SEA and/or reduction of demand in SEA can be used as a tool to sooth trade imbalances within euro area. We do so by using a structural Bayesian GVAR. Our framework allows us to account for spillover effects of demand or competitiveness shocks emanating from any country or region. We identify structural shocks – demand, supply and competitiveness – by imposing theory-consistent sign restrictions based on Corsetti and Müller (2006) and Corsetti et al. (2008), while we account for long-run restrictions implied by the characteristic of each region: ELGH and ILGH. [80] In doing so, we can also evaluate, via the PPs of each shock, the speed of adjustment to long-run equilibria.

Empirical results show that there is strong evidence that an improvement of competitiveness in SEA can indeed be used as a tool to rectify trade deficits in SEA: we observed that either a depreciation of SEA rer and/or a reduction of SEA ulc will have a positive impact on SEA exports without affecting SEA imports. We also observed that a contractionary demand shock in SEA can lead to a persistent increase of exports while imports also decline. Note that the improvement of SEA trade balance following a negative SEA demand shock is facilitated by a depreciation of the rer and a reduction of ulc as implied by the theory-consistent sign restrictions. There is also evidence from the PPs analysis that among the policies that restore trade balance in the SEA, a negative demand (imports) shock in SEA is less painful in terms of speed of adjustment to the long-run equilibrium. A 'welfare' exercise shows that contractionary policy in SEA will maximize the pan-European social welfare. There is also evidence that a positive demand shock – positive import shock – in the NEA will also maximize the social welfare but impulse response functional analysis show that this will ameliorate trade imbalance only through a depreciation of SEA ner. Therefore, although a positive demand shock in NEA will improve the social welfare, it will not improve trade imbalances in SEA.

Finally, counterfactual analysis shows that if the suggested policies – depreciation of SEA rer and/or negative demand shock in the SEA – had been adopted prior to 2010, the European debt crisis might have been averted.

[80] We have also account for long-run restriction based on the growth characteristics of the NEA and SEA.

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Online Appendices for

'European Trade and Growth Imbalances'

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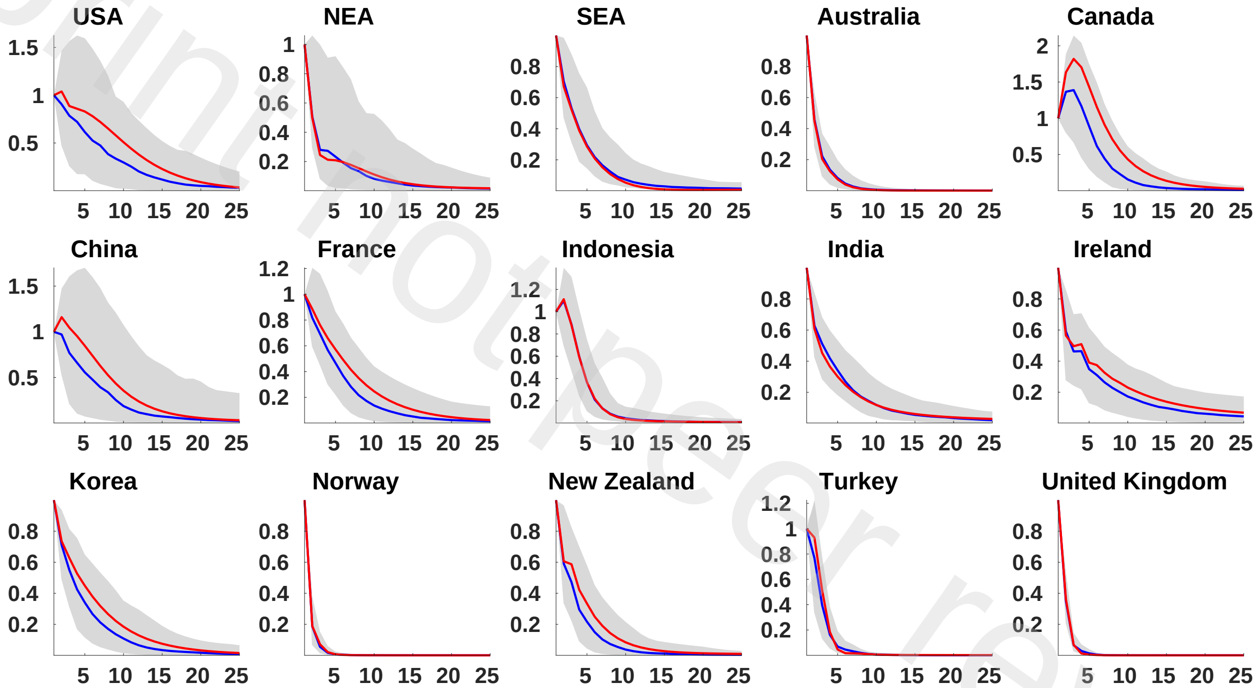
A Additional figures

FIGURE A1: Persistence profiles with respect to a system-wide shock.



B Data and model

Table B1: Specification for the country-specific VARX* models.

Country/ Region	Endogenous Variables	Exogenous Variables	Cointegrating Vectors
Australia	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}, poil\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}\}$	1
Brazil	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it} poil_t\}$	3
Canada	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	2
China	$\{y_{it}, ex_{it}, im_{it}, rer_{it}\}$	$\{y^*_{it}, rer^*_{it}, poil_t\}$	2
France	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
Indonesia	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, poil_t\}$	1
India	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, poil_t\}$	1
Ireland	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
Japan	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	2
Korea	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
Mexico	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	3
NEA	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	3
Norway	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
New Zealand	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
South Africa	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	2
SEA	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	2
Sweden	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
Switzerland	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	3
Turkey	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	2
UK	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	1
USA	$\{y_{it}, gcf_{it}, ex_{it}, im_{it}, rer_{it}, ulc_{it}\}$	$\{y^*_{it}, gcf^*_{it}, rer^*_{it}, ulc^*_{it}, poil_t\}$	3

TABLE B2: Annual PPP-GDP for countries included in the two regions, used for the construction of the domestic variables for the two regions.

	NEA				
Year/Country	Austria	Belgium	Finland	Germany	Netherlands
2012	449.297	535.475	248.784	4011.033	868.913
2013	449.412	537.935	246.541	4028.585	867.782
2014	452.383	546.426	245.641	4117.598	880.134
2015	456.973	557.581	246.977	4179.030	897.377
2016	466.064	564.644	253.920	4272.222	917.045
2017	476.590	573.789	262.026	4386.727	943.740
2018	488.513	584.227	265.019	4434.368	966.021
2019	495.798	596.785	268.254	4481.173	984.912
Weights:	0.072	0.087	0.039	0.659	0.143
	SEA				
Year/Country	Greece	Italy	Portugal	Spain	
2012	312.823	2471.000	317.093	1673.047	
2013	304.953	2425.507	314.167	1649.032	
2014	306.403	2425.397	316.656	1671.853	
2015	305.802	2444.274	322.331	1735.972	
2016	304.313	2475.890	328.840	1788.594	
2017	307.636	2517.184	340.370	1841.781	
2018	312.769	2540.489	350.069	1883.935	
2019	318.410	2550.912	359.460	1923.219	
Weights:	0.064	0.507	0.067	0.362	

Source: OECD.
Notes: PPP-GDP in billions. For each country, the sum of annual PPP-GDP over the period 2012-2019 is divided by the sum of annual PPP-GDP over the period 2012-2019 for all countries included in the region.

TABLE B3: Data sources

Country	y	gcf	ex	im	rer	ulc
Australia	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Austria	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Belgium	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Brazil	OECD(2)	WDI(3)	WDI(3)	WDI(3)	IFS(4)	
Canada	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
China	WDI(3)		WDI(3)	WDI(3)	IFS(4)	
Finland	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
France	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Germany	OECD(2)	OECD(1) / WDI(3)*	OECD(2)	OECD(2)	IFS(4)	OECD(1)*
Greece	OECD(2)	OECD(1) / WDI(3)*	OECD(2)	OECD(2)	IFS(4)	OECD(1)*
India	OECD(1)	WDI(3)	WDI(3)	WDI(3)	OECD	
Indonesia	OECD(1)	WDI(3)	WDI(3)	WDI(3)	OECD	
Ireland	OECD(2)	OECD(1) / WDI(3)*	OECD(2)	OECD(2)	IFS(4)	OECD(1)*
Italy	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Japan	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Korea	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(1)	OECD(1)
Mexico	OECD(2)	OECD(1)*	OECD(2)	OECD(2)	IFS(4)	FRED(5)
Netherlands	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
New Zealand	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	FRED(5)
Norway	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)*
Portugal	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)*
South Africa	OECD(2)	OECD(1)*	OECD(1)	OECD(1)	IFS(4)	FRED(5)
Spain	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)*
Sweden	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
Switzerland	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)*
Turkey	OECD(2)	OECD(1)*	OECD(2)	OECD(2)	OECD	FRED(5)
UK	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)
USA	OECD(1)	OECD(1)	OECD(1)	OECD(1)	IFS(4)	OECD(1)

Notes: (1) Economic Outlook No 106. OECD (2) Quarterly National Accounts. (3) World Development Indicators. (4) IMF, International Finance Statistics. (5) Federal Reserve Bank of St. Louis. (*) Interpolated from annual data. Where, as previously, we have the labels: real output (y), real gross capital formation (gcf), real exports and imports (ex, im), real exchange rate (rer) and real unit labor cost (ulc).