Economic growth and exports: A GVAR approach

Author: Konstantinos Chisiridis
Supervisor: Theodore Panagiotidis

Master in Economics,
University of Macedonia

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Presentation Outline

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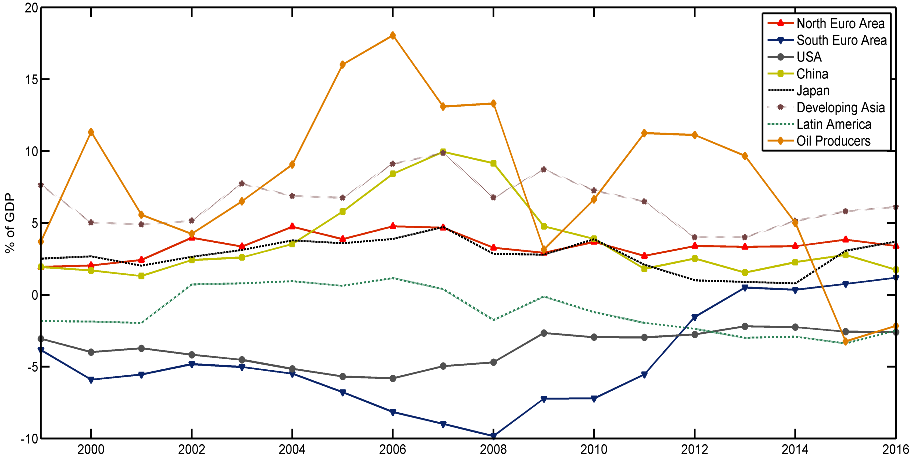
Global Imbalances and Financial Crisis

- The formation of **Global Imbalances** (GIs) have been outlined as a key contributor to the recent financial crisis in 2008 (see Obstfeld and Rogoff, 2009).
- The following mechanism occurred:
  Current account surpluses of the emerging economies supported deficits in developed countries $\rightarrow$ Risk taking behavior $\rightarrow$ Distortions in fundamental financial factors.
- Interest in investigating the sources and the patterns of disparities in trade relationships.

Imbalances within the Euro Area: North and South Division

- Trade imbalances and different economic models within the Euro area.
  - North Euro Area (NEA) countries such Germany, Netherlands, Austria, Belgium and Finland: Coordinated market economies and policies that promote the Export-Led-Growth (ELG) regime.
  - South Euro Area (SEA) countries such Italy, Spain, Greece and Portugal: Rely on increased domestic consumption and consumer spending as a mechanism of growth.
- Fact: From the establishment of the EMU in 1999, the **average current account surplus of the NEA** (3.4% of GDP) is mirrored to the **average current account deficit of the SEA** (4.6% of GDP).

Current Account Balances as % of GDP



Source: OECD, World Bank and authors' calculations.

Questions to be Answered in this Paper

- We are interested in examining the propagation mechanisms of real trade and macroeconomic origin shocks under a global frame.
  - Particular interest in the interconnections among the NEA and the SEA which are treated as two separate sub-regions.
  - Dynamics of various scenarios are also assessed.
- How do we achieve this?
  - After employing a Global VAR (GVAR) model that incorporates theory-based long-run restrictions.
  - The variables in the model are suggested by an augmented ELG production function.

Related Literature

- This study is indirectly related to four different strands in the literature:

ELGH	Balassa, (1978)
	Feder, (1983)
	Dreger and Herzer, (2013)
Imports & Growth	Esfahani, (1991)
	Grossman and Helpman, (1991)
GIs	Jaumotte and Sodriwiboom, (2010)
	Lane and Milesi Ferretti, (2012)
	Chen *et al.*, (2012)
GVAR Analysis	Dees *et al.*, (2007a)
	Dees *et al.*, (2007b)
	Greenwood- Nimmo *et al.*, (2010)
	Busserie *et al.*, (2012)

Global VAR: An Overview

- First introduced by Pesaran *et al.* (2004) and developed further by Dees *et al. (2007a).*
- A global modeling framework for the assessment of global interactions and analysis of regional shocks in the world economy.
- Establishes a connection of domestic variables with the outside economy via the corresponding constructed country-specific foreign “star” variables based on the trade pattern of the country under consideration.
- A set of *N* economies indexed by $i = 0, \dots N - 1$ yields:

$$x^*_{it} = \sum_{j=0}^{N} w_{ij} x_{ij} \tag{1}$$

where $w_{ij} \geq 0$, represents the share of country j to the total trade share of country i.

Global VAR Methodology: First Step

- Specification and estimation of the country-specific $VARX^*(p_i, q_i)$ models.
- We consider the case of a $VARX^*(2,1)$ at the time period $t = 1, \ldots, T$:

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Phi_{i2}x_{i,t-2} + \Lambda_{i0}x^*_{it} + \Lambda_{i1}x^*_{i,t-1} + \delta_{i0}d_t + \delta_{i1}d_{t-1} + u_{it} \quad (2)$$

where:

- x_{it} is a $k_i \times 1$ vector of endogenous country-specific domestic variables, x^*_{it} is a $k^*_i \times 1$ vector of weakly exogenous foreign variables and d_t is a $m_d \times 1$ vector of global variables (e.g. oil price).
- Φ_{i1} and Φ_{i2} are $k_i \times k_i$ matrix of lagged coefficients.
- α_{i0} and a_{i1} are $k_i \times 1$ vectors of intecept terms and trend coefficients respectively.

Global VAR Methodology: First Step

The corresponding error correction representation of *(2)* is:

$$\Delta x_{it} = c_{i0} - \alpha_i \beta_i^{\prime} [z_{i,t-1} - \mu_i d_{i,t-1} - \gamma_i (t-1)] \\ + \Gamma_i \Delta x_{i,t-1} + \Lambda_i \Delta x_{it}^{*} + \delta_{i0}^{*} \Delta d_t + \delta_{i1}^{*} \Delta d_{t-1} + u_{it} \tag{3}$$

where:

- $z_{it} = (x_{i,t-1}^{\prime}, x_{i,t-1}^{*\prime})^{\prime}$ is a $k_i + k_i^{*}$ dimensional vector
- α_i is a $k_i \times r_i$ matrix of rank r_i
- $\beta_i^{\prime}$ is a $(k_i + k_i^{*} + m_d) \times r_i$ matrix of rank r_i
- Under this context we can account for the possibility of cointegration within x_{it} and x_{it}, x_{it}^{*} and d_{it} based on Johansen's test.

Global VAR Methodology: Second Step

- The second step involves the solution of the global model based on the OLS estimation of the country-specific VECMs.
- If $\zeta_{it} = \begin{pmatrix} x_{it} \\ x^*_{it} \\ dt \end{pmatrix}$ then (2) can be written as:

$$A_i \zeta_{it} = a_{i0} + a_{i1} t + B_{i1} \zeta_{i,t-1} + B_{i2} \zeta_{i,t-2} + u_{it} \tag{4}$$

where $A_i = (I_{ki} - \Lambda_{i0})$, $B_{i1} = (\Phi_{i1}, \Lambda_{i1})$ and $B_{i2} = (\Phi_{i2}, 0)$.

- Stacking all the domestic variables into a $k \times 1$ vector, where $k = \sum_{i=0}^{N} k_i$ yields:

$$\tilde{x}_t = (x'_{0t}, x'_{1t}, \ldots, x'_{Nt})'$$

Global VAR Methodology: Second Step

- The matrix W_i is of $(k_i + k_i^*) \times k$ dimension and defined by the country-specific trade weights w_{ij}.
- Hence, $\zeta_{it} = W_i \tilde{x}_t$ and based on equation *(4)* and multiple replacements

$$\vdots$$

- We obtain the reduced form GVAR(2) model for all the endogenous variables x_t:

$$\tilde{x}_t = v_{i0} + v_{i1}t + G_1\tilde{x}_{t-1} + G_2\tilde{x}_{t-2} + \varepsilon_t \tag{5}$$

where $G_1 = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_{N-1} W_{N-1} \end{pmatrix}^{-1} \begin{pmatrix} B_{01} W_0 \\ B_{11} W_1 \\ \vdots \\ B_{(N-1)1} W_{N-1} \end{pmatrix}$, $G_2 = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_{N-1} W_{N-1} \end{pmatrix}^{-1} \begin{pmatrix} B_{02} W_0 \\ B_{12} W_1 \\ \vdots \\ B_{(N-1)2} W_{N-1} \end{pmatrix}$,

$v_{i0} = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_{N-1} W_{N-1} \end{pmatrix}^{-1} \begin{pmatrix} \alpha_{00} \\ \alpha_{10} \\ \vdots \\ \alpha_{(N-1)0} \end{pmatrix}$, $v_{i1} = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_{N-1} W_{N-1} \end{pmatrix}^{-1} \begin{pmatrix} \alpha_{01} \\ \alpha_{11} \\ \vdots \\ \alpha_{(N-1)1} \end{pmatrix}$, $\varepsilon_t = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_{N-1} W_{N-1} \end{pmatrix}^{-1} \begin{pmatrix} u_{0t} \\ u_{1t} \\ \vdots \\ u_{(N-1)t} \end{pmatrix}$

Data and countries in our model

- We employ quarterly data ranging from 1980:I to 2016:IV (148 observations in total) for 28 developed and developing countries.
- Inclusion of 5 endogenous variables in the model:
  1. non-export real output (ny_{it})
  2. real gross capital formation (k_{it})
  3. real exports of goods and services (ex_{it})
  4. real imports of goods and services (im_{it})
  5. real effective exchange rate $(reer_{it})$
  6. real oil price $(poil)$ as a global variable

  (Data sources OECD, IMF and World Bank).
- All series are seasonal adjusted and refer to natural logarithm values.

Countries and Regions in the GVAR Model

China	**South Euro Area**	*Scandinavia*	*Rest of the World*
France	Greece	Norway	India
Japan	Italy	Sweden	Indonesia
UK	Portugal		Korea
USA	Spain		South Africa
			Turkey
North Euro Area	*Other Developed Economies*	*Latin America*	
Austria	Australia	Brazil	
Belgium	Canada	Mexico	
Finland	Ireland		
Germany	Switzerland		
Netherlands	New Zealand		

Model Specification

- Vectors of domestic and foreign variables are:

$$x_{it} = (ny_{it}, k_{it}, ex_{it}, im_{it}, reer_{it})' \; for \; i = 1, \ldots, 20$$

$$x^*_{it} = (ny^*_{it}, k^*_{it}, reer^*_{it})' \; and \; d_t = (poil) \; for \; i = 1, \ldots, 20$$

- For the case of the USA model:

$$x_{0t} = (ny_{0t}, k_{0t}, ex_{0t}, im_{0t}, reer_{0t}, poil)' \; and \; x^*_{0t} = (ny^*_{0t}, k^*_{0t}, reer^*_{0t})'$$

$$ny^*_{it} = \sum_{j=0}^{20} w_{ij} ny_{jt}, \; k^*_{it} = \sum_{j=0}^{20} w_{ij} k_{jt}, \; reer^*_{it} = \sum_{j=0}^{20} w_{ij} reer_{jt}$$

- Trade weights were based on total trade schemes (exports+imports) using data from IMF, Direction of Trade Statistics.
- Due to the possibility of $ex_{it} = im^*_{it}$ (see Greenwood-Nimmo *et al.*, 2010) we choose to include real trade variables only as endogenous in the system.

Long-Run Relationships in the GVAR Analysis

- We impose and test overidentifying restrictions in the elements of the country-specific cointegrating matrices β_i, as suggested by economic theory.
- Under this context, we are able to draw theory-based inferences regarding the transmission of shocks and interlinkages among northern and southern Euro area and the rest of the world.
- We consider the following economic theory equations:

Export-led-growth hypothesis		$ny_{it} - c_{1i}k_{it} - c_{2i}ex_{it} - c_{3i}im_{it} \sim I(0)$
"Enhanced" trade equations	*Exports*	$ex_{it} - a_{1i}im_{it} - a_{2i}ny^*_{it} - a_{3i}reer_{it} \sim I(0)$
	Imports	$im_{it} - \beta_{1i}ex_{it} - \beta_{2i}ny_{it} - \beta_{3i}reer_{it} \sim I(0)$
Stationarity of the Trade Balance		$ex_{it} - im_{it} \sim I(0)$

Modeling Strategy

- First, we define and estimate the unrestricted GVAR model based on various lags and deterministics (LR test). In most of the cases, we selected the lags of the domestic variables based on the AIC with $p_{i,max} = 2$, $q_i = 1$ in all cases.
  - In this way, we identify the cointegrating vectors of the individual VARX * models.
- Second, if there is evidence of cointegrating vectors (varying from 1 to 3 vectors in our case) we impose and test the theory-based overidentifying restrictions to the elements of matrix β_i.
- Third, we choose and impose only the long-run relations that satisfy the likelihood-ratio test and at the same time exhibit satisfying PPs, impulse responses and stability of the estimated coefficients.

Over-identified Long Run Restrictions in the GVAR model

Country	Imposed Restrictions	Type	p_i	q_i	r	LLR	99% CV
China	$ex_t - im_t$	$TB \sim I(0)$	2	1	1	24.15	32.65
France	$ny_t - 1.54k_t - 0.58ex_t + 1.18im_t$	$ELGH$	2	1	1	27.05	34.92
NEA	$ny_t - 3.14k_t - 3.38ex_t + 5.02im_t$	$ELGH$	2	1	1	10.68	29.92
SEA	$im_t - 0.86ex_t - 0.94ny_t - 1.02reer_t$	$Imports\,Eq.$	2	1	1	22.61	34.73
UK	$im_t - 0.57ex_t - 1.40ny_t - 0.24reer_t$	$Imports\,Eq.$	1	1	1	28.85	31.78
USA	$ex_t - 0.47im_t - 0.82ny_t^* + 1.6reer_t$	$Exports\,Eq.$	2	1	1	10.62	31.77

- In total, we include overidentifying restrictions for 15 of the 21 entities of our model.

Unit Root Test & Robustness Checks

- We base our unit root tests in the weighted symmetric estimation of the ADF test (WS) which introduced by Park and Fuller, (1995)
  - The majority of the variables of interest are *I(1).*
- We employ a test for the **weak exogeneity** of the foreign variables based on the works of Johansen (1992) and Harbo et al. (1998).
- We employ a battery of tests in order to determine the **stability of the estimated parameters** of the country-specific models (Ploberger and Kramer (1992) such PK sup and PK msq , Nyblom (1989) test for time-varying parameters and sequential Wald test such as QLR, MW and APW).
  - The results from both tests are reassuring for the countries/regions of interest. This contributes to the adequacy of the model.

Contemporaneous Effects on Domestic Counterparts

Country	Domestic variables		
	ny	k	$reer$
USA	0.07	0.60	0.11
	[0.56]	[3.28]	[0.52]
NEA	0.19	0.54	−0.44
	[0.82]	[3.56]	[−2.85]
SEA	0.28	0.54	0.31
	[3.11]	[3.66]	[1.22]
France	0.17	0.42	1.09
	[2.92]	[3.28]	[5.90]
UK	0.36	0.45	−1.78
	[2.58]	[1.86]	[−3.78]
China	0.29		0.30
	[2.10]		[0.59]

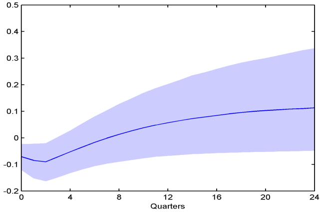
Note: Newey-West t-ratio's in brackets.

Dynamic Analysis of the GVAR Model

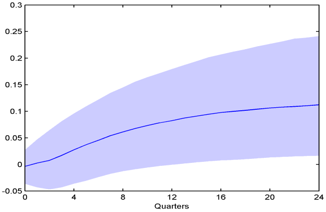
- To investigate the dynamic properties of the model we employ the Generalized Impulse Response Functions (GIRFs) as proposed by Koop, Pesaran and Potter (1996) and developed further by Pesaran and Shin (1998). We simulate the following scenarios:
  1. A positive shock to the real imports of the NEA and the SEA which proxies an expansionary shock in these sub-regions.
  2. A real depreciation to the SEA in order to assess the macroeconomic impact of higher competitiveness in the sub-region.
  3. U.S. origin shocks, concerning an increase in the domestic demand and a real depreciation of the economy.
  4. A negative oil supply shock.

Dynamic Analysis: An expansionary shock to the NEA

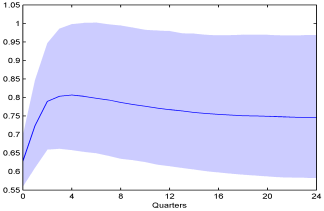
Effect on NEA real domestic output



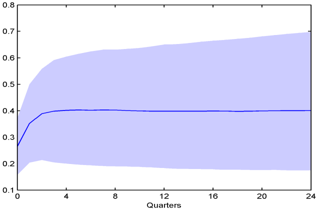
Effect on SEA real domestic output



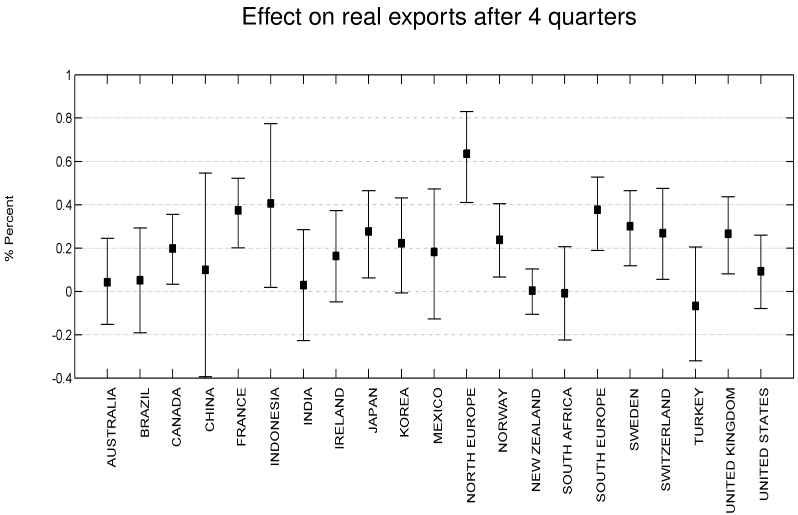
Effect on NEA real imports



Effect on SEA real imports

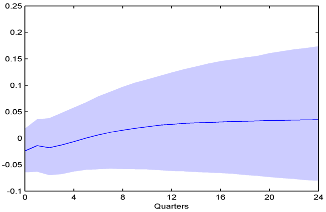


Dynamic Analysis: An expansionary shock to the NEA

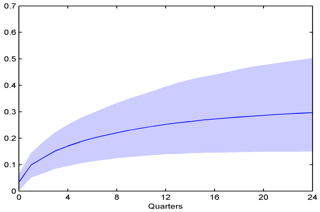


Dynamic Analysis: An expansionary shock to the SEA

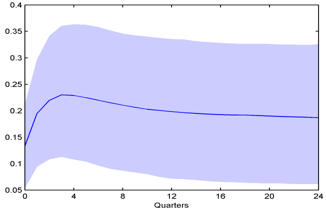
Effect on NEA real domestic output



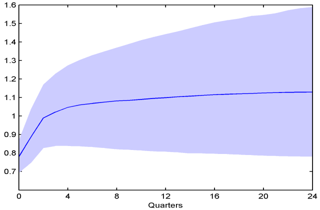
Effect on SEA real domestic output



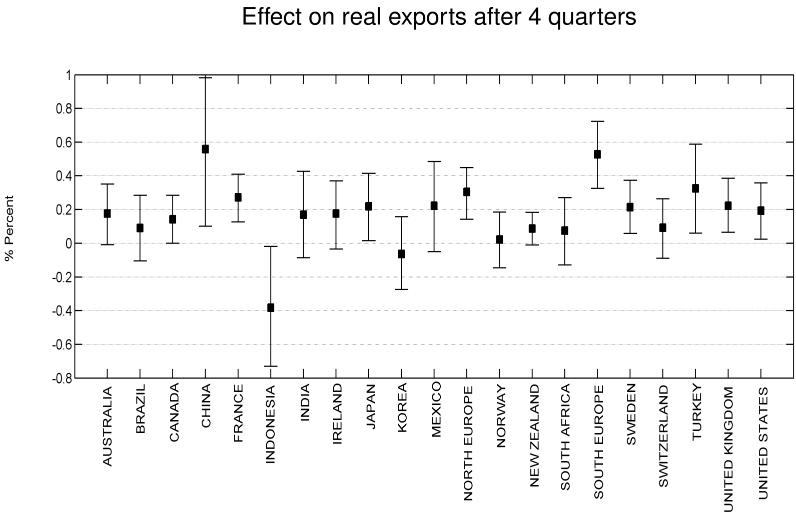
Effect on NEA real imports



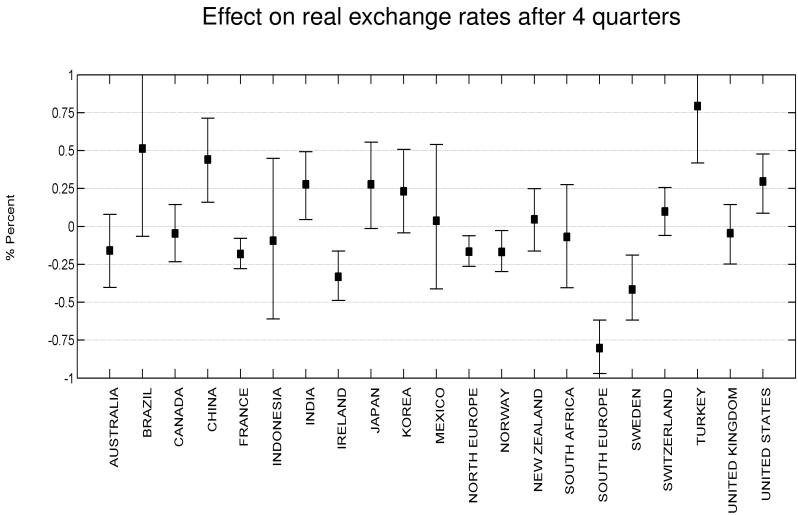
Effect on SEA real imports



Dynamic Analysis: An expansionary shock to the SEA

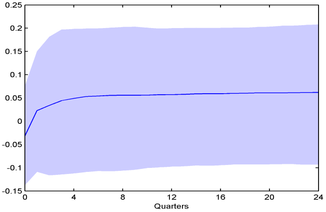


Dynamic Analysis: Real depreciation shock to the SEA

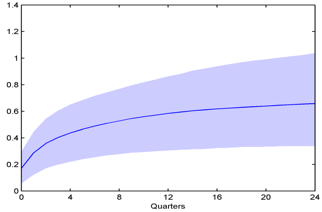


Dynamic Analysis: Real depreciation shock to the SEA

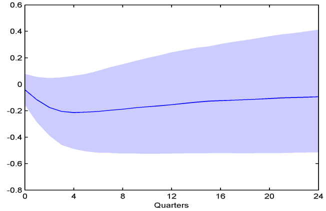
Effect on NEA real exports



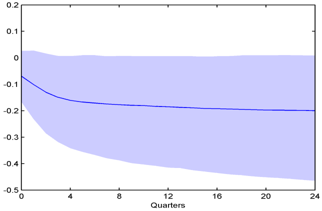
Effect on SEA real exports



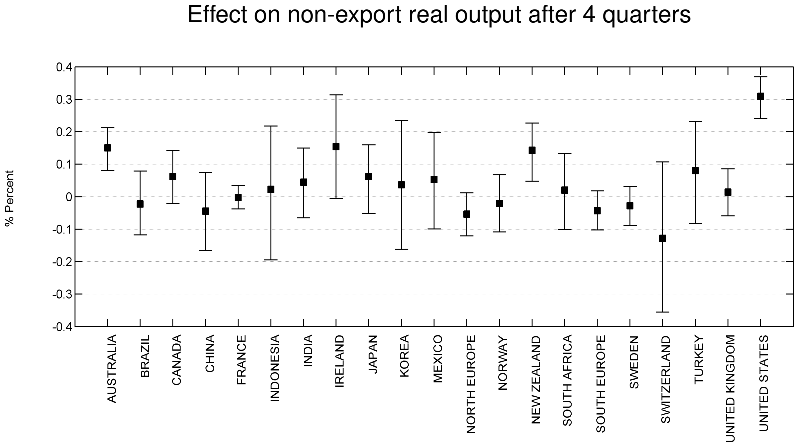
Effect on SEA real imports



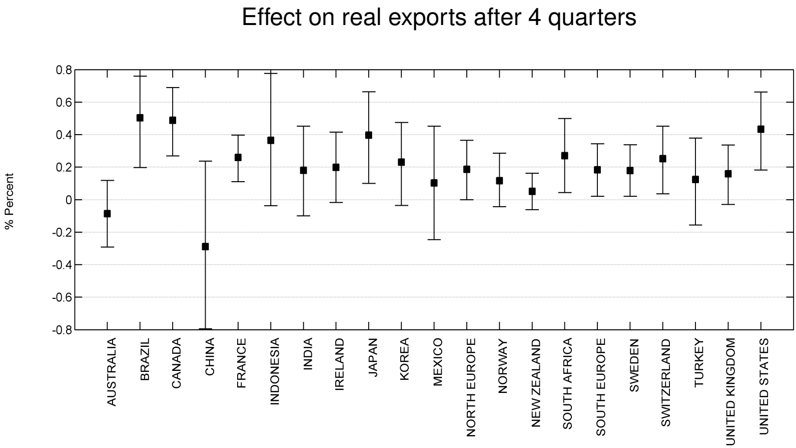
Effect on USA real exports



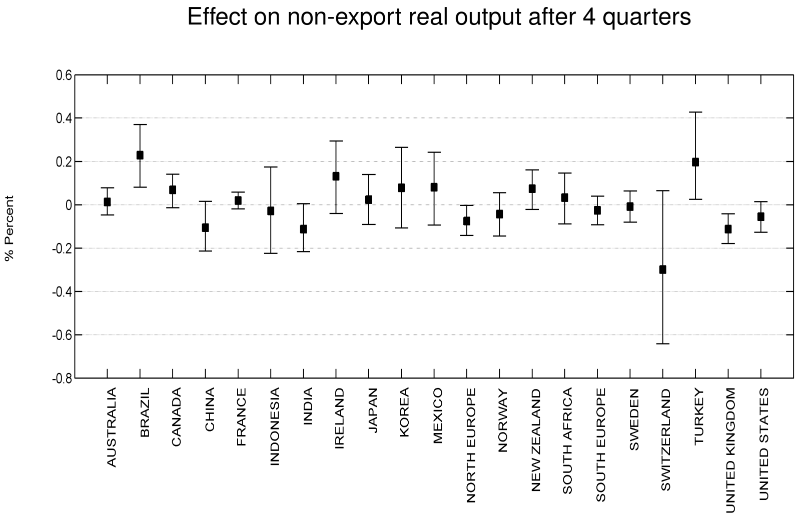
Dynamic Analysis: Positive shock to the U.S. real domestic output



Dynamic Analysis: Positive shock to the U.S. real domestic output



Dynamic Analysis: A negative oil supply shock



Conclusion

- In this study, we implemented a GVAR model using theory-based long-run restrictions in order to investigate trade imbalances and macroeconomic origin shock spillovers between NEA and SEA sub-regions, the USA and the rest of the world.
- The results seem in align with the consensus of a symmetric adjustment in the Eurozone.
- Enhanced output in the U.S has stimulating effects on global real trade flows while a real depreciation of the U.S economy would act positively on the CA adjustment.
- We propose two coordinated policies:
  1. Increased consumption (expansionary policy) in the NEA
  2. Increased competitiveness in the SEA
- Further research & paper extension:
  - Identification of the IRFs through sign restrictions
  - Connectedness measures based on GFEVDs

Thank you for your attention!