Passing European financial shocks through GVAR

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Dmitrij Celov (VU) and Laura Gudauskaitė (VU and LB)

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PROJECT “EURO4EUROPE”

Aim – to reassess business cycle synchronization (BCS) using an integrated approach.

Study the impact of European integration on business cycle asymmetries (BCA) and provide empirical evidence on the long standing dispute among proponents of endogenous optimal currency area (OCA) theories, on whether integration increases BCA (as argued by Frankel and Rose, 1998) or decreases it (Krugman, 1993).

…

B. Economic Integration and the Transmission of Macroeconomic Shocks. Here we will focus on transmission mechanisms on the BC. It will employ a GVAR framework to assess the transmission of macroeconomic demand and supply shocks across European countries. The comparison of shock transmission across countries within the euro area and in other world regions will also provide evidence the effects of integration on BC symmetry.

…

INTRODUCTION AND CONTRIBUTION

Research question and brief summary

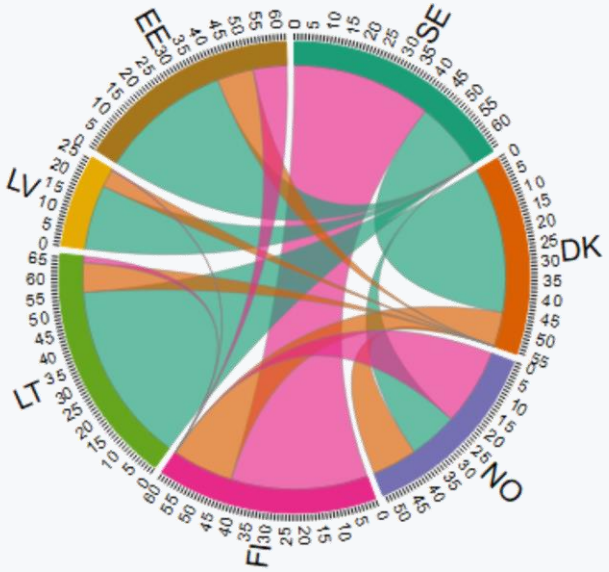


Figure 1: Financial liabilities between Baltic and Nordic countries

RESEARCH QUESTION

What?/Why?

- Within last two decades, the economic and financial integration within the European Union and euro area strengthened financial and trade linkages between club members, increased participation in global production chains (BIS Annual Economic Report, 2017), hypothetically implying higher risks for financial stability dealing with global and domestic shocks like the global financial crisis of 2008-2009 and recent COVID-19 pandemic lockdown
- Questions: how through financial and trade linkages shocks are transmitted and how macro-economic and financial sectors interact when shocks are transmitted(Dees et al. (2007), Galesi and Sgherri (2009))
- Figure 1 shows the percentage of financial liabilities between countries. The three Baltic States have the bulk of their commitments to Sweden, motivating the examples of shocks chosen for the paper
- This paper contributes to a better understanding of the transmission of financial shocks for European countries focusing on in the Baltic region: Lithuania, Latvia and Estonia and their interaction with Nordic countries, especially Sweden
- Previous research perceived Baltic trio as a single region (Galesi and Sgherri (2009), Sun, Heinz, and Ho (2013)) but are the Baltic countries homogenous in their response to the financial shocks?

  → The countries more financially related to Nordic countries are more responsive to Nordic shocks

RESEARCH QUESTION

And How?

- This paper analyses linkages between European countries using Global VAR (GVAR) approach (Pesaran, Shuermann, and Weiner (2004)) allowing for separate investigation of the Baltic trio and their interaction with the Nordic region
- GVAR is a two-step approach:
  1. Evaluates separate VARX models for each country using domestic and foreign variables
  2. Separate models are combined in one system to solve Global VAR model that allows analyzing cross-border spillovers between countries
- The matrix of weights reflects the strength of financial linkages – cross-border position liabilities – between European countries as they fit-for-purpose of analysing the financial stability
- Coverage: The analysis covers macroeconomic and financial variables for 30 European countries
- Sampled from 2006Q1 to 2019Q2 (54 quarters)
- 5 variables: real GDP, loans to the non-financial private sector, CPI inflation, interest rate, and house price index

LITERATURE REVIEW

Bilateral? Panel? Go GVAR!

http://www.econ.cam.ac.uk/people-files/emeritus/mhp1/Resources.html

LITERATURE REVIEW

Bilateral? Panel? Go GVAR!

- Two cross-country spillovers modelling frameworks are often encountered:
  1. Bilateral models analysing the link between the spillover-sender and the spillover-recipient
  2. Panel VAR framework with a single spillover sender and multiple spillover-recipients (Ioannou (2018))
- Cons: while bilateral models are easy to implement, they do not account for a higher geographical dimension. Panel VAR can estimate a higher dimension, but they do not capture any linkages (feedback loops) between countries
- A GVAR, on the contrary, allows us to study relationships between countries and treat separate subsystems inside a global system
- As all three Baltic economies are small and relatively open to trade, analysis requires to consider the size of the economy and ~~trade-related linkages~~ financial linkages as the main of focus of current research
- GVAR is a comprehensive and flexible way to tackle high-dimensional systems such as the global economy and variuos spillovers in, for instance, credit and labour markets.
- The flexibility is achieved by picking the fit-for-purpose weighting matrix, for financial stability this is the cross-border positions of the countries as the banking sector is exposed to the shocks in the countries where the financial institutions own their assets (Galesi and Sgherri (2009))

LITERATURE REVIEW

Go GVAR!

- Pesaran and Smith (2006) showed that:
  1. VARX* models can be derived as the solution to a dynamic stochastic general equilibrium (DSGE) model where overidentifying long-run theoretical relations can be tested and imposed if acceptable (and similar to short-run ones)
  2. Impulse response functions from a GVAR model help analysing interdepedencies of the countries involved and the transmission of the shocks across countries
- Mauro and Smith (2013) discuss if foreign variables are weakly exogenous. This means that every country can be estimated as a single small economy. Due to weak exogeneity, country models can be estimated individually and the number of parameters decreases substantially (feasible solution to the curse-of-dimensionality).
- The studies of financial linkages in Europe often consider wider regions: West, Nordic, Baltic, Central (Sun, Heinz, and Ho (2013), Galesi and Sgherri (2009)).

- The focus of the current study is on higher granularity (country level) of Europe with specific attention paid to the individual responses of Baltic countries (Lithuania, Latvia, Estonia) to the shocks originated from Sweden – the base country in current research

THE GVAR APPROACH

A lazy half-page introduction

GVAR is a set of VARX models specified for each country *i*:

$$x_{i,t} = a_{i,0} + a_{i,1}t + \underbrace{\sum_{j=1}^{q_i} \alpha_{i,j} x_{i,t-j}}_{endogeneous} + \underbrace{\sum_{j=0}^{q_i^*} \beta_{i,j} x_{i,t-j}^*}_{foreign} + \underbrace{\sum_{j=1}^{l_i} \gamma_{i,j} d_{t-j}}_{global} + u_{i,t},$$

where $u_{i,t} \sim \text{iid}(0, \Sigma_{u,i})$. The foreign variables in a country's VARX are constructed as weighted averages of other countries' variables:

$x_{i,t}^* = \sum_{j=1}^{N} w_{i,j} x_{j,t}$, where $w_{i,j}$, $i, j = 1, 2, \ldots, N$ financial linkages based weights, $w_{i,i} = 0$.

Two step procedure:

1. Matrix error-correction form VARX with (likely) weakly exogenous variables individually estimated for $A_{i,j}$
2. Stack into GVAR using estimated parameters $A_{i,j}$ and link matrices W_i and good luck with matrix algebra

DATA

Countries, and variables

27 European Union countries, the UK, Switzerland and Norway sampled from 2006Q1 to 2019Q2 (54 quarters)

Notation	Variable	Description	Transformation	Source
gdp	Real gross domestic product	Seasonally adjusted	Log	Eurostat
credit	Bank loans to the non-financial private sector	Credit to households and non financial corporations	Log	ECB SDW
inflation	Consumer price index	2015 = 100	Log	Eurostat
interest rate	Long-term interest rates	May be government bond rate or bank lending rate depending on countries	Non	ECB SDW
hpi	House price index	2015 = 100	Log	Eurostat

Some country specific models do not have all variables

LINK MATRIX

Cross-border position liabilities

	SE	DK	NO	FI	LT	LV	EE	PL	PT	ES	CZ	HU	SK	SI	HR	RO	AT	BE	GB	CH	CY	FR	DE	GR	IE	IT	LU	MT	NL	IS
SE	0,000	0,218	0,000	0,431	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,012	0,153	0,008	0,000	0,039	0,074	0,000	0,001	0,001	0,019	0,000	0,039	0,000
DK	0,449	0,000	0,000	0,106	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,011	0,104	0,004	0,000	0,100	0,183	0,000	0,008	0,003	0,008	0,000	0,018	0,000
NO	0,150	0,140	0,000	0,237	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,006	0,299	0,007	0,000	0,079	0,043	0,000	0,007	0,006	0,013	0,000	0,009	0,000
FI	0,423	0,190	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,009	0,026	0,169	0,012	0,000	0,084	0,028	0,000	0,003	0,010	0,008	0,000	0,034	0,000
LT	0,558	0,091	0,000	0,020	0,000	0,000	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,012	0,068	0,053	0,000	0,090	0,045	0,000	0,001	0,000	0,042	0,000	0,002	0,000
LV	0,199	0,055	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,000	0,000	0,000	0,120	0,052	0,164	0,108	0,000	0,110	0,116	0,000	0,001	0,002	0,049	0,000	0,014	0,000
EE	0,406	0,113	0,000	0,104	0,000	0,000	0,000	0,000	0,000	0,023	0,000	0,000	0,000	0,000	0,000	0,000	0,046	0,006	0,023	0,079	0,000	0,117	0,035	0,001	0,001	0,001	0,032	0,000	0,014	0,000
PL	0,023	0,034	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,057	0,000	0,000	0,000	0,000	0,000	0,000	0,037	0,074	0,416	0,080	0,000	0,091	0,093	0,000	0,011	0,013	0,024	0,000	0,046	0,000
PT	0,006	0,010	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,292	0,000	0,000	0,000	0,000	0,000	0,000	0,007	0,025	0,201	0,087	0,000	0,222	0,044	0,000	0,007	0,007	0,055	0,000	0,037	0,000
ES	0,003	0,012	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,051	0,249	0,071	0,000	0,348	0,082	0,000	0,018	0,118	0,027	0,000	0,010	0,000
CZ	0,002	0,110	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,245	0,060	0,135	0,122	0,000	0,128	0,161	0,000	0,015	0,011	0,006	0,000	0,000	0,000
HU	0,001	0,024	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,016	0,000	0,000	0,000	0,000	0,000	0,000	0,222	0,163	0,144	0,055	0,000	0,082	0,108	0,000	0,028	0,145	0,011	0,000	0,000	0,000
SK	0,002	0,017	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	0,000	0,000	0,000	0,000	0,000	0,000	0,262	0,015	0,274	0,055	0,000	0,218	0,063	0,000	0,038	0,029	0,024	0,000	0,000	0,000
SI	0,002	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,009	0,000	0,000	0,000	0,000	0,000	0,000	0,255	0,016	0,163	0,029	0,000	0,253	0,177	0,000	0,000	0,035	0,013	0,000	0,041	0,000
HR	0,006	0,002	0,000	0,005	0,000	0,000	0,000	0,000	0,000	0,024	0,000	0,000	0,000	0,000	0,000	0,000	0,171	0,094	0,127	0,068	0,000	0,139	0,260	0,000	0,000	0,081	0,006	0,000	0,015	0,000
RO	0,003	0,007	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,024	0,000	0,000	0,000	0,000	0,000	0,000	0,240	0,040	0,118	0,085	0,000	0,054	0,144	0,102	0,007	0,160	0,016	0,000	0,000	0,000
AT	0,004	0,034	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,024	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,128	0,102	0,000	0,240	0,359	0,000	0,004	0,050	0,015	0,000	0,029	0,000
BE	0,003	0,004	0,000	0,224	0,000	0,000	0,000	0,000	0,000	0,013	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,158	0,034	0,000	0,214	0,092	0,000	0,016	0,018	0,031	0,000	0,190	0,000
GB	0,026	0,019	0,000	0,014	0,000	0,000	0,000	0,000	0,000	0,042	0,000	0,000	0,000	0,000	0,000	0,000	0,011	0,051	0,000	0,101	0,000	0,267	0,168	0,008	0,050	0,061	0,016	0,000	0,164	0,000
CH	0,009	0,018	0,000	0,011	0,000	0,000	0,000	0,000	0,000	0,012	0,000	0,000	0,000	0,000	0,000	0,000	0,013	0,024	0,396	0,000	0,000	0,198	0,117	0,000	0,007	0,009	0,113	0,000	0,072	0,000
CY	0,005	0,005	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,041	0,021	0,212	0,409	0,000	0,046	0,053	0,100	0,001	0,003	0,080	0,000	0,020	0,000
FR	0,007	0,006	0,000	0,007	0,000	0,000	0,000	0,000	0,000	0,124	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,077	0,281	0,072	0,000	0,000	0,079	0,001	0,038	0,145	0,084	0,000	0,072	0,000
DE	0,011	0,014	0,000	0,013	0,000	0,000	0,000	0,000	0,000	0,047	0,000	0,000	0,000	0,000	0,000	0,000	0,059	0,016	0,277	0,045	0,000	0,244	0,000	0,004	0,030	0,054	0,094	0,000	0,091	0,000
GR	0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,019	0,431	0,194	0,000	0,073	0,153	0,000	0,008	0,006	0,076	0,000	0,022	0,000
IE	0,007	0,007	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,015	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,049	0,495	0,010	0,000	0,204	0,033	0,001	0,000	0,058	0,031	0,000	0,083	0,000
IT	0,001	0,002	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,043	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,020	0,238	0,068	0,000	0,401	0,100	0,001	0,055	0,000	0,054	0,000	0,004	0,000
LU	0,016	0,003	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,014	0,000	0,000	0,000	0,000	0,000	0,000	0,020	0,061	0,161	0,050	0,000	0,438	0,138	0,003	0,008	0,056	0,000	0,000	0,032	0,000
MT	0,020	0,010	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,016	0,000	0,000	0,000	0,000	0,000	0,000	0,052	0,045	0,191	0,276	0,000	0,136	0,063	0,012	0,006	0,016	0,117	0,000	0,040	0,000
NL	0,006	0,004	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,031	0,000	0,000	0,000	0,000	0,000	0,000	0,004	0,107	0,391	0,021	0,000	0,243	0,096	0,001	0,057	0,016	0,015	0,000	0,000	0,000
IS	0,061	0,080	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,069	0,560	0,035	0,000	0,065	0,068	0,000	0,019	0,000	0,030	0,000	0,005	0,000

EMPIRICAL RESULTS

Co-integrating relationships and lag order

Country	co-integrating relationships	p	q
Sweden	3	2	1
Denmark	3	1	1
Norway	2	1	1
Finland	4	1	1
Lithuania	3	2	1
Latvia	4	2	1
Estonia	3	2	1
Poland	3	2	1
Portugal	4	2	1
Spain	4	2	1
Czech Respublic	1	2	1
Hungary	3	1	1
Slovakia	3	1	1
Slovenia	3	2	1
Croatia	1	2	1
Romania	1	2	1
Austria	1	2	1
Belgium	2	1	1
UK	3	2	1
Switzerland	1	2	1
Cyprus	5	2	1
France	2	2	1
Germany	3	2	1
Greece	3	2	1
Ireland	2	2	1
Italy	3	2	1
Luxembourg	3	2	1
Malta	5	2	1
Netherlands	4	2	1
Iceland	1	2	1

TRANSFORMATIONS AND TESTS

Some standard processing steps

- Logarithmically transformed trending variables: GDP, credit, CPI and housing prices → proportions are more stable than absolute differences
- ADF test for the order of integration
- Johansen trace statistic for cointegration
- Akaike information criterion (AIC) used to select the order of the VARX system
- Weak exogeneity tested applying:
  1. Johansen (1992) and Harbo (1998) procedure – roughly in this context that ECM terms jointly do not have a statistically significant impact on the development of foreign variables each tested individually by F-test
  2. Pairwise weak cross-sectional correlation analysis between individual model residuals and exogenous variables following Pesaran, Shuermann, and Weiner (2004)

WEAK EXOGENEITY

- The weak exogeneity is not rejected with some exceptions
- Several countries (Czech Republic, Iceland or Romania) have rejected weak exogeneity assumption at a 5% significance level but they are not in the focus of research
- Nordic countries and Baltic states have not rejected weak exogeneity for all foreign variables

- We expect the distortions of violation of weak exogeneity will be minimal on the focus group of countries (?)

Country		gdp^*	$credit^*$	$inflation^*$	$interestrate^*$	hpi^*
Sweden	F(3,39)	0.10	1.19	0.06	2.05	1.01
Denmark	F(1,47)	1.56	1.02	0.48	0.03	0.90
Norway	F(3,44)	0.15	1.46	1.33	2.01	0.88
Finland	F(4,43)	1.82	2.06	0.13	0.66	0.13
Lithuania	F(3,39)	0.56	1.98	0.05	1.13	0.98
Latvia	F(3,44)	2.01	0.56	0.62	0.55	1.87
Estonia	F(2,40)	0.23	1.17	0.03	0.94	2.01
Poland	F(3,41)	1.53	0.18	0.96	0.07	1.02
Portugal	F(4,38)	1.23	1.01	0.19	0.52	0.13
Spain	F(1,43)	1.06	3.05	0.49	0.23	1.03
Czech Respublic	F(1,45)	2.03	0.12	4.31	0.98	1.27
Hungary	F(2,47)	1.59	1.16	0.69	2.05	0.18
Slovakia	F(3,44)	1.76	2.66	0.25	0.06	0.37
Slovenia	F(2,48)	0.58	1.54	0.65	1.15	0.97
Croatia	F(1,49)	0.14	1.37	0.89	1.01	0.55
Romania	F(4,41)	0.09	2.02	1.06	3.21	0.88
Austria	F(2,49)	0.45	1.36	0.86	1.09	1.88
Belgium	F(1,49)	1.13	1.32	0.96	2.97	0.21
UK	F(3,44)	0.85	1.41	1.87	0.15	0.64
Switzerland	F(2,41)	2.22	0.52	0.63	0.78	1.37
Cyprus	F(1,48)	0.05	0.68	1.41	1.58	0.95
France	F(3,42)	0.69	1.29	0.03	2.01	0.76
Germany	F(2,46)	0.55	0.12	1.22	2.07	2.05
Greece	F(3,40)	2.01	0.89	0.68	0.04	1.67
Ireland	F(2,47)	0.55	1.06	1.13	0.56	1.38
Italy	F(1,47)	2.23	0.86	0.03	0.15	1.74
Luxembourg	F(1,48)	0.81	1.44	0.12	0.26	1.06
Malta	F(3,41)	0.56	1.25	0.02	2.06	0.22
Netherlands	F(2, 46)	0.06	1.58	1.24	1.89	0.02
Iceland	F(3,42)	0.39	1.23	3.05	1.84	2.59

GENERALIZED IMPULSE RESPONSE FUNCTIONS

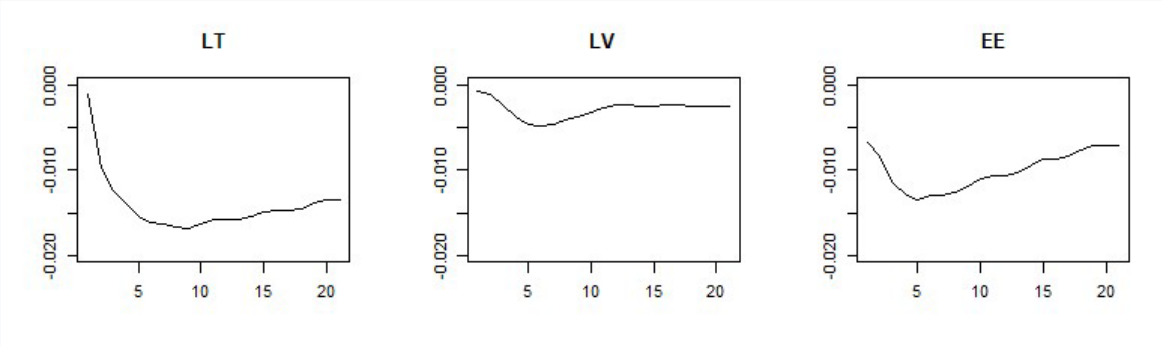
A lazy introduction without formulas

- A GVAR model with his high dimensionality and cross-country interactions brings difficulties for the identification of shocks across countries.
- The GIRF approach (Pesaran, Shuermann, and Weiner (2004), Pesaran and Smith (2006), Dees et al. (2007)) does not aim identification of shocks, it represents historical correlations of impulses

- Pros: unlike the orthogonalized impulses, the generalized impulses are invariant to ordering variables and the countries in the GVAR model

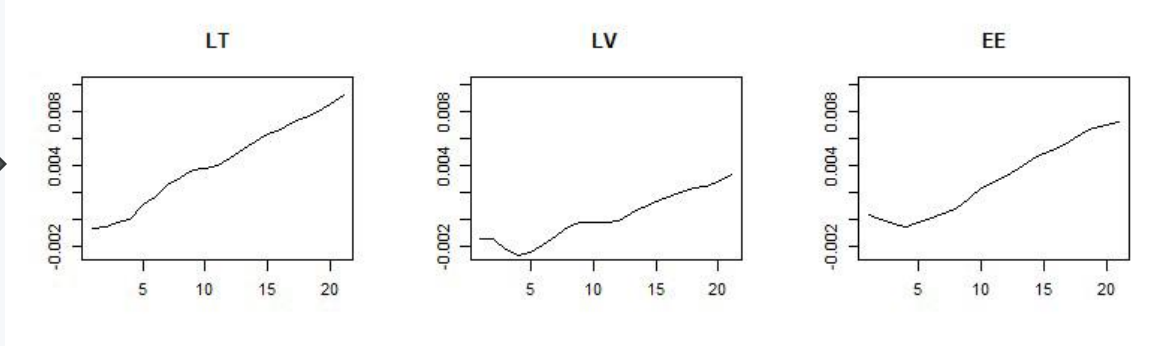
REAL ECONOMY SHOCK

1% decrease in Sweden's real GDP
(x100 means percentage points on scales)



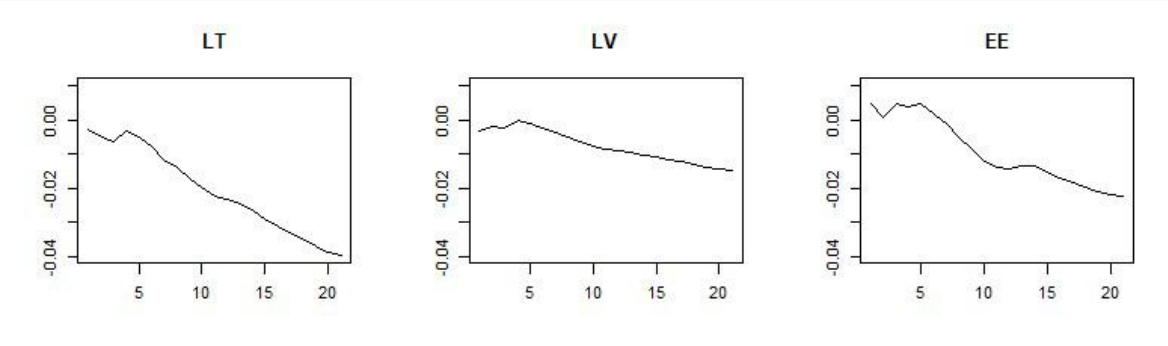
Stronger financial linkage implies higher negative impact on GDP…

… while deflation response after couple of years reverts



FINANCIAL SHOCK

1% decrease in Sweden's credit to private non-financial sector
(x100 means percentage points on scales)



Stronger financial linkage implies higher negative impact on credit

TAKEAWAYS

Stronger financial linkages make economies more vulnerable to macro-financial shocks

- The GVAR modelling framework employed in this paper provides a reasonable and manageable spatial-temporal structure for the analysis of the transmission of financial and real economic shocks originated in Sweden and second-round effects
- Greater global financial integration and increasing cross-border liabilities between countries magnifies the probability of financial and real economic imbalances
- Baltic economies are dependent on the Nordic countries. Sweden accounts for more than half of Lithuania's liabilities 55 percent followed Estonia with 40 percent and Latvia 20 percent.
- The greater liabilities imply higher responses to macro-financial shocks, where Lithuania reacts the most followed by Estonia and Latvia being the least responsive.
- Impulse response analysis show that financial and real economic shocks are transmitted relatively quickly in Baltic states and the impacts are quite persistent for GDP and credit

THANK YOU FOR YOUR ATTENTION!

GRAZIE! AČIŪ! DANKE!

Contacts: Laura Gudauskaitė

LGudauskaite@lb.lt

Contacts: Dmitrij Celov

dmitrij.celov@mif.vu.lt