Sovereign-Bank Nexus: Sovereign Debt Shocks Propagation and Their Role in Forecasting Episodes of Financial Distress

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SGH

Why does Sovereign-Bank Nexus (SBN) matter?

Sovereign-Bank Nexus in a nutshell

When the sovereign debt market experiences periods of stress, the **lending capacity of local banks tends to be impaired**. *The resulting* **credit crunch** *leads to a deterioration of the economy, which eventually ends up* **exacerbating the stress in the sovereign debt market** *even further.*

Albertazzi, Cimadomo, and Maffei-Faccioli (2022)

Sovereign-Bank Nexus from a policy perspective

We must also break the **vicious cycle** *of banks hurting sovereigns and sovereigns hurting banks.* **This works both ways.** *Making banks stronger (. . .) stops banks from hurting sovereigns (. . .) and restoring confidence in sovereign debt helps banks, which are important holders of such debt*

Christine Lagarde (2012)

My research in a nutshell

- **What's the problem?** Sovereign debt shocks (SDS) can generate periods of elevated systemic distress[1]. **Empirical literature hasn't reached consensus on how to identify them econometrically**
- **What do I do?**
  1. Building upon Antolín-Díaz and Rubio-Ramírez (2018), I develop a novel **identification scheme:** Sign-Restricted Narrative Approach (SRNA)
  2. Propagation schemata derived from SRNA (IRFs) are put into a **macroprudential early-warning logit** (EWL) as input scenarios to study **impact on systemic stress**
- **What do I find?** Estimation of a SVAR model documents several sovereign-bank nexus-related phenomena:
  1. Substantial role of SDS in shaping supply of loans
  2. Significance of the balance sheet transmission channel
  3. Heavy build-up of systemic stress following a SDS incident, up to 3.74% in a 12M horizon

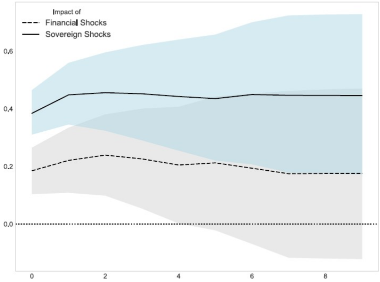
[1] Due to the vicious circle of sovereign debt valuation and the financial sector (Sovereign-Bank Nexus, SBN).

Agenda

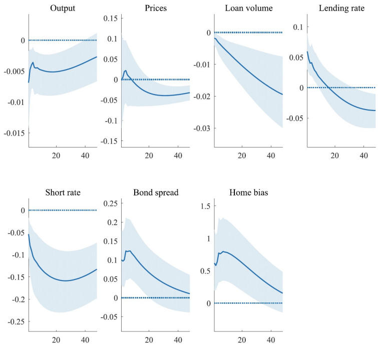
SDS identification: state of the game

1. Empirical literature on SDS identification: **no consensus**
2. Two **most notable** identification approaches:
   - **Narrative Approach**:
     - Extremely versatile
     - Allows for detailed examination of the known shock periods
   - **Sign restrictions**
     - Easy alignment of the model to stylised facts and theoretical findings
     - Ambiguous in character, minimally restrictive
3. Building on Antolín-Díaz and Rubio-Ramírez (2018), I aim to **reconcile** both those identification schemes and **apply them jointly** to the empirical study of SBN in seven EA countries.

SDS identification: excerpts from the literature



(a) Manzo and Picca (2018)



(b) Palmén (ibid.)

Figure: SDS IRFs identified with narrative methods (LHS) and sign restrictions (RHS).

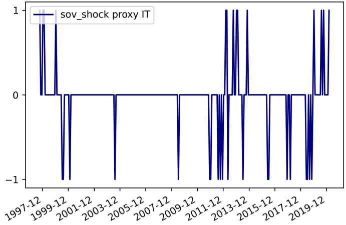
Agenda

SRNA step 1: SDS proxy estimation (1/2)

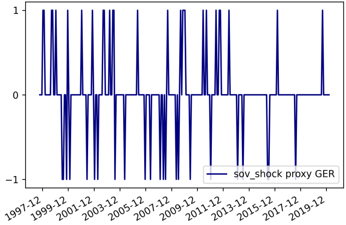
SDS proxy is derived from in-sample forecast errors of long-term (10Y maturity) sovereign debt interest rate (LTI) using an ARIMA model. Derivation goes **country by country** as to fully capture **cross-country heterogeneity**.

1. Take series of monthly, country-specific LTI data and fit the ARIMA forecasting model. Choose AR, I, and MA orders which minimises Bayesian Schwarz information criterium (BIC, see Schwarz, 1978)
2. After ARIMA estimation, conduct in-sample forecast
3. Compute forecast errors
4. Fix a cut-off point at a country-specific level. Identify periods with absolute errors above the chosen cut-off and label them as shock periods
5. Label periods with highest positive errors as negative shocks (-1) and periods with highest absolute negative errors as positive shocks (+1). All other periods take value 0.

SRNA step 1: SDS proxy estimation (2/2)



(a) Italy



(b) Germany

Figure: SDS proxy based on ARIMA in-sample forecast LTI errors with 80% cut-off threshold.

Appendix: Why country-specific thresholds?

Agenda

SRNA step 2: sign restrictions (1/2)

Assumption: SDS transmitted *via* balance sheet channel have:

- **Positive (+)** impact on:
  - Domestic bonds portfolio (*home bias*)
  - Credit supply
- **Negative (-)** impact on:
  - Foreigns bonds portfolio (*run to quality*)

Assumption: SDS regardless of transmission channel have:

- **Positive (+)** impact on:
  - Credit supply

SRNA step 2: sign restrictions (2/2)

Identification matrix B_0^{-1} is defined as follows:

$$B_0^{-1} = SH \tag{1}$$
$$S = \mathrm{chol}(\Sigma) \tag{2}$$
$$H : (HH^T = \mathcal{I}) \text{ and sign restrictions satisfied} \tag{3}$$

There are infinitely many matrices H satisfying this definition. Sampling algorithm is following:

1. Take $S = \mathrm{chol}(\Sigma)$
2. Draw $M_{n,n}$ such that $\forall_{1 \leq i,j \leq n} M_{i,j} \sim \mathcal{N}(0,1)$
3. Make QR decomposition and normalise: $M = QR$
   Appendix: Normalisation of diagonal
4. Let $H = Q$.
   - If in given periods k impulse responses of variable i to SDS $(\mathbb{A}^k_{[i,1]} \cdot SH)$ satisfy restrictions: `iteration successful`
   - Else go back to step 2 (draw new matrix M)

SRNA step 3: SVAR specification and estimation

Model specification (all variables in logs but for the SDS proxy):

$$Y_t = \left[proxy_t \quad BH_t^{\text{dom}} \quad BH_t^{\text{for}} \quad L_t \quad rGDP_t \right]' \tag{4}$$

Estimation of a reduced-form SVAR:

$$Y_t = \sum_{j=1}^{p} A_{t-j} Y_{t-j} + \epsilon_t \tag{5}$$

Baseline specification has $p = 5$ lags as indicated by AIC.

Data overview

The dataset includes **monthly** data spanning from late 90s to the end of 2023, i.e. **306-314 observations per country**. The dataset includes **GIPS, Germany, France, and the Netherlands**. Data sources:

- **ECB SDW** (balance sheet entries and credit supply: BSI, LTI: IRS)
- **FRED** (real GDP)

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EWL specification and estimation

- I estimate probability of a financial crisis outbreak with **country-specific logits**. Common tendencies come from a **panel**
- Benchmark specification comprised credit gap as the sole regressor[2].
- Alternative specification selected additional controls from a broad pool proposed by Jarmulska (2020). More on controls

$$ProbSys_t = \alpha_0 + \alpha_1 Basel_t + \sum \beta_i Control_{i,t} \tag{6}$$

- For the purpose of EW, lag distribution has been applied:

$$ProbSys_t = \alpha_0 + \sum_{i=1}^{I} \alpha_i Basel_{t-i} + \sum_{j}^{J} \sum_{k}^{K} \beta_{j,k} Control_{j,t-k} \tag{7}$$

Data overview

- **Dependent variable** comes from ESRB Financial Crisis Database (Lo Duca et al., 2017) which comprises detailed data on systemic stress spells in the Euro Area. The series is of **monthly** frequency, spanning from early 70s to 2017.

Bridging SVAR to the EWL *via* cIRF

Note: for simplicity it is assumed that a SDS has **no impact** *on GDP. Empirical findings support this assumption.*
Note: post-SDS values are apostrophed (')
Given that SVAR is estimated in logs, cumulative IRf of credit supply is given by:

$$cIRF_t = \log L'_t - \log L_t = \log \frac{L'_t}{L_t} \tag{8}$$

$$gap'_t = gap_t \times e^{cIRF_t} \tag{9}$$

Eventually — given that **contemporaneous credit gap is the sole driver of systemic stress**, as in the baseline specification — we have:

$$\Delta p_{systemic} = \frac{dy}{dx} \times gap_t (e^{cIRF_t} - 1) \tag{10}$$

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Findings — SDS transmission *via* balance sheet channel

- *Home bias* **present** in **all economies** — yet peak impact timing differs tremendously IRF
- *Run to quality* **measures resistance to SDS** — it's **permanently negative** in fiscally weakest economies (Greece), **indifferentiable from zero** in the most austere (Germany, the Netherlands), in other cases **transitory** IRF
- **Credit** IRF to SDS **similar in all countries** (instantaneous impact approx. 0,005, wanes out in a year) IRF
- Impact on **GDP**: actually **insignificant**; notably, **confidence bands converge over time** IRF

Review of the robustness checks

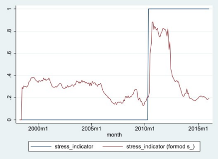
Findings — systemic stress build-up

country group	country	0M effect [%]	12M effect [%]
GIPS (non-austere)	Greece	0.39	3.74
	Italy	0.04	0.34
	Portugal	0.20	3.30
	Spain	0.33	1.72
non-GIPS (austere)	Germany	0.38	2.61
	France	0.34	3.32
	Netherlands	0.32	1.86

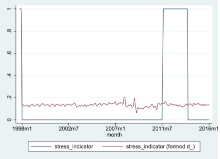
Table: Increment in probability of a systemic crisis outbreak following a sovereign yield shock (baseline specification)

More on marginal effects | AUROC statistics | Panel estimates

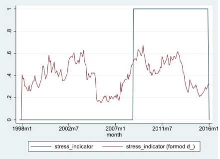
EWL: in-sample forecasting capacity



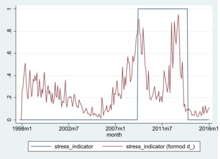
(a) Greece



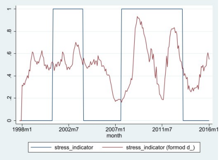
(b) Italy



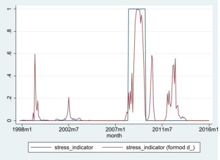
(c) Portugal



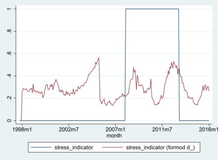
(d) Spain



(e) Germany



(f) France



(g) Netherlands

Figure: EWL performance in an in-sample forecasting exercise

Findings: — balance sheet channel *vs* other channels

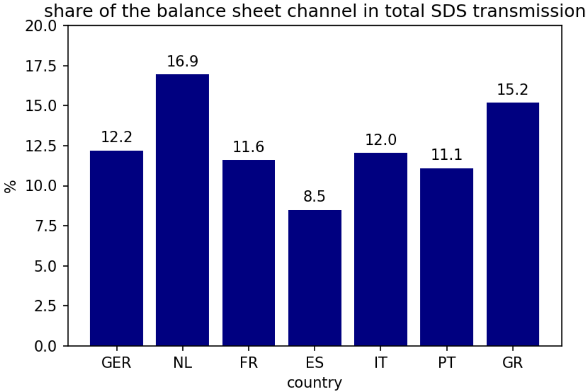


Figure: Ratio of acceptance ratios (3 sign restrictions *vs* 1)

Findings — cross-country contagion

	GR	IT	PT	ES	GER	FR	NL
GR	1.00	0.08	0.33	0.12	-0.07	-0.04	-0.04
IT		1.00	0.38	0.62	0.27	0.45	0.38
PT			1.00	0.42	0.17	0.22	0.21
ES				1.00	0.45	0.59	0.55
GER					1.00	0.81	0.83
FR						1.00	0.90
NL							1.00

Table: Correlations between country-specific SDS indicators

All in all, despite **heavy GIPS-to-GIPS and austere-to-austere SDS proxy correlations**, overall contagion effects seem limited. More

SRNA robustness checks

SRNA identification scheme has been subject to various robustness checks:

1. **More selective SDS threshold:** In line with Antolín-Díaz and Rubio-Ramírez (2018), narrative identification of SDS has been based on extremely rare events (approx. 3 per country) More
2. **Rolling 3M sum of SDS proxy:** This method takes into account possible cumulation of subsequent shocks More
3. **One-sided SDS proxy:** Ultimately, one-sided proxy allows for non-symmetric IRFs to positive and negative shocks

Results **do not diverge** from the baseline findings.

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Conclusions

Regarding **impact on the systemic risk in the EA**:

1. **Significant, instantaneous effect** on systemic stress with **rapid build-up** of risk

Regarding **Sign-Restricted Narrative Approach** (SRNA):

1. My method allows to **document particular SBN-related phenomena** in the EA:
   - balance sheet phenomena (*home bias, run to quality*)
   - nominal phenomena (impact on the supply of credit)
   - real (no impact on real GDP)
2. It shows the role of **balance sheet channel** in SDS identification. This channel is responsible for approx. **20% of the overall transmission**

Regarding **Sovereign-Bank Nexus** (SBN):

1. SDS have significant impact on credit supply
2. No **direct impact** on real GDP

Thank you for your attention!
Any remarks are more than welcome!

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Agenda

Threshold selection — discussion

- **Heterogeneity** across LTI processes in different Eurozone countries is **clearly visible**
- **Relative approach** addresses the issue of cross-country heterogeneity — there **does not exist a single, absolute cut-off** that could fit both austere economies and GIPS countries

country group	country	SD
GIPS (non-austere economies)	Greece	0.9222
	Italy	0.2732
	Portugal	0.3084
	Spain	0.2301
non-GIPS (austere economies)	Germany	0.1601
	France	0.1685
	Netherlands	0.1626

Table: In-sample LTI one-period-ahead forecast error standard deviation

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Normalisation of H diagonal

- QR decomposition of a given matrix is **indefinite**
  - In particular, it is **indefinite wrt sign**
- QR algorithm implementation (both `R` and `Python`) **forces** $Q[1,1] < 0$ and thus **is biased towards** negative diagonal
- **Solution:** Normalisation of Q columns with negative diagonal numbers

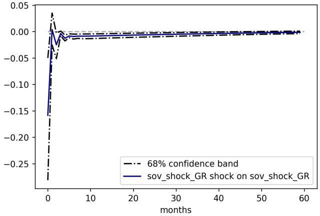

Figure: Non-normalised Q matrix: unexpected IRF (Greece) Back

Selection of additional controls in EWL with LASSO

In line with Jarmulska (2020), a pool of additional controls consisted of five sub-groups:

- **Global macro:** US policy rate, US GDP, Chinese GDP, Brent oil price index
- **Local macro & competitiveness:** GDP growth rate, GDP PC, current account balance (net), net exports, consumption, investment, CPI, index of housing prices
- **Financial:** EURUSD exchange rate
- **Fiscal:** general government debt and balance, implicit interest rate
- **Labour market:** rate of unemployment

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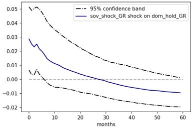
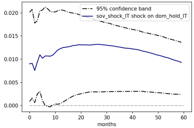
Home bias: IRF



(a) Greece



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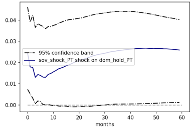
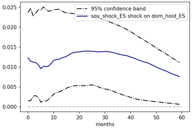
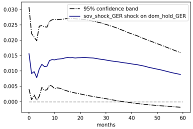


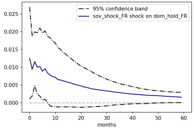
(c) Portugal



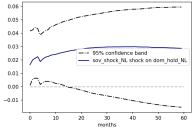
(d) Spain



(e) Germany



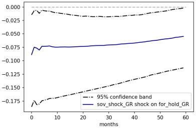
(f) France



(g) Netherlands

Figure: *Home bias* — IRFs of domestic bond holdings in response to a sovereign debt shock (balance sheet transmission channel) Back

Run to quality: IRF



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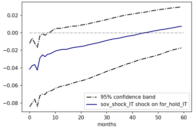

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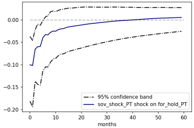

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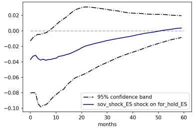

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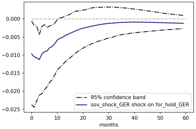

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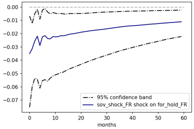

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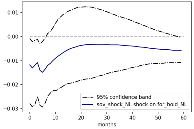
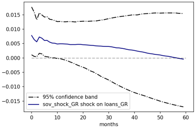


(g) Netherlands

Figure: *Run to quality* — IRFs of foreign bond holdings in response to a sovereign debt shock (balance sheet transmission channel) Back

Credit supply: IRF



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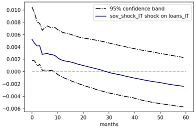

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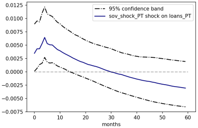

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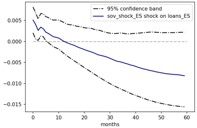

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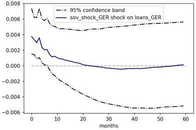

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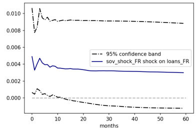

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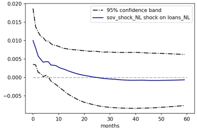
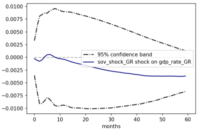


(g) Netherlands

Figure: IRFs of loan supply in response to a sovereign debt shock (balance sheet transmission channel) Back

GDP: IRF



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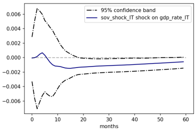

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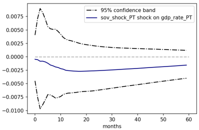
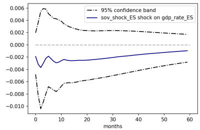
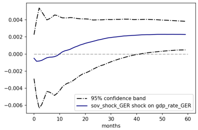


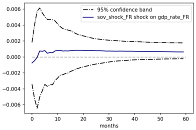
(c) Portugal



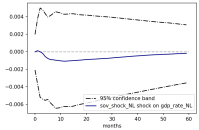
(d) Spain



(e) Germany



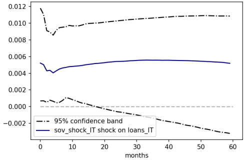
(f) France



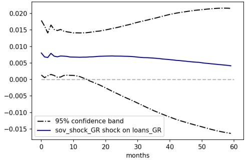
(g) Netherlands

Figure: IRFs of real GDP in response to a sovereign debt shock (balance sheet transmission channel) Back

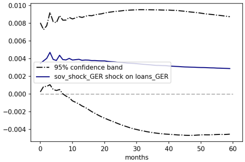
SRNA: Narrative Approach using extremely rare events



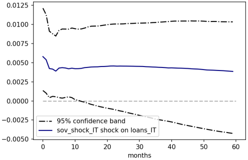
(a) IT (rare events)



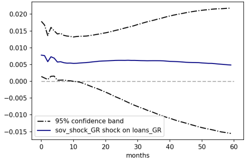
(b) GR (rare events)



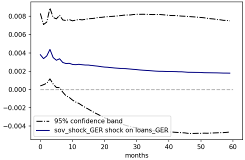
(c) GER (rare events)



(d) IT (standard)



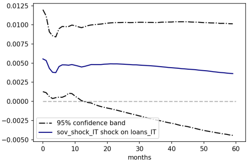
(e) GR (standard)



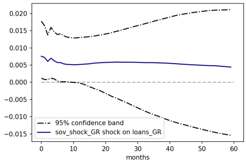
(f) GER (standard)

Figure: IRFs of loan supply in response to a sovereign debt shock (all transmission channels) — narrative approach comparison Back

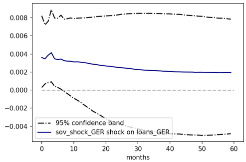
SRNA: Narrative Approach using rolling sum of proxy



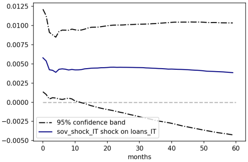
(a) IT (rollsum)



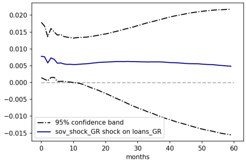
(b) GR (rollsum)



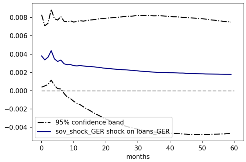
(c) GER (rollsum)



(d) IT (standard)



(e) GR (standard)



(f) GER (standard)

Figure: IRFs of loan supply in response to a sovereign debt shock (all transmission channels) — narrative approach comparison Back

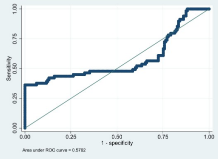
EWL: marginal effects at means

country group	country	$\frac{dy}{dx}$
GIPS (non-austere economies)	Greece	0.5034***
	Italy	0.0853
	Portugal	0.5714***
	Spain	0.6487***
non-GIPS (austere economies)	Germany	1.0083***
	France	0.6964***
	Netherlands	0.3240***

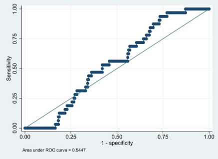
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table: Marginal effects calculated at means under baseline specification Back

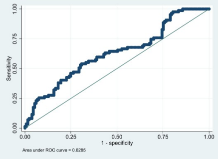
EWL: Area Under Receiver Operating Curve



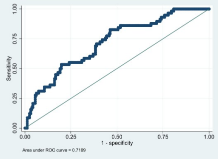
(a) Greece



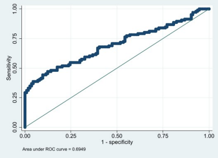
(b) Italy



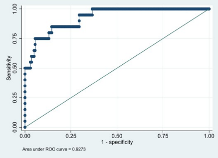
(c) Portugal



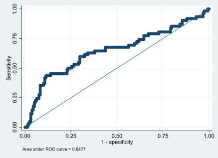
(d) Spain



(e) Germany



(f) France



(g) Netherlands

Figure: Area under ROC for country-specific early-warning logit models under baseline specification Back

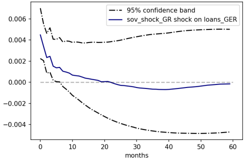
EWL: common tendencies (panel estimation)

model	controls	$\frac{dy}{dx}$	OR
pool	no	0.5018***	
LASSO	yes		4.5921***
FE	no	0.6458***	

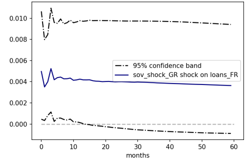
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table: Marginal effects calculated at means/odds ratios under various panel specifications Back

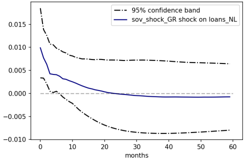
Greece-to-austere contagion: IRF



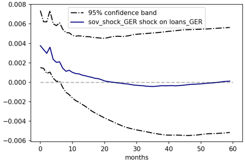
(a) GR to GER



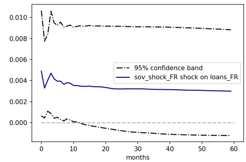
(b) GR to FR



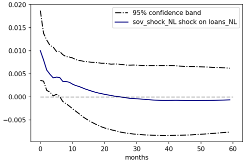
(c) GR to NL



(d) GER



(e) FR



(f) NL

Figure: SDS contagion coming from Greece — loans Back