



CompNet The Competitiveness Research Network



EUROPEAN CENTRAL BANK
EUROSYSTEM

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Crisis severity and the international trade network

WORK IN PROGRESS...

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Overview

1 Motivation

2 Literature

3 Data

4 Results

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Motivation

- **Fall in trade and financial flows were major features of the recent crisis**
 - does the position of a country in the trade network (own and neighbours' connectivity , strength) play a role for the severity of the crisis?
- **New: combine literature on crisis with networks and VA trade**
- **Approach:**
 - Quarterly GDP data to define the depth and length of the crisis
 - Annual WIOT value added trade data to compute network indicators (-> final user perspective – not just weights, but links are different)
 - Evaluate impact of network indicators on crisis measures

Overview

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4 Results

1. Explaining cross-country differences in the global crisis

- **Feldkircher (2014):**
 - Most influential factors: pre-crisis credit growth, real activity, international reserves
- **Cecchetti, King & Yetman (2011):**
 - Significant impact of capitalization of banking sector, loan to deposit ratios, CA, FX reserves, credit growth
- **Berkmen, Gelos, Rennhack & Walsh (2012):**
 - Leverage, strong credit growth and more short-term debt are important
- **Hausman & Guil (2014):**
 - Impact of trade and financial integration only above a threshold
- **Catao & Milesi-Feretti (2013):**
 - Impact of NFL mainly through debt, with stronger effect when $NFL/GDP > 50\%$ or > 20 ppt higher than country-specific historical mean

Overall:

- **Compelling evidence on the importance of financial channels**
- **Mixed/weak evidence on trade channel**

2. Network measures and crisis

- **Minoiu, Kang, Subrahmanian & Bera (2013) :**
 - Higher own financial interconnectedness, and lower neighbours financial connectedness -> higher crisis probability
- **Chinazzi, Fagiolo, Reyes & Schiavo (2013):**
 - Position in financial network helps to explain severity of the crisis
 - More connected countries had smaller output loss
 - Strong non-linearity
- **Kali & Reyes (2005):**
 - Being integrated into the ITN amplified shocks, but also helps to dissipate impact

Overall:

- **Most of the applications focus on financial networks**
- **Financial integration matters**
- **Connectivity increases the likelihood of crisis, however lowers output loss**

3. Recent findings of network theory

Elliott Golub Jackson 2014, Cabrales Gottardi Vega-Redondo 2014

Vulnerability of the system depends on:

- Connectivity / number of links
- Integration / exposure
- Size of shock

This paper: Connectivity and integration of the countries and their neighbours

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Crisis measures

Crisis à la Feldkircher (2014) and Cecchetti et al. (2011):

- Start of crisis: first Q with negative GDP growth for at least 2 consecutive quarters between 2007Q3 and 2009Q1

2007Q4	GBR, ROU
2008Q1	DNK, IRL
2008Q2	AUT, ESP, FIN, GRC, ITA, JPN, LUX, LVA, PRT, TUR
2008Q3	BEL, DEU, FRA, LTU, MEX, NLD, RUS, SVN, SWE, USA
2008Q4	AUS, BGR, BRA, CAN, CHN, CZE, EST, HUN, IDN, KOR, MTA, POL, SVK
2009Q1	CYP, IND

Crisis measures

- 1) Length of crisis: quarters of GDP below pre-crisis peak
- 2) Length of negative growth: quarters of negative growth

3) Cumulated loss:
$$cumloss = 100 * \frac{\sum_{t=crisis_start}^{crisis_end} (y_t - y_{crisis_start-1})}{y_{crisis_start-1}}$$

4) Depth of the crisis from peak to trough

$$depth_pt = 100 * \frac{y_{trough} - y_{crisis_start-1}}{y_{crisis_start-1}}$$

5) ... from pre-crisis avg to trough

$$depth_avg = 100 * \frac{y_{trough} - \bar{y}}{\bar{y}}$$

6) Loss compared to pre-crisis trend growth

7) Loss compared to total period trend growth

$$trendloss = 100 * \frac{GDP_t - trend\ GDP}{trend\ GDP}$$

Control variables

2007 data, mostly in % of GDP:

- Private sector credit
- Foreign exchange reserves
- Net Foreign Assets
- Current Account balance
- FDI (net)
- Government debt
- GDP per capita
- Fiscal deficit
- GDP participation

Growth from 2004-2007

- Private sector credit
- REER
- GDP
- Consumer prices

Dummies:

- Dummy for inflation targeting
- Dummy for FX peg

Network indicators

- **A network is a graph-theoretic representation of relationships (links) between units (nodes) of a system**
- **International Trade Network (ITN): nodes are countries and links represent import/export relationships (directed)**
- **New in this project: we take into account final (value added) trade as we analyse the effect of a demand shock**

Node degree / connectivity

- Node in-degree = number of import links of a country
- Node out-degree = number of export links of a country

Node strength / integration

- Node in-strength = sum of imports of a country
- Node out-strength = sum of exports of a country

Average Nearest-Neighbour Degree/Strength (ANND/ANNS) (in-in, in-out, out-out, out-in)

- Average degree/strength of a node's neighbours

Problems with the dataset

- **It is a complete network – no variation in degree / connectivity indicators**
 - For binary indicators, we restrict the sample by dropping certain links if $< 0.1\%$ of GDP of the country
- **Rest of the World distorts certain network indicators**
 - Calculating two versions, with and without RoW

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- **BMA addresses model uncertainty**
- **Limited amount of observations (39)**
- **Empirical Bayes (Local) (EBL) g-prior: Liang et al. (2008), model specific g estimated via ML**
- **Random model prior (Ley and Steel, 2008) -> binomial-beta hyperprior on the a priori inclusion probability**
- **First regressions only with control variables, eliminating those which are significant in none of the equations.**

Results

Control variables only

	q_crisis		q_neggrth		depth_pt		depth_avg		cumloss		trendd_pre		trendd_tot	
	Post		Post		Post		Post		Post		Post		Post	
	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean
ca_gdp07	0.2	0.1	0.3	0.1	0.2	0.1	0.4	0.3	0.4	0.2	0.2	0.1	0.2	-0.1
dcredit0407	0.9	-0.6	0.6	-0.3	0.9	-0.5	0.7	-0.4	0.7	-0.4	0.9	-0.6	1.0	-0.5
debtgvt07	0.2	-0.1	0.2	0.0	0.2	0.0	0.3	-0.1	0.3	0.1	0.2	0.1	0.2	0.0
dreer0407	0.9	0.5	0.7	0.4	0.5	0.3	0.7	0.4	0.5	0.3	0.6	0.3	0.3	0.2
dyera_nc0407	0.4	0.2	0.3	0.1	0.3	-0.2	0.3	0.1	0.3	-0.2	0.3	-0.2	0.3	-0.2
fiscdef07	0.3	-0.2	0.4	-0.2	0.3	-0.2	0.4	-0.2	0.3	-0.2	0.3	-0.2	0.2	-0.2
fxres_gdp07	0.4	0.2	0.9	0.4	0.2	0.1	0.5	0.2	0.3	0.2	0.2	0.1	0.1	0.0
gvc_part07	0.3	-0.1	0.3	0.1	0.2	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.2	0.1
nfa_gdp07	0.2	0.1	0.3	0.1	0.2	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.2	-0.1

Mean no. regre: 3.89

3.84

2.97

3.91

3.13

3.08

2.55

Shrinkage-Stats Av=0.8463

Av=0.7965

Av=0.8234

Av=0.7249

Av=0.6813

Av=0.8583

Av=0.8594

Results

Control variables with interaction terms

	q_crisis		q_neggrth		cumloss		depth_pt		depth_avg		trendd_pre		trendd_tot	
	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean
ca_gdp07	0.2	0.1	0.3	0.1	0.2	0.2	0.1	0.0	0.3	0.1	0.1	0.0	0.4	-0.3
dcredit0407	0.7	-0.5	0.4	-0.3	0.2	0.2	0.3	0.4	0.7	0.6	0.2	0.3	0.3	0.4
dreer0407	0.9	0.5	0.8	0.4	0.4	0.3	0.7	0.3	0.9	0.4	0.6	0.3	0.5	0.3
dreer0407_dcr	0.4	0.3	0.4	0.3	0.3	-0.1	0.2	-0.1	0.3	-0.1	0.2	-0.1	0.2	-0.1
dyera_nc0407	0.4	0.2	0.3	0.1	0.2	0.0	0.1	0.1	1.0	0.6	0.1	0.1	0.1	0.1
dyera_nc0407_dcr	0.4	-0.3	0.4	-0.3	1.0	-0.8	1.0	-1.0	1.0	-1.3	1.0	-1.0	1.0	-1.0
fiscdef07	0.3	-0.2	0.4	-0.2	0.3	-0.2	0.2	-0.1	0.3	-0.1	0.2	-0.2	0.2	-0.1
fxres_gdp07	0.5	0.2	0.9	0.4	0.2	0.1	0.2	0.1	0.3	0.1	0.2	0.1	0.1	0.0
fxres_gdp07_dcr	0.3	0.1	0.3	0.0	0.5	-0.5	0.3	-0.3	0.5	-0.3	0.5	-0.4	0.2	-0.3

Mean no. regressors

4.07

4.03

3.35

3.17

5.12

3.17

2.97

Shrinkage-Stats

Av=0.8493

Av=0.8182

Av=0.8827

Av=0.938

Av=0.9128

Av=0.9401

Av=0.944

Results

Including network indicators

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki
	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng
kin07	-0.1	9	-0.2	7	-0.1	9	0.0	10	-0.1	10	-0.1	8	0.0	10
kout07	-0.2	3	-0.1	8	-0.1	9	-0.1	10	-0.1	8	-0.1	8	0.0	10
ktot07	-0.2	4	-0.1	7	-0.1	9	-0.1	10	-0.1	8	-0.1	8	0.0	10
sin_07	-0.2	8	-0.1	9	0.0	9	0.0	10	0.0	10	0.0	10	0.1	8
sout_07	-0.2	5	0.0	10	0.0	10	0.0	10	0.0	10	0.0	10	0.0	10
stot_07	-0.2	5	0.0	10	0.0	10	0.0	10	0.0	10	0.0	10	0.1	9
anndoutout07	-0.1	8	-0.2	3	-0.1	9	-0.1	10	-0.1	8	-0.1	8	-0.1	9
anndoutin07	-0.1	9	-0.2	3	-0.1	10	-0.1	10	-0.1	10	-0.1	8	0.0	10
anndinout07	-0.1	9	-0.2	3	-0.1	9	-0.1	9	-0.1	7	-0.1	7	-0.1	8
anndinin07	-0.1	9	-0.2	6	-0.1	10	0.0	10	-0.1	10	-0.1	8	0.0	10
annsoutout07	0.2	3	0.1	7	0.1	9	0.0	10	0.1	8	0.1	8	0.0	10
annsoutin07	0.2	3	0.1	7	0.1	9	0.0	10	0.1	10	0.1	8	0.0	10
annsinout07	0.1	9	0.2	5	0.1	9	0.0	10	0.1	8	0.1	8	0.0	10
annsinin07	0.1	9	0.2	5	0.1	9	0.0	10	0.1	10	0.1	8	0.0	10

Results

Including network indicators and non-linearities (1)

	Post Mean	ranki ng	Post Mean	ranki ng	Post Mean	ranki ng	Post Mean	ranki ng	Post Mean	ranki ng	Post Mean	ranki ng		
kin07	-0.5	9	-0.6	7	-0.1	9	0.1	11	0.1	11	-0.2	8	0.0	11
kout07	-0.5	4	-0.5	8	-0.1	9	0.1	11	0.0	9	-0.1	8	0.1	11
ktot07	-0.3	7	-0.7	7	-0.1	10	0.2	11	0.2	9	-0.1	8	0.1	11
sin_07	-0.3	8	-0.2	9	0.0	11	0.0	11	0.1	11	0.0	11	0.2	8
sout_07	-0.3	5	-0.1	11	-0.2	9	-0.1	10	-0.2	10	-0.1	8	0.0	10
stot_07	-0.3	5	-0.3	10	-0.1	10	-0.1	10	0.0	11	-0.1	10	0.0	11
kin07_sq	0.4	10	0.4	8	-0.1	10	-0.1	10	-0.2	10	0.1	9	0.1	10
kout07_sq	0.1	5	0.4	10	0.0	10	-0.2	10	-0.2	8	0.0	9	-0.1	10
ktot07_sq	0.0	8	0.5	8	-0.1	9	-0.3	10	-0.3	7	0.0	9	-0.1	10
sin_07_sq	-0.1	9	0.0	10	-0.1	9	-0.1	10	-0.1	10	0.0	8	0.0	9
sout_07_sq	0.1	9	0.1	10	0.1	11	0.1	11	0.1	11	0.1	11	0.1	8
stot_07_sq	0.0	8	0.2	11	0.0	11	0.0	11	0.0	10	0.0	11	0.0	10

Results

Including network indicators and non-linearities (2)

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki	Post	ranki
	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng	Mean	ng
anndoutout07	-5.0	6	-1.0	3	-0.2	10	0.6	11	0.6	9	-0.2	9	0.8	9
anndoutin07	-6.5	6	-1.2	3	-0.7	9	-0.1	11	0.0	11	-0.5	8	0.2	11
anndinout07	0.5	10	1.8	4	3.6	9	2.7	10	6.3	6	3.5	8	13.1	4
anndinin07	0.8	10	0.4	8	1.2	10	2.3	10	3.5	9	1.3	9	2.8	9
annsoutout07	0.2	6	0.1	8	0.2	9	0.5	9	0.4	7	0.2	8	0.3	8
annsoutin07	0.3	5	0.1	8	0.2	9	0.5	9	0.4	7	0.2	8	0.3	9
annsinout07	-0.3	10	0.0	8	0.2	9	0.3	10	0.4	8	0.0	9	0.1	10
annsinin07	-0.2	10	0.1	8	0.3	9	0.3	10	0.4	8	0.0	9	0.1	10
anndoutout07_sq	4.9	7	0.6	4	0.0	9	-0.7	10	-0.8	8	0.0	8	-1.0	8
anndoutin07_sq	6.4	7	0.8	4	0.6	10	0.0	10	-0.1	10	0.4	9	-0.2	10
anndinout07_sq	-0.7	9	-2.2	3	-3.8	7	-2.8	9	-6.4	5	-3.6	7	-13.1	3
anndinin07_sq	-1.0	9	-0.7	7	-1.3	9	-2.4	9	-3.6	8	-1.4	8	-2.9	8
annsoutout07_sq	0.2	5	0.2	7	-0.1	10	-0.4	11	-0.3	9	0.0	9	-0.3	9
annsoutin07_sq	0.1	6	0.1	9	-0.1	10	-0.5	10	-0.4	9	0.0	9	-0.3	8
annsinout07_sq	0.5	8	0.4	5	0.0	10	-0.2	11	-0.3	9	0.1	8	-0.1	11
annsinin07_sq	0.4	9	0.3	7	-0.1	10	-0.3	11	-0.4	10	0.1	8	-0.1	11

Results

- **Credit growth is detrimental mainly when accompanied with high pre-crisis GDP growth or low foreign reserves**
- **Some evidence for negative impact of connectivity mainly for length of crisis:** large number of export links worsens the crisis. No diversification benefit kicks in.
 - are the numbers of links too small or too large to benefit from diversification?
 - Did shock hit too many countries?
- **Use of value added data helps detecting importance of trade channel (openness / integration)**
- **Neighbours' connectivity and integration matter**

Way forward

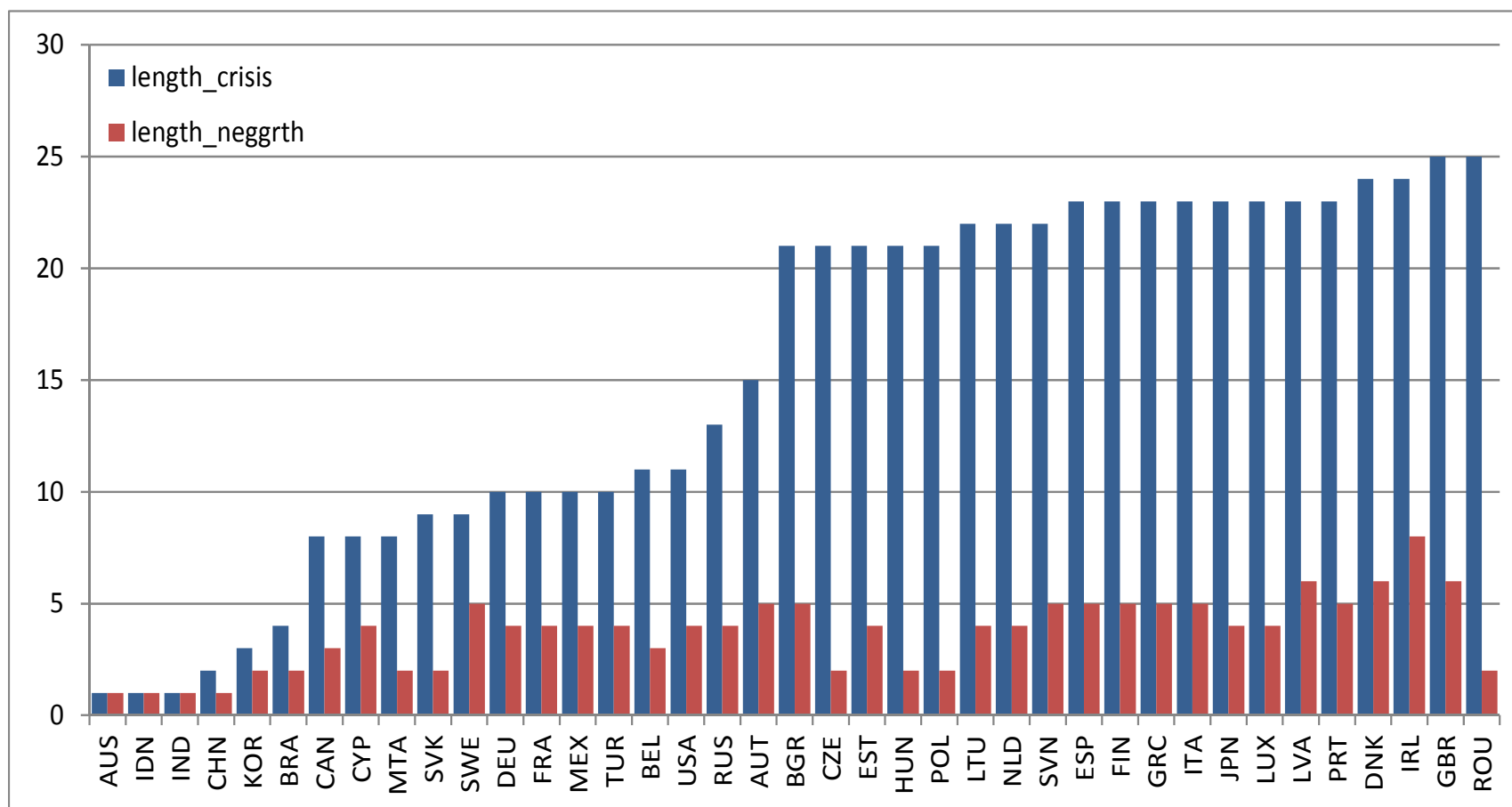
- Further finetuning of BMAs
- Introduce different combinations of network indicators
- Check for threshold effects
- Robustness checks:
 - with gross exports
 - Control variables for 2004-2007 average
- Further network indicators: clustering
- Any further proposals?



Thank you !

Crisis measures

- 1) Length of crisis: quarters of growth below pre-crisis peak
- 2) Length of negative growth: quarters of negative growth



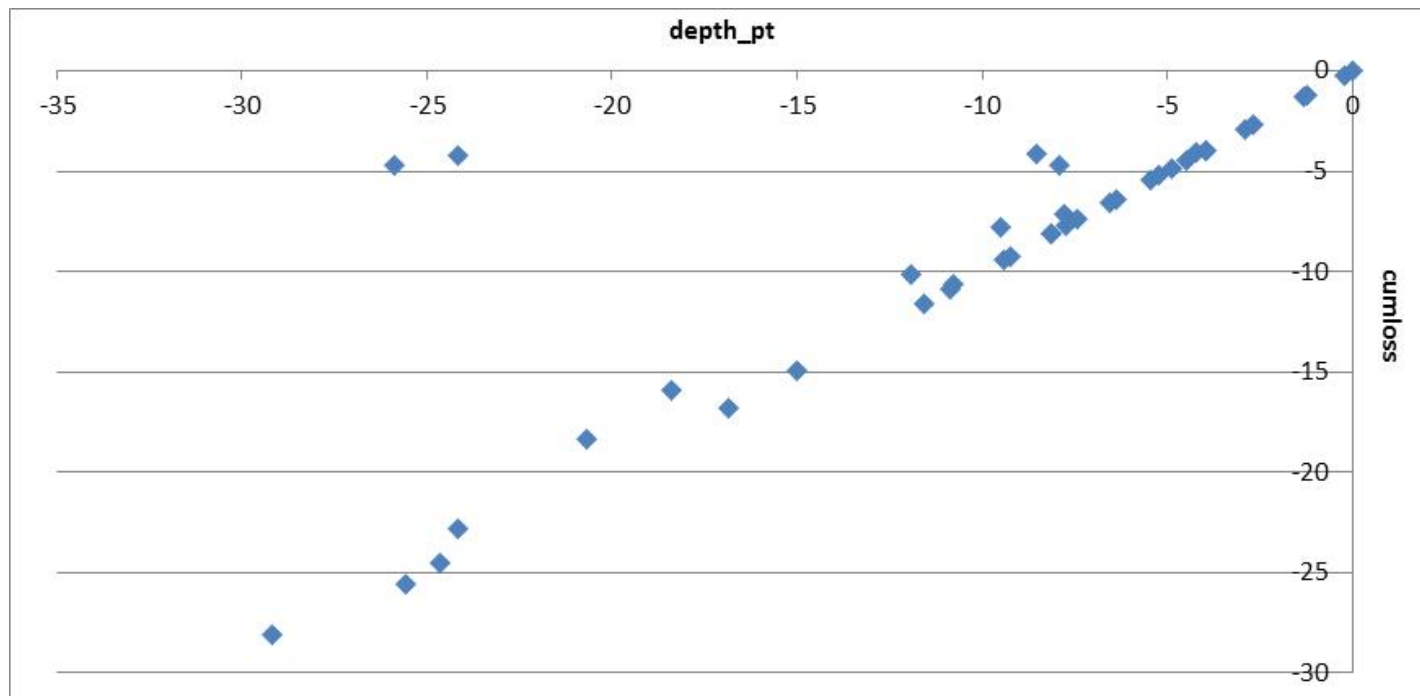
Crisis measures

3) Cumulated loss:
$$cumloss = 100 * \frac{\sum_{t=crisis_start}^{crisis_end} (y_t - y_{crisis_start-1})}{y_{crisis_start-1}}$$

4) Depth of the crisis from peak to trough **5) ... from pre-crisis avg to trough**

$$depth_pt = 100 * \frac{y_{trough} - y_{crisis_start-1}}{y_{crisis_start-1}}$$

$$depth_avg = 100 * \frac{y_{trough} - \bar{y}}{\bar{y}}$$

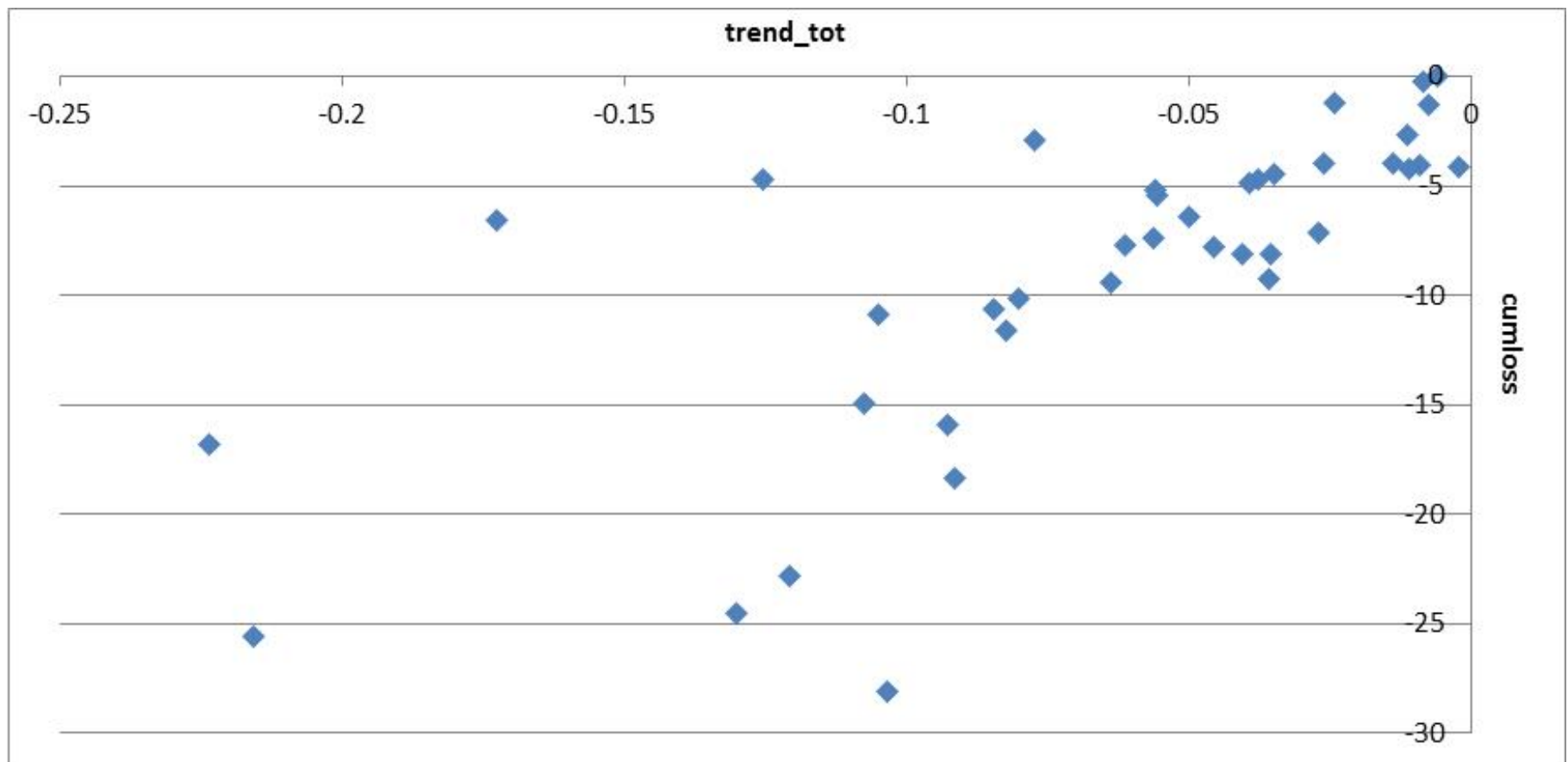


Crisis measures

6) Loss compared to pre-crisis trend growth

7) Loss compared to total period trend growth

$$\text{trendloss} = 100 * \frac{\text{GDP}_t - \text{trend GDP}}{\text{trend GDP}}$$



Correlations

	dyera_nc0407	dcredit0407	dreer0407	ca_gdp07	fiscdef07	fxres_gdp07	gvc_part07	debtgvt07	nfa_gdp07
dyera_nc0407	1.0								
dcredit0407	0.4	1.0							
dreer0407	0.3	0.5	1.0						
ca_gdp07	-0.2	-0.5	-0.1	1.0					
fiscdef07	0.1	0.0	0.0	0.3	1.0				
fxres_gdp07	0.6	0.1	0.2	-0.2	0.1	1.0			
gvc_part07	0.1	0.4	-0.1	-0.1	0.3	0.2	1.0		
debtgvt07	-0.5	-0.5	-0.4	0.2	-0.5	-0.2	-0.4	1.0	
nfa_gdp07	-0.1	-0.3	-0.3	0.7	0.3	0.0	0.0	0.2	1.0
kin07_restr1_noRW	0.0	0.3	-0.1	-0.5	0.0	0.1	0.6	-0.2	-0.3
kout07_restr1_noRW	0.1	0.1	-0.1	0.1	0.3	0.1	0.8	-0.3	0.1
ktot07_restr1_noRW	0.1	0.3	-0.1	-0.2	0.2	0.1	0.7	-0.3	-0.1
sin_07	0.2	0.4	-0.1	-0.6	0.0	0.3	0.7	-0.4	-0.3
sout_07	0.1	0.1	-0.1	0.2	0.3	0.1	0.8	-0.4	0.3
stot_07	0.2	0.3	-0.1	-0.2	0.2	0.2	0.8	-0.4	0.0
anndoutout07_restr1_noRW	0.2	0.4	-0.1	-0.3	0.1	0.2	0.6	-0.2	-0.2
anndoutin07_restr1_noRW	0.3	0.4	-0.1	-0.4	0.1	0.2	0.5	-0.3	-0.2
anndinout07_restr1_noRW	0.1	0.5	0.2	-0.4	0.2	-0.1	0.5	-0.5	-0.3
anndinin07_restr1_noRW	0.1	0.5	0.1	-0.4	0.1	0.1	0.6	-0.4	-0.3
anssoutout07_restr1_noRW	-0.1	-0.1	0.2	0.0	-0.3	-0.1	-0.7	0.3	-0.1
anssoutin07_restr1_noRW	-0.1	-0.1	0.2	0.0	-0.2	-0.1	-0.7	0.3	-0.1
anssinout07_restr1_noRW	0.0	-0.3	0.1	0.4	-0.1	0.0	-0.5	0.2	0.2
anssinin07_restr1_noRW	0.0	-0.3	0.2	0.4	0.0	0.0	-0.5	0.2	0.2
cc_out07_restr1_noRW	-0.1	-0.2	0.1	0.0	-0.2	-0.1	-0.7	0.3	0.0
cc_in07_restr1_noRW	0.2	0.3	0.2	0.1	0.0	-0.5	0.1	-0.2	-0.2
cc_cycle07_restr1_noRW	-0.1	-0.1	0.1	0.4	0.2	-0.4	-0.2	0.1	0.3
cc_middle07_restr1_noRW	0.1	0.2	0.2	-0.1	0.1	-0.4	-0.2	-0.1	-0.2

Correlations

	kout07_restr1	kin07_restr1	ktot07_restr1	sout_07	sin_07	stot_07	anndoutout07_restr1	anndoutin07_restr1	anndinin07_restr1	anndinout07_restr1	annsoutout_07_restr1	annsoutin_07_restr1	annsinin_07_restr1	annsinout_07_restr1	cc_out07_restr1	cc_in07_restr1	cc_cycle07_restr1	cc_middle07_restr1
kin07_restr1_noRW	1.0																	
kout07_restr1_noRW	0.7	1.0																
ktot07_restr1_noRW	0.9	0.9	1.0															
sin_07	0.8	0.6	0.7	1.0														
sout_07	0.4	0.8	0.7	0.6	1.0													
stot_07	0.7	0.8	0.8	0.9	0.9	1.0												
anndoutout07_restr1_noRW	0.9	0.7	0.8	0.7	0.4	0.6	1.0											
anndoutin07_restr1_noRW	0.9	0.6	0.8	0.7	0.3	0.6	1.0	1.0										
anndinout07_restr1_noRW	0.8	0.5	0.7	0.5	0.3	0.5	0.7	0.7	1.0									
anndinin07_restr1_noRW	0.9	0.6	0.8	0.7	0.4	0.6	0.9	0.9	0.9	1.0								
annsoutout07_restr1_noRW	-0.7	-1.0	-0.9	-0.5	-0.7	-0.7	-0.7	-0.7	-0.5	-0.7	1.0							
annsoutin07_restr1_noRW	-0.7	-1.0	-0.9	-0.5	-0.7	-0.7	-0.7	-0.6	-0.5	-0.6	1.0	1.0						
annsinout07_restr1_noRW	-1.0	-0.7	-0.9	-0.7	-0.4	-0.6	-0.9	-0.9	-0.8	-0.9	0.8	0.8	1.0					
annsinin07_restr1_noRW	-1.0	-0.7	-0.9	-0.7	-0.3	-0.6	-0.9	-0.8	-0.8	-0.9	0.7	0.7	1.0	1.0				
cc_out07_restr1_noRW	-0.8	-1.0	-0.9	-0.5	-0.7	-0.7	-0.8	-0.7	-0.6	-0.7	1.0	0.9	0.8	0.7	1.0			
cc_in07_restr1_noRW	-0.3	0.0	-0.1	-0.3	0.1	-0.1	-0.2	-0.2	0.0	-0.2	0.0	0.0	0.3	0.3	0.0	1.0		
cc_cycle07_restr1_noRW	-0.4	-0.3	-0.4	-0.5	-0.2	-0.4	-0.3	-0.2	-0.1	-0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.0	
cc_middle07_restr1_noRW	-0.3	-0.4	-0.4	-0.3	-0.2	-0.3	-0.3	-0.2	-0.1	-0.3	0.3	0.3	0.3	0.3	0.4	0.7	0.7	1.0