Debt deflation, financial market, and regime change
Evidence from Europe

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Literature Review

Liquidity trap literature (Werning 2011, others):

- disinflationary scenario: real interest rate rises and liquidity trap emerges.
- short run model: no evolution of debt, no regime change in the financial market

Eggertsson and Krugman 2012 (Fisher-Minsky-Koo theory):

- fall in prices, increase in real debt, plus asset price fall and Minsky moment leading to deleveraging
- decrease in spending and debt deflation, prolonged recession

Secular stagnation and hysteresis

- Secular stagnation, potential output declines; Summers (2013, 2015)
- Hysteresis, potential output declines; Blanchard/Cerutti/Summers (2015)

Is there a Fisher debt deflation?

Large Drop in Output and Employment after 2007-8:

- Large debt overhang in the EU (specifically in banks),
- Slow process of disinflation in the Euro-Area and deflation (Southern Europe),
- Not an eminent danger of debt-deflation yet, process rather slow
- Becomes a danger if there re-emergence of financial instability

→ Intensification of debt deflation, financial instability, and adverse macroeconomic feedback loops

The Great Depression and The Great Recession

	The Great Depression 1929-33	The Great Recesssion 2011-12
Debt-to-Income Ratio	$\sim 300\%$	Germany: 188%, Italy: 259%, France: 280%, Spain: 313%
Change in Price Level	-22% (Non-Agriculture Economy)	Euro-Area: $2009 : 0.3\%$, $2010 : 1.6\%, 2011 : 2.7\%$
Change in Output	-30% (Non-Agriculture Economy)	Euro-Area: $2009 : -4.6\%$, $2010 : 2.1\%, 2011 : 1.6\%$

Interest Rate Spreads

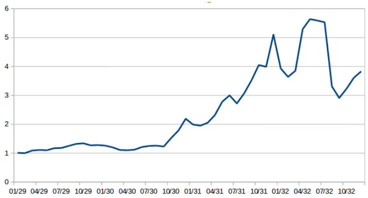


Figure : Corporate Bond Yield Spread

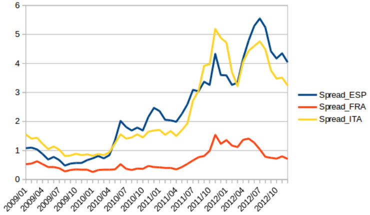
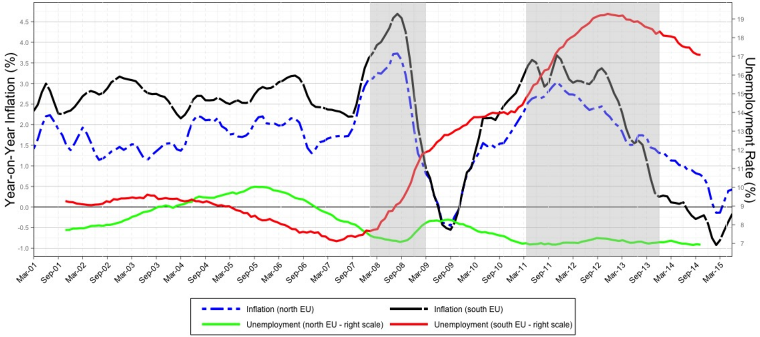


Figure : Long Term Government Spread over German bonds

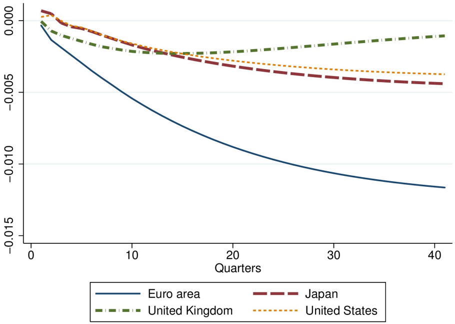
Stylized Facts

Inflation and Unemployment in the Euro-Area:



Stylized Facts: Evidence from GVAR

- large scale econometric model with cross-countries interdependencies,
- broad set of economic variables (inflation rates, output, equity, short and long rates),
- stronger deflationary trends in Euro-Area compared with US, UK, and Japan.



Overleveraging of EU banking systems

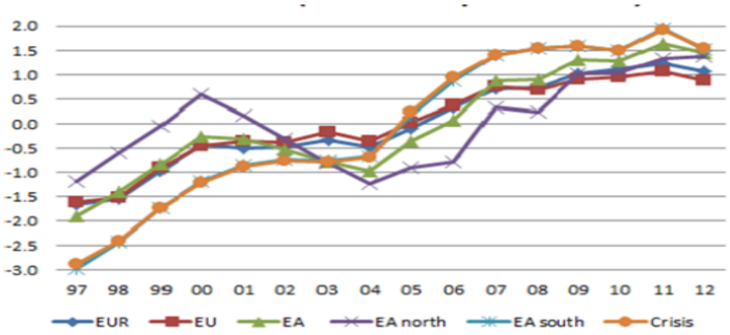


Figure : Actual-sustainable debt, Source: Henry et al. (2015), ECB WP

ZEW Financial Condition Index, FCI

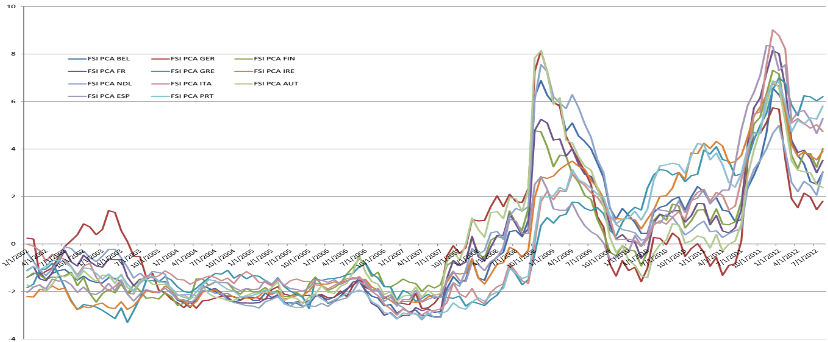


Figure : ZEW Financial Condition Index, FCI; Source: Schleer and Semmler (2014), JME 2015

Model Overview

Dynamic Macro Model:

- decentralized matching mechanisms on labor and financial markets,
- Phillips curve driving rate of change of inflation rate,
- debt build up, impacted by the price level,
- debt deflation and financial market risk drivers,
- macro feedbacks and regime change in a multi-period model

Econometric MRVAR:

- studying of regime changes in a 4 dim MRVAR
- exploring the asymmetry of regime dependent shocks through IRFs
- exploring regime dependent macro laws

Solution Method

Non-linear Model Predictive Control (NMPC):

- approximating accurate dynamic of the model,
- N-period receding horizon model,
- approximates infinite horizon model with N becoming large,
- Regime switching

A Model with Debt Dynamics and Inflation

Augmented Core Model–moving away from representative saver:

$$\max_{C_t,\mathcal{I}_t,\mathcal{V}_t} \int_0^N U\left(C_t, N_t\right) e^{-\rho t} = \int_0^N \left\{ \frac{C_t^{1-\eta}}{1-\eta} - eN_t^{\chi} \right\} e^{-\rho t}$$

s.t.

$$\dot{N}_t = m^L\left(s_t \cdot \mathcal{U}_t, \mathcal{V}_t\right) - \sigma N_t \quad (1)$$

$$\dot{K}_t = m^B\left(\mathcal{I}_t/P_t, \mathcal{B}_t/P_t\right) - \delta K_t \quad (2)$$

$$\dot{d}_t = rd_t - \frac{1}{P_t}(\upsilon[P_t Y_t\left(K_t, AN_t\right) - P_t C_t - P_t I_t - \Phi\left(s_t\right)\left(1 - N_t\right) - \zeta \cdot \mathcal{V}_t - \varphi(g_t K_t)]) - \pi_t d_t \quad (3)$$

Core features:

- Consumption: No credit market intermediation, consumption behavior driver of available funds,
- Investment: Supply and demand of funds through credit market intermediation,
- inflation rate and price level adjust slowly

Inflation Dynamics:

Change of Inflation Rate:

$$\dot{\pi}_t = \beta(\frac{Y_t}{Y^*} - 1) + {\eta^c}_t \tag{4}$$

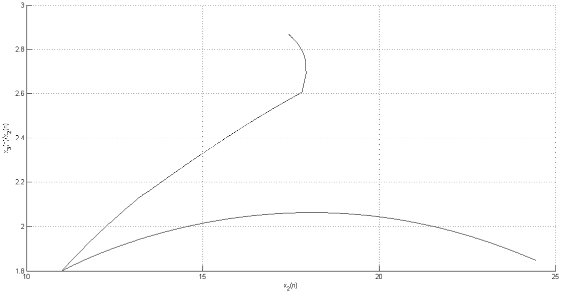
The inflation rate expression, ${\eta^c}_t$, represents some inflationary climate – of the change of inflation rates – in which the current inflation dynamics is operating, see also Gross and Semmler (2015), ECB WP.

Price Level Dynamics:

$$\dot{P}_t = \pi_t \tag{5}$$

The equation for price level dynamics can be used to determine a price index, starting with $P_0 = 1$.

Solution path of capital and real debt to capital ratio:

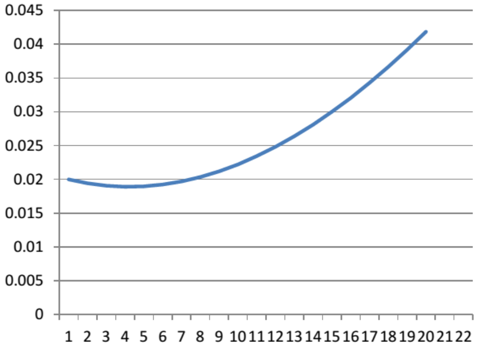


lower trajectory: low and declining real interest rate: k_t moves up and the leveraging ratio moves up a bit and then down; $\pi(0) = 0.02$

upper trajectory: deflation and high real interest rates, and high debt, k_t first moves up, but then down, and debt and the leverage ratio become unstable, $\pi(0) = 0.0$

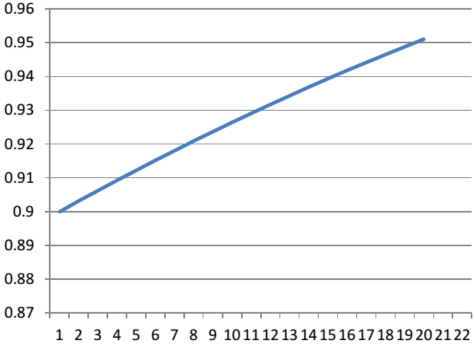
Debt deflation and slow recovery

Inflation rate corresponding to **lower trajectory** for initial $\pi(0) = 0.02$



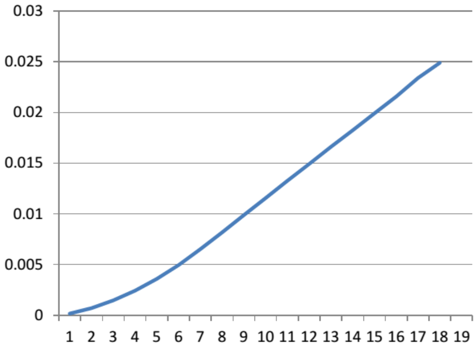
Debt deflation and slow recovery

Employment gap corresponding to **lower trajectory** for initial value of $\pi(0) = 0.02$



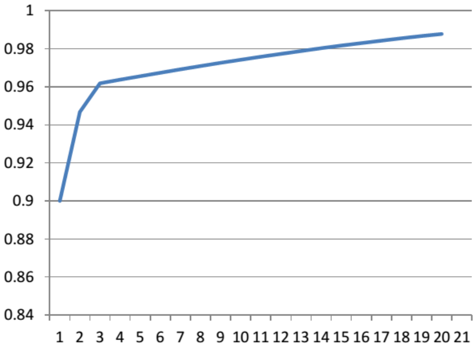
Debt deflation and prolonged recession

Inflation rate corresponding to **upper trajectory** for initial value of $\pi(0) = 0.0$:



Debt deflation and slow recovery

Employment gap corresponding to **upper trajectory** for initial value of $\pi(0) = 0.00$



Rise of financial market stress: Fisher, Kindleberger, Minsky

Instead of using the nexus of asset price fall, borrowing constraints and deleveraging shocks (EK 2012) we introduce endogenous credit cost, credit spreads and financial market stress

- rise of real debt,
- rise of default risk, and risk premia
- greater credit spreads, financial stress

→ two models: weak macro feedbacks vs. strong macro feedbacks

Endogenous credit spreads and weak macro feedbacks

Model with endogenous credit cost and credit spreads

$$\dot{N}_t = m^L(sU_t, \mathcal{V}_t) - \sigma N_t \quad (6)$$

$$\dot{K}_t = m^B(\mathcal{I}_t, \mathcal{B}_t) - \delta K_t \quad (7)$$

$$\dot{D}_t = r(fs_t|\gamma,)D_t - \upsilon[Y_t - C_t - I_t - \Phi(s_t)(1 - N_t) - \zeta \cdot \mathcal{V}_t - \varphi(g_t K_t)] \quad (8)$$

Endogenous credit spreads and weak macro feedbacks

Credit spreads as a nonlinear function of leveraging: Same as the Minsky moment in EK (2012); Fisher (1933)

$$r(fs_t|\gamma, c) = [1 + \exp(-\gamma(fs_t - c))]^{-1}, \ \gamma > 0 \tag{9}$$

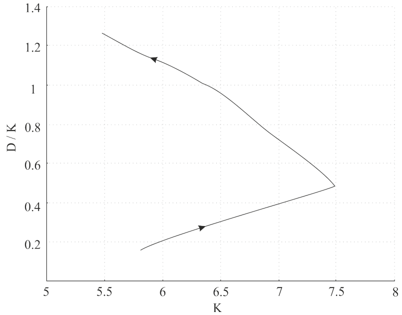


Figure : Dynamics with credit spread, without macro feedback loops

Endogenous credit spreads and strong macro feedbacks

Blanchard (2013): "The higher the debt, the higher the probability of default,,,, . But the adverse effects do not stop there. Higher sovereign spreads affect private lending spreads, and in turn affect investment and consumption"

Model with endogenous credit cost and credit spreads (also for consumption)

$$\dot{N}_t = m^L(s_t U_t, \mathcal{V}_t) - \sigma N_t \quad (10)$$

$$\dot{K}_t = m^B(\mathcal{I}_t, \mathcal{B}_t) - \delta K_t \quad (11)$$

$$\dot{D}_t = r(fs_t|\gamma, c))D_t - \upsilon[Y_t^a - C_t^a - I_t^a - \Phi(s_t)(1 - N_t) - \zeta \cdot \mathcal{V}_t - \varphi(g_t K_t)] \quad (12)$$

Endogenous credit spreads and strong macro feedbacks

Introduction of strong macro feedback loops: consumption and investment demand depending on credit spreads triggered by rising risk premia and yields of bonds.

$$C_t^a = f(r(fs_t|\gamma, c))C^{opt} \tag{13}$$

$$I_t^a = g(r(fs_t|\gamma, c))I^{opt} \tag{14}$$

Actual consumption and investment decline due to rising risk premia, credit spreads and financial stress:

$$Y_t^a = u(r(fs_t|\gamma, c)Y_t^{opt} \tag{15}$$

Endogenous credit spreads and strong macro feedbacks, see also Fisher 1933

Macroeconomic feedback loops may arise for the following reasons:

- Falling asset prices: wealth effect reducing aggregate demand,
- income and credit constrained households, sales constrained firms
- CB may not have any instruments to lower the interest rate and/or reduce risk premia,
- loan defaults by households (and firms) due to labor (and product) market constraints,
- *diabolic loop:* weak financial sector holding risky sovereign debt: sovereign debt default and reduced lending by banks to the real economy.

Endogenous credit spreads and weak and strong macro feedbacks

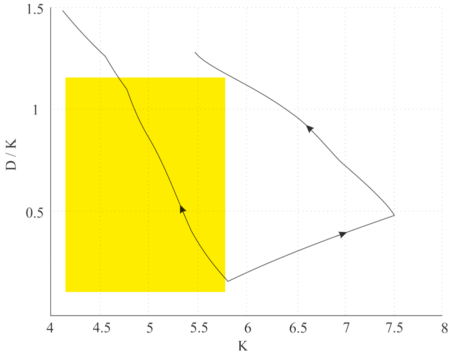
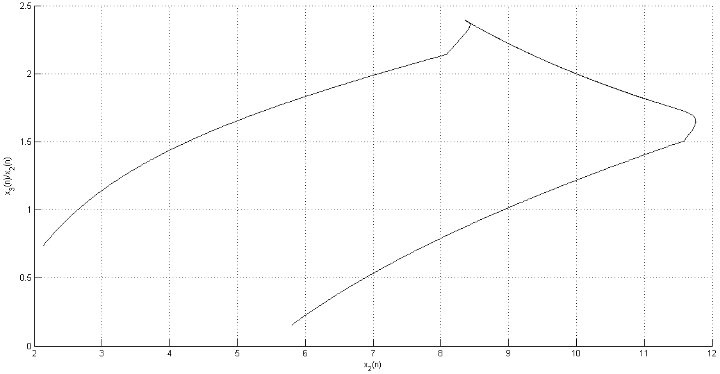


Figure : Debt dynamics with credit spreads, with weak (right) and strong macro feedback loops (left)

Tranquil Period

CB keeping interest rate low; not state dependent credit cost, convergence to steady state



Summary: Dynamics with two equilibria

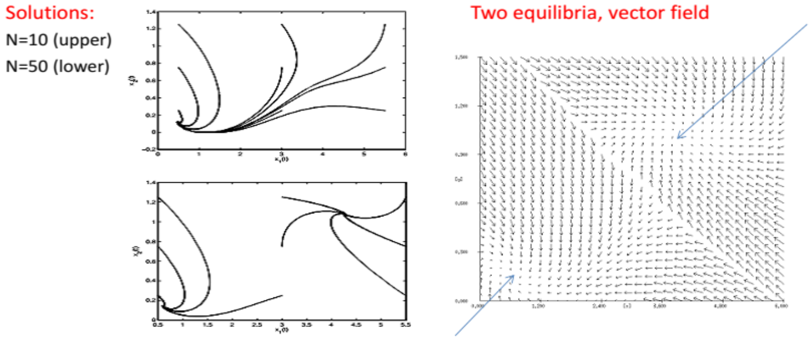


Figure : Change from one to two equilibria

Empirical Evidence: Overview

- Theoretical model emphasizes regime switching $\rightarrow$ multi-regime VAR (MRVAR), Mittnik/Semmler, JEBO 2012, JEDC 2013, MD 2015
- Generalized Impulse Responses (Koop et al 1996),
- Variables:
    - inflation rate (source: OECD)
    - change in GDP (source: GVAR; Smith and Galesi, 2014)
    - credit cost/long-term interest rate (sources: Smith and Galesi 2014, ECB)
    - Financial stress index; ZEW FCI (source: Schleer and Semmler 2014, JME 2015)

ZEW Financial Condition Index, FCI

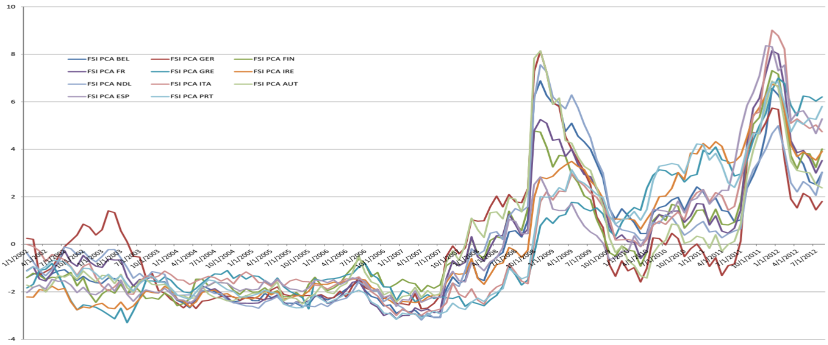


Figure : ZEW Financial Condition Index, FCI; Source: Schleer and Semmler (2014), JME 2015

Jump in credit cost

Interest Rates for Spain, Italy, Germany and France since 2003:

Figure : Total long-term cost of borrowing, Source: https://sdw.ecb.europa.eu/browse.do?node=9613587

MRVAR and GIRF

MRVAR Theory:

$$\mathbf{y_t} = \mathbf{c_i} + \sum_{j=1}^{p} A_{ij}\mathbf{y_{t-j}} + \epsilon_{it} \quad \text{if } \tau_{i-1} < r_{t-d} \leq \tau_i \qquad (16)$$

$\mathbf{y_t}$ ... endogenous variables, 4 dim
$\mathbf{c_i}$ ... vector of regime-dependent constants,
A_{ij} ... coefficient matrix,
τ ... values below and above threshold,
r_{t-d} ... endogenous threshold variable with d as threshold delay.

MRVAR Results: Spain

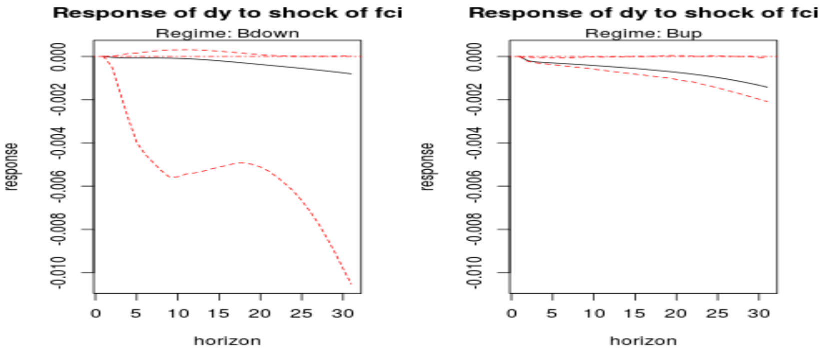


Figure : Response of change in output to a FCI shock of 1 s.d.

MRVAR Results: Italy

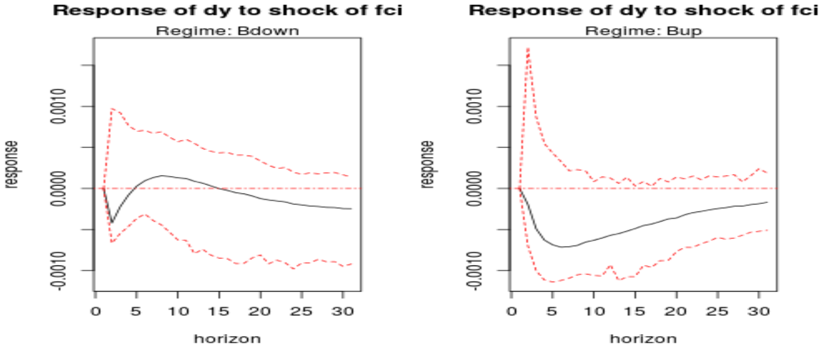


Figure : Response of change in output to a FCI shock of 1 s.d.

MRVAR Results: Germany

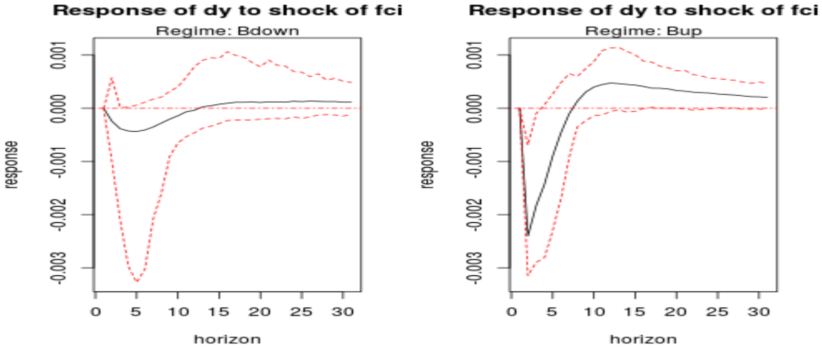


Figure : Response of change in output to a FCI shock of 1 s.d.

MRVAR Results: France

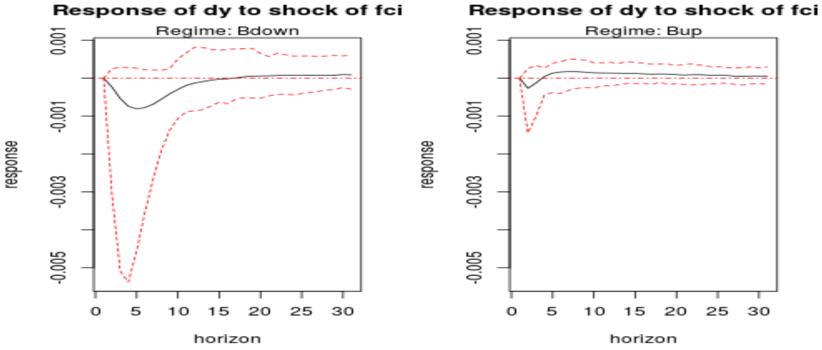


Figure : Response of change in output to a FCI shock of 1 s.d.

Extensions: Great Recession and macro laws

- Regime dependence of credit-output relations (dependent on leveraging regime of banks, overleveraging of 40 EU banks estimated in Schleer et al. (2014), used in the ECB study, Henry et al. (2015),
- Regime dependence of the Phillips curve (dependent on high or low financial stress or output gap),
- Regime dependence of Okun's law (dependent on high or low financial stress),

Conclusion: Great Recession 2007-9

- new period of disinflation, and even deflation,
- yet process of debt deflation is rather slow,
- risk of regime shift into high financial stress and rising credit spreads,
- exacerbation by macroeconomic feedback loops,
- possibility of unstable dynamics and downward spirals,
- through a combination of debt deflation as well as financial risk drivers

Appendix: MRVAR and GIRF

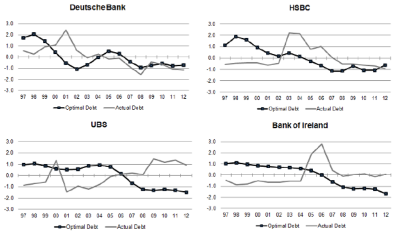
GIRF:

1. Histories are split into M regime-subsets $(\Omega_1, \ldots, \Omega_M)$
2. Compute regime-dependent Variance-Covariance Matrices Σ_i.
3. Cholesky decompose $\Sigma_i = C_i C_i'$ to get structural shocks: $e_i = C_i^{-1} \epsilon_i$
4. Draw a history $\omega_j \in \Omega_i$.
5. From e_i draw a set of n four-dimensional structural errors with replacement and transform the residuals back into their reduced form representation: $\epsilon_i^* = C_i e_i^*$.
6. Use the history from step (4) and the structural errors from step (5) to simulate the model.

Estimation of EU-countries' Excess Debt

Starting with the country's individual banks' excess debt, then aggregating to country bank debt

Computing optimal debt - Example banks



MRVAR and GIRF

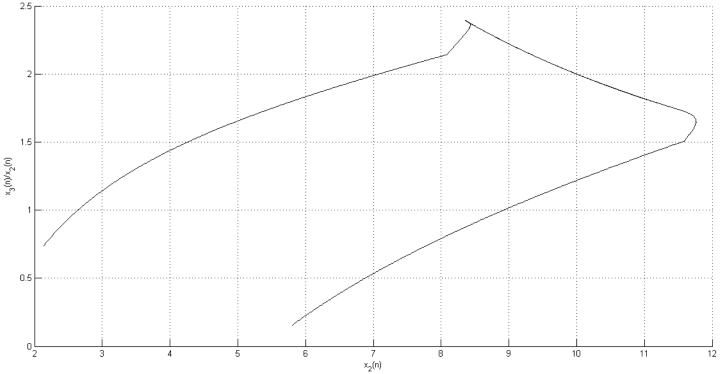
7. Add a shock in period $t : e_i^v = (e_{it} + v_t, \ldots, e_{it+n})$ and compute reduced form errors.
8. Use the history from step (4) and the structural errors from step (7) to simulate the model.
9. Repeat steps (5) through (8) R times. The difference of the averages represents the GIRF for history j.
10. Repeat steps (2) through (9) I times for regime i. Take the average to get GIRF for regime i.
11. Repeat steps (2) through (10) for all regimes.
12. Confidence intervals are computed by taking the 5% and 95% percentile of the densities

Stylized Facts

Real corporate Bonds and US Treasury Securities:

Tranquil Period

CB keeping interest rate low; not state dependent credit cost, convergence to steady state



Endogenous credit spreads and weak and strong macro feedbacks

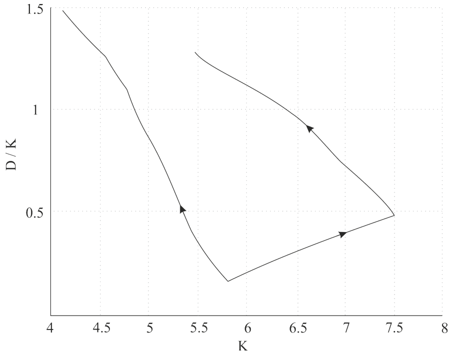


Figure : Debt dynamics with credit spreads, with weak (right) and strong macro feedback loops (left)

Overleveraging of EU banking systems

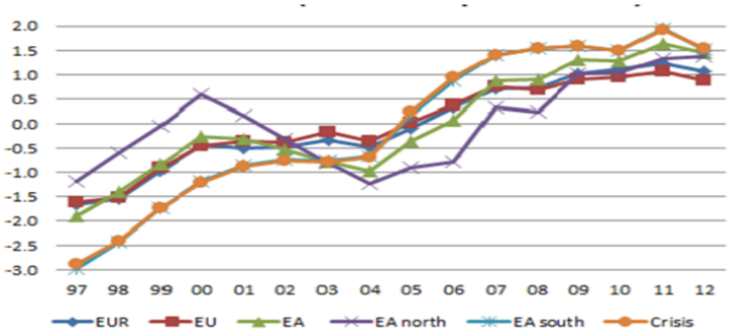


Figure : Actual-sustainable debt, Source: Henry et al. (2015), ECB WP

Dynamics with two equilibria

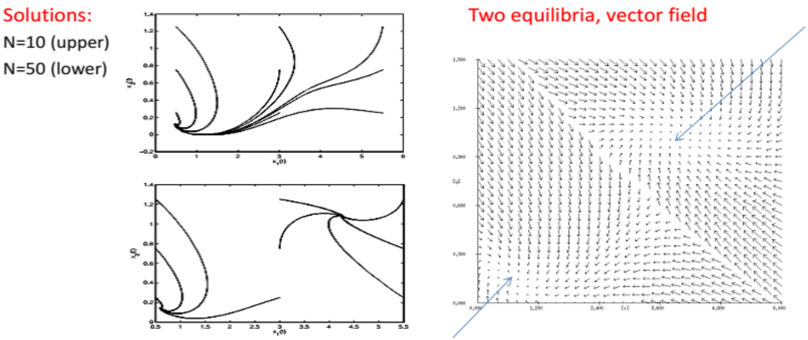
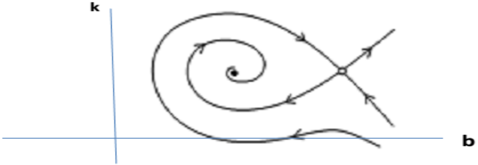


Figure : Change from one to two equilibria, both stable

Dynamics with two equilibria

Solutions of figure 1-3 have similarity to Bautin-Taken bifurcation:



Yet we have in figures 1-3 a controlled nonlinear system, 2 dim, 2 controls, solution depends on initial conditions:
Beyond the right (bad) equilibrium) the probability of default rises, interest rate rises and so on. The left equilibrium is stable

Figure : change from one to two equilibria, stable and unstable