The Analytics of the Greek Crisis

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The Greek Depression

- In 2007, Greek GDP per capita was around $35,000 and the unemployment rate was 8.4%.
- In 2014, Greek GDP per capita was around $25,000 and the unemployment rate was 26.6%
- What happened?

An 'Interim Report'

- Empirical investigation: Was Greece really that bad?
  - *Yes!*
  - Much worse than emerging market sudden stops
  - Even for 'strict peggers'
- Model-Based investigation: Why?
  - Because Greece caught an EM disease with AE leverage ratios
  - What would have helped?
    - Less leverage
    - Banking union
    - Fiscal discipline
    - More flexible prices

Three Interlinked Crises (at least)

- A sovereign debt crisis
  - Rapidly deteriorating fiscal accounts
  - Greek sovereign debt appears increasingly unsustainable
  - Default in 2012.
- A banking crisis
  - Boom in credit to the private non financial sector peaks in 2008-09
  - Increasing projected losses on their assets
  - Investors question Greek banks solvency.
  - Multiple rounds of resolution & recapitalization
- A sudden stop
  - Large & persistent current account deficits
  - After the GFC, foreign investors unwilling to lend to government, banks, firms
  - Startling development for a currency union (Ingram (1973))
- All three crises linked (doom loops)

Literature

- Empirical literature on Crises
  - Calvo et al (2006), Dornbusch & Werner (1994), Gourinchas et al (2001), Gourinchas & Obstfeld (2012), Kaminsky & Reinhart (1999), Korinek & Mendoza (2014), Ranciere et al (2008)...
- DSGE literature and estimation
  - Galì and Monacelli (2008), Iacovello (2015), Mendoza (2010)...
  - An & Schorfheide (2007)...
- Analysis of the Eurozone & Greek crises
  - de Grauwe (2013), Martin & Philippon (2016), Shambaugh (2012)...

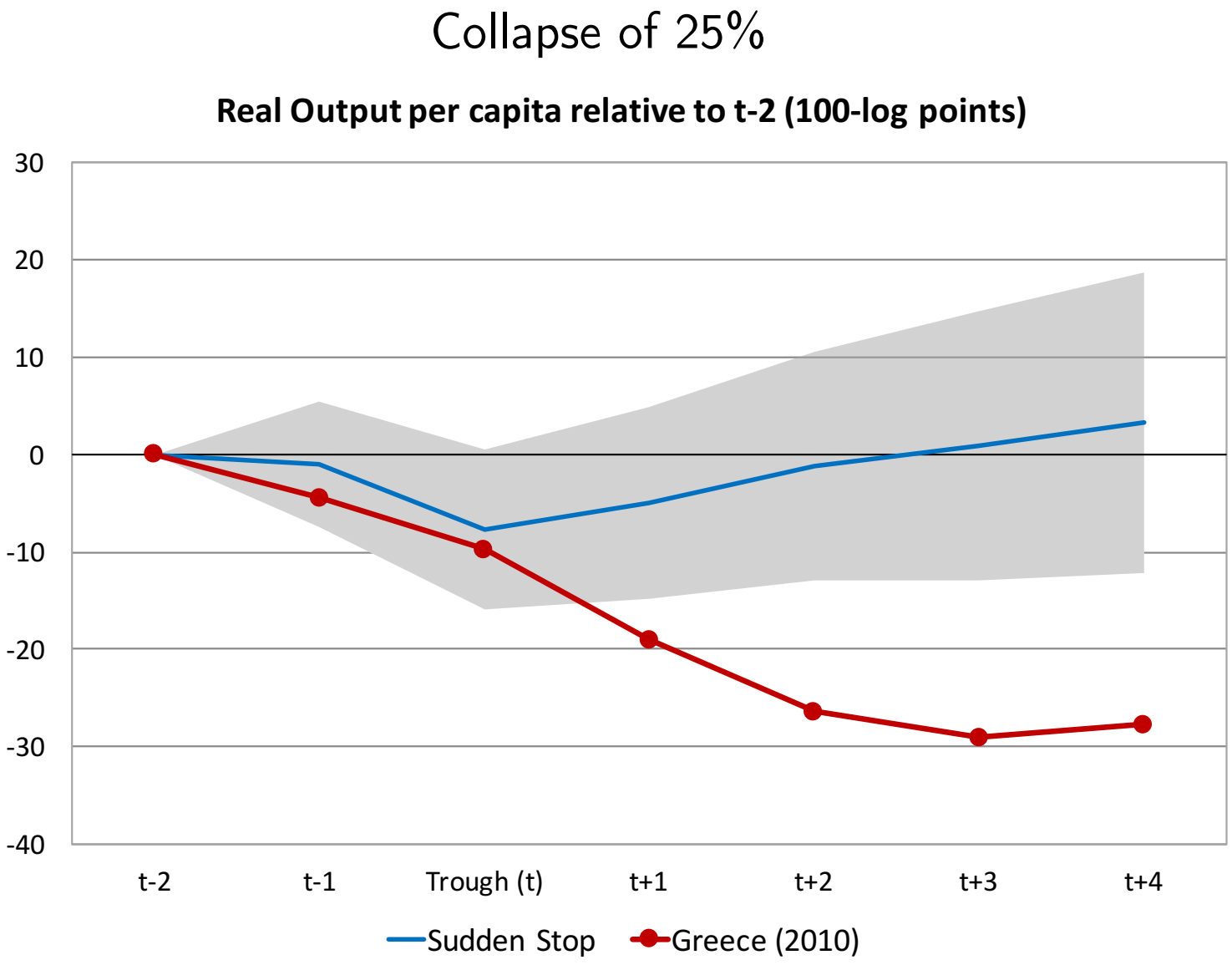
Benchmarking: the Comparison Group

- Sudden Stops
  - Combination of capital flow reversal & large drop in domestic output
  - Extend Calvo et al (2006), Korinek & Mendoza (2013)
  - 49 sudden stops
- Sovereign Defaults
  - from Gourinchas & Obstfeld (2012) based on literature
  - default on domestic or external debt
  - 65 default episodes
- Lending booms/busts
  - defined as in Gourinchas et al (2001)
  - deviation of credit/output from trend
  - 114 boom/busts

The Incidence of Crises

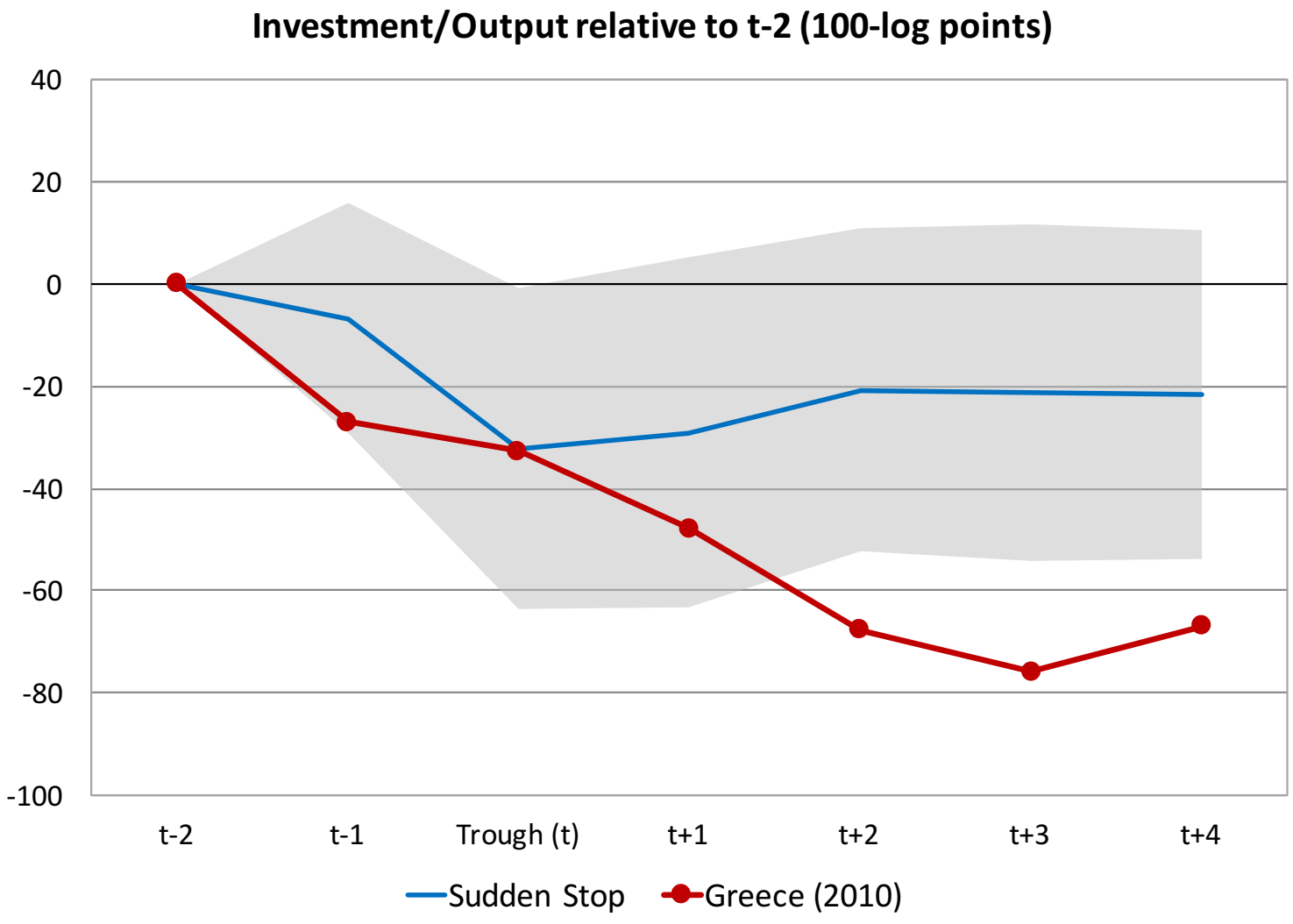
	Sudden Stop	Defaults	Credit Booms	'Trifecta'	#
AE	13	Greece	18	Greece	22
EM	36	64	96	9	57
Total	49	65	114	10	79

Benchmarking Ia: GDP Relative to All Sudden Stops

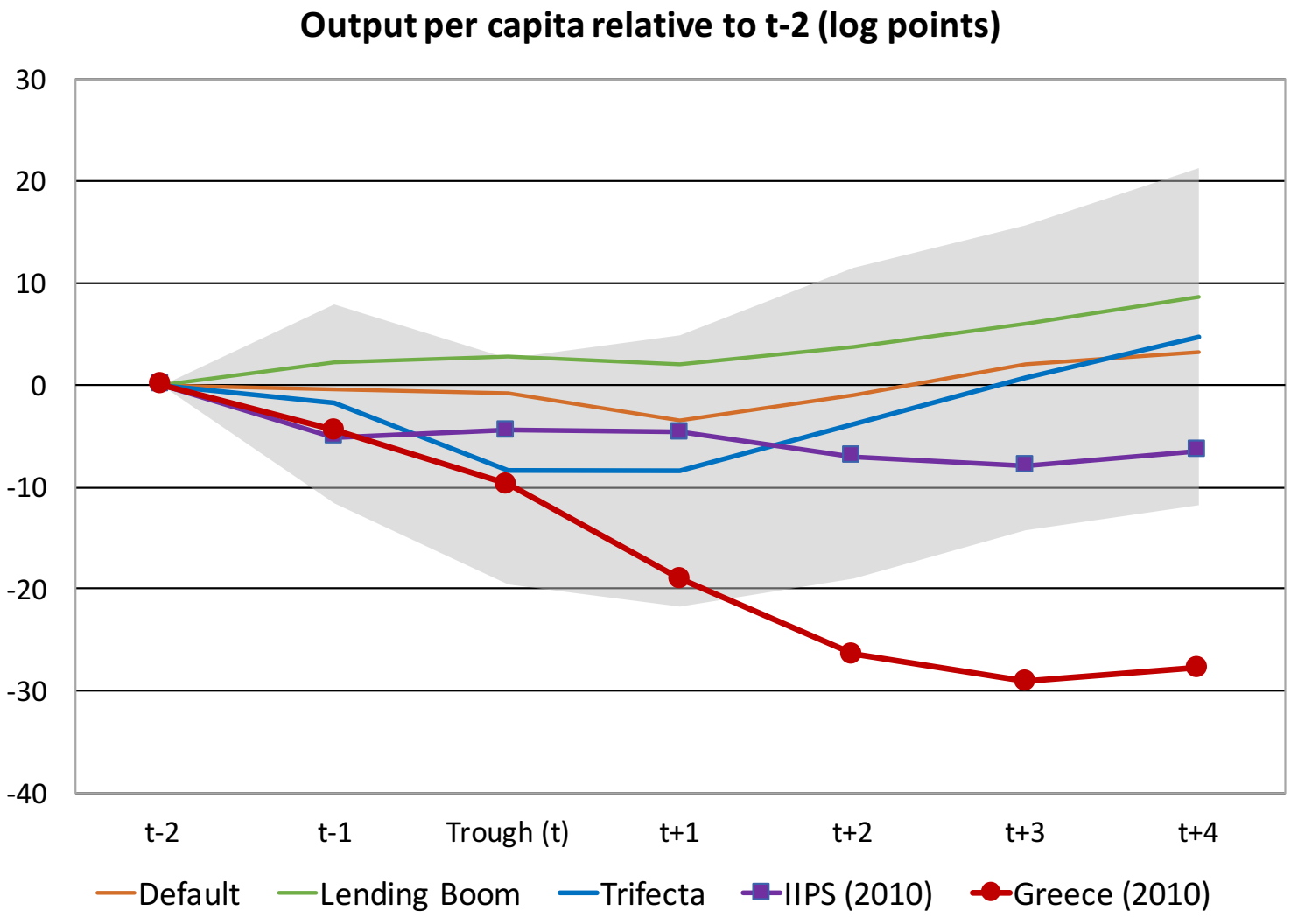


Benchmarking Ia: Aggregate Domestic Investment/Output

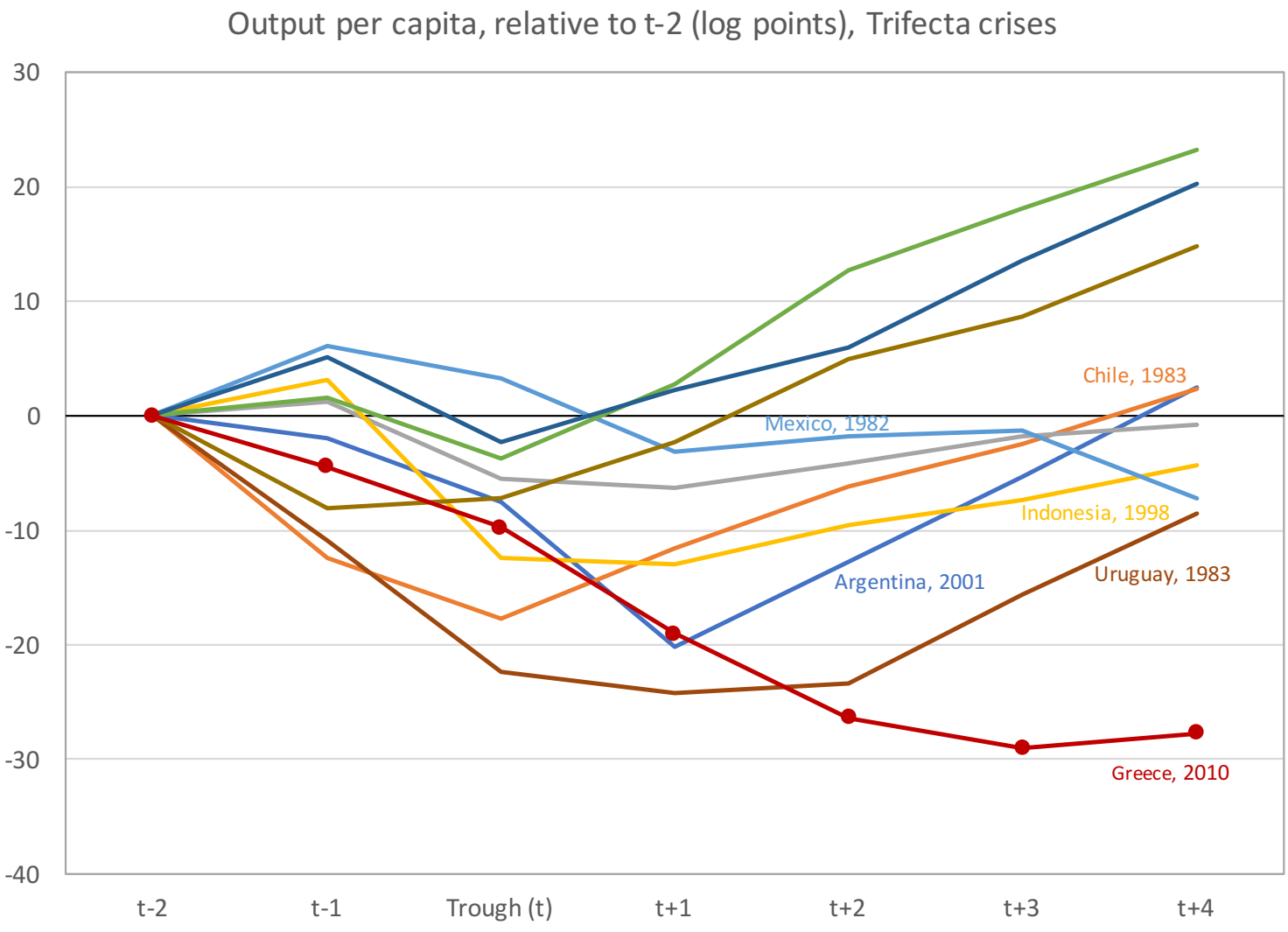
Collapse of 50%



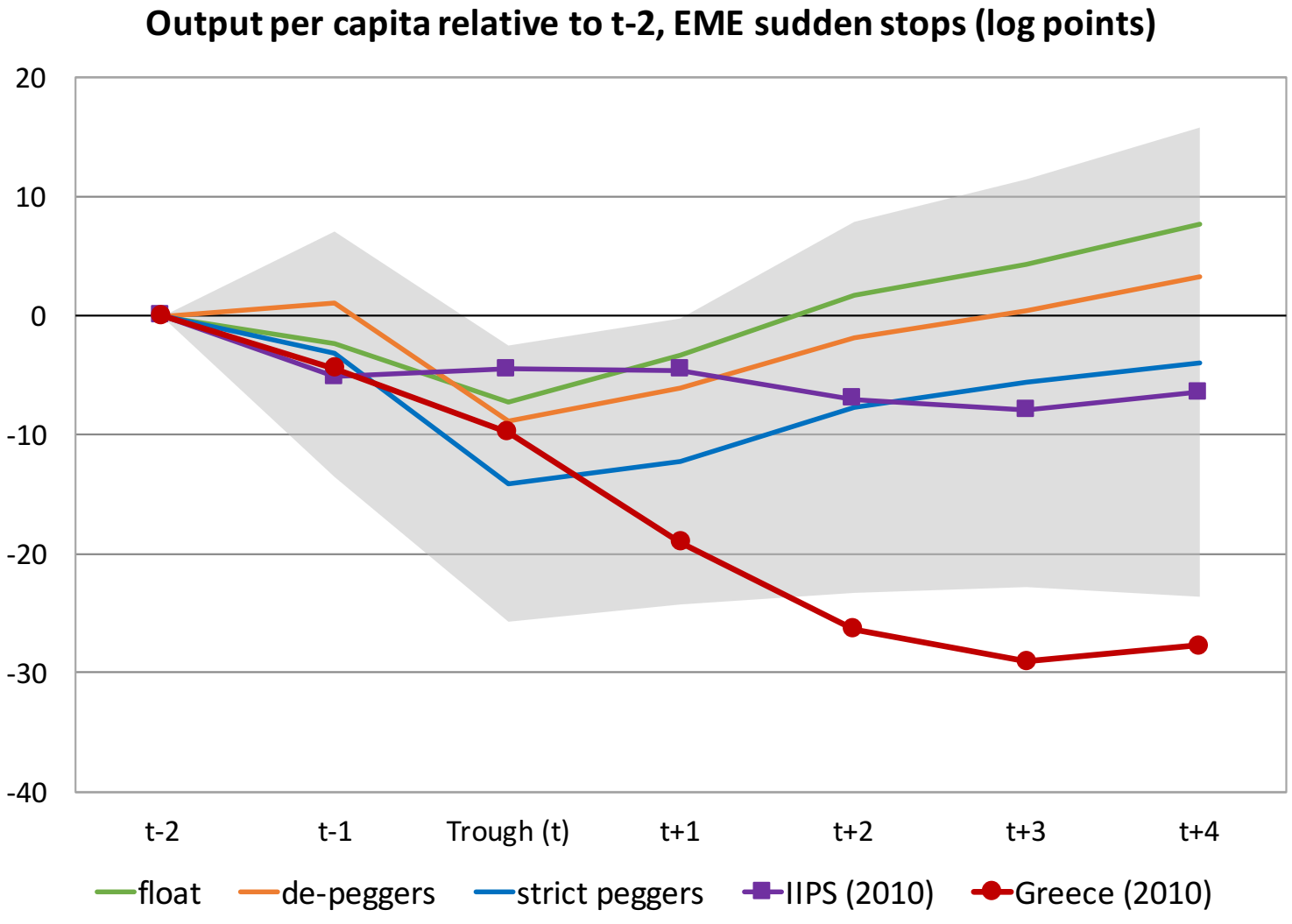
Benchmarking Ib: Other Crises



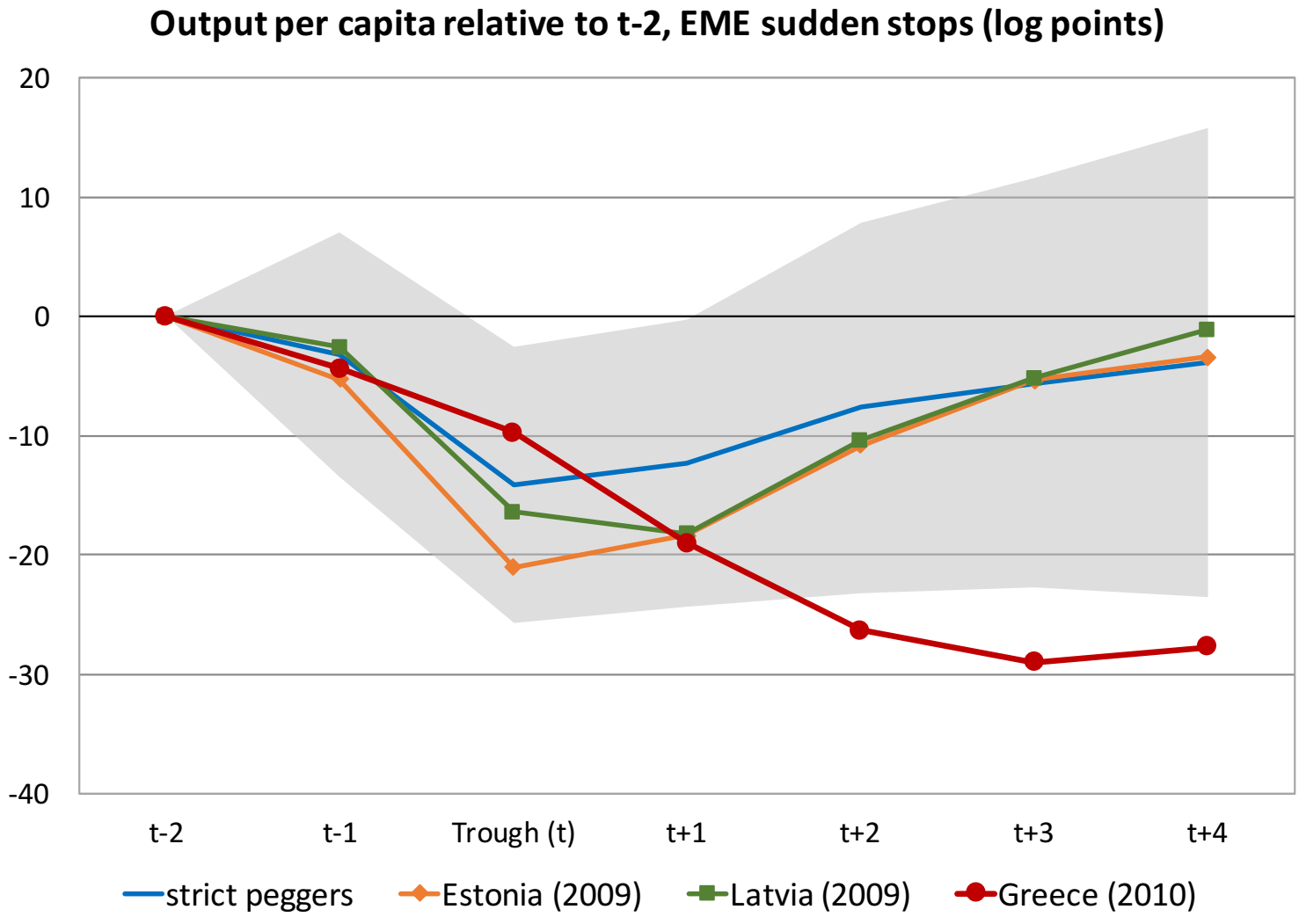
Sovereign Default? Credit Bust?... Trifecta



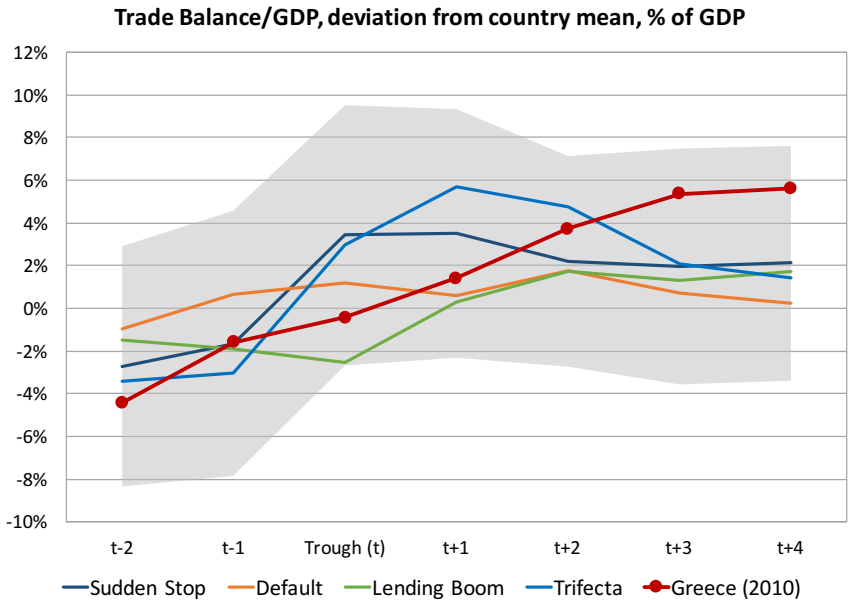
Benchmarking Ic: Compared to EM Floaters & Peggers

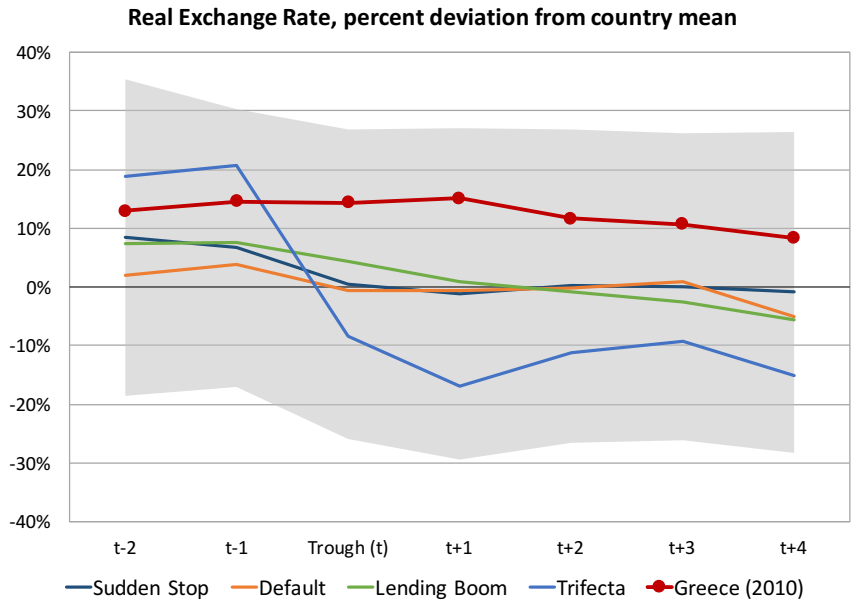


Benchmarking Id: Endogenous Peg?



External Adjustment





Empirical Lessons

1. Greek crisis significantly more severe persistent and backloaded than typical sudden stop
2. Greek crisis significantly more severe persistent and backloaded than 'Trifecta' episodes
3. Greek crisis more severe than for peggers (even Estonia or Latvia)
4. Collapse in aggregate investment unprecedented in its persistence and magnitude
5. Adjustment in external balances was very gradual, despite any significant movement in RER

Model

- Small Open Economy in a currency union (r, π^F exogenous)
- Standard NK DSGE à la Galì (2011) with financial frictions
  - Government (B^g, T, G, r^g)
  - Banks (V, r^d)
  - Households (B^h, C, r^h)
  - Firms (I, K, r^k)
- Various shocks

$$\zeta_t^{\#} = \rho^{\#} \zeta_{t-1}^{\#} + \sigma^{\#} \varepsilon_t^{\#}$$

Government

- Budget constraint

$$\frac{B_t^g}{R_t^g} + \tau_t Y_t = G_t + T_t + \frac{B_{t-1}^g}{\Pi_t^H}$$

- Fiscal rule (spending and social transfers)

$$g_t = F_l g_{t-1} - F_n n_t - F_r r_t^g - F_b b_t^g + \zeta_t^{spend}$$

- Tax rate

$$\tau_t = \bar{\tau} + \zeta_t^{tax}$$

- Government funding cost ($x \equiv \ln(x/x_{ss})$, $d_t^g \equiv$ *expected* losses)

$$\begin{aligned} r_t^g &= r_t + d_t^g \\ d_t^g &= \bar{d}_g \frac{B^g}{Y} \left(b_t^g - \mathbb{E}_t \left[y_{t+1} \right] - \mathbb{E}_t \left[\pi_{t+1}^h \right] + \zeta_t^{dg} \right) \end{aligned}$$

Households

$$U^i = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left(\frac{\left(\mathbf{C}_t^i\right)^{1-\gamma}}{1-\gamma} - \frac{\left(N_t^i\right)^{1+\phi}}{1+\varphi} \right) \quad ; \quad \mathbf{C}_t^i \equiv \left[(1-\varpi)^{\frac{1}{\varepsilon_h}} C_{H,t}^{i\,\frac{\varepsilon_h - 1}{\varepsilon_h}} + \varpi^{\frac{1}{\varepsilon_h}} C_{F,t}^{i\,\frac{\varepsilon_h - 1}{\varepsilon_h}} \right]^{\frac{\varepsilon_h}{\varepsilon_h - 1}}$$

- **Borrowers**, β_b (mass χ), $d^p \equiv$ *realized* loss rate, $B_t^h \leq \bar{B}_t^h$,

$$\mathbf{P}_t \mathbf{C}_t^b = (1-\tau_t) W_t N_t^b + \frac{P_{H,t} B_t^h}{R_t^h} - \left(1 - d_t^p\right) P_{H,t-1} B_{t-1}^h + P_{H,t} T_t^b$$

$$d_t^p = -\bar{d}_y y_t + \bar{d}_b b_t^h + \zeta_t^{def}$$

$$\bar{b}_t^h = \psi_{bh} \bar{b}_{t-1}^h - \xi^{bh} r_t^d + \zeta_t^{bh}$$

- **Savers**, $\beta > \beta_b$ (mass $1-\chi$),

$$\mathbf{P}_t \mathbf{C}_t^s = (1-\tau_t) W_t N_t^s + \tilde{R}_t P_{H,t-1} S_{t-1} - P_{H,t} S_t + P_{H,t} T_t^s$$

Non-Financial Firms

- Break down into capital- and goods-producing firms.
- Capital-producing firms:
  - Convert consumption goods into capital, and rent to goods-producing firms.
  - Q rule for investment.
- Goods-producing firms:
  - Convert capital and labor into goods.
  - Cobb-Douglas with constant TFP.
  - Financing friction: pay part of wage bill in advance. Intraperiod loan with funding cost r^k.

Price and Wage Rigidity

- Wage-calvo process yields a Phillips curve for wages

$$\pi_t^w = \beta \mathbb{E}_t \pi_{t+1}^w - \lambda_w \left(w_t - \gamma c_t - \varphi n_t \right) + \zeta_t^w$$

- Price-calvo process yields a Phillips curve for domestic prices

$$\pi_t^h = \beta \mathbb{E}_t \pi_{t+1}^h + \lambda_p \mathtt{mc}_t + \zeta_t^{\pi h},$$

  where $\mathtt{mc}_t$ is log real marginal cost in terms of domestic goods.

- ζ_t^w : wage markup shock, $\zeta_t^{\pi h}$: domestic price markup shock

Banks

- Domestic deposits and foreign loans
- Lend to households, firms and government
- Subject to capital requirement

$$V_t \geq \kappa \left(\frac{B_t^k}{R_t^k} + \frac{B_t^h}{R_t^h} \right)$$

  where V_t is franchise value.
- No capital requirement for sovereign exposure
- Bank funding costs

$$r_t^d = r_t + \zeta_t^r + \xi^d L\mathbb{E}_t \left[d_{t+1}^p \right]$$

Summary of Funding Costs

- Key equations
  - Banks fund households and firms

$$r_t^k = r_t^d$$

  - Banks: sudden stop and capital loss

$$\begin{aligned} r_t^d &= r_t + \zeta_t^r + \xi^d L\mathbb{E}_t\left[d_{t+1}^p\right] \\ d_t^p &= -\bar{d}_y y_t + \bar{d}_b b_{t-1} + \zeta_t^{def} \end{aligned}$$

  - Government

$$\begin{aligned} r_t^g &= r_t + d_t^g \\ d_t^g &= \bar{d}_g \frac{B^g}{Y}\left(b_t^g - \mathbb{E}_t\left[y_{t+1}\right] - \mathbb{E}_t\left[\pi_{t+1}^h\right] + \zeta_t^{dg}\right) \end{aligned}$$

  - Households

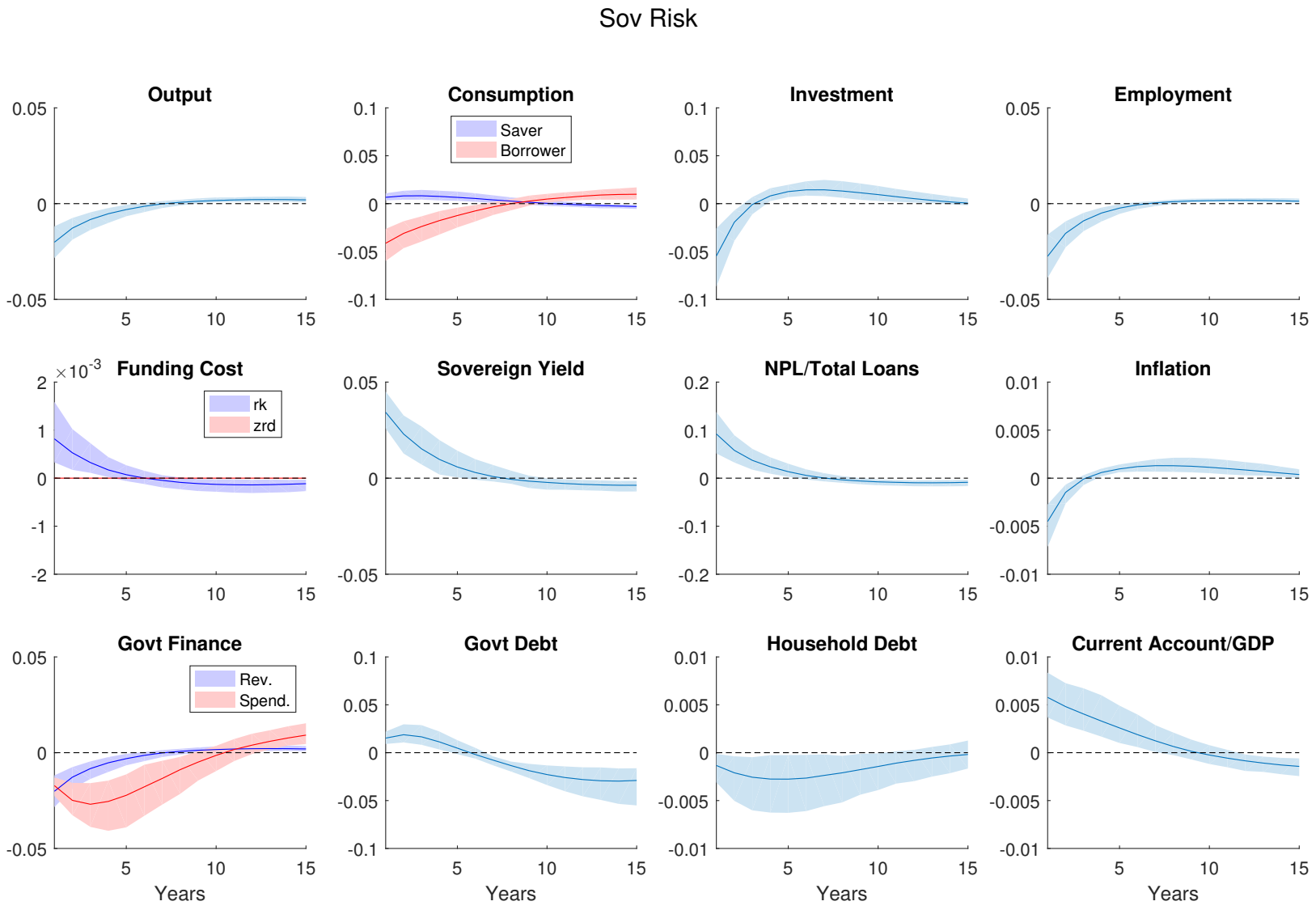
$$r_t^h = r_t^d + \mathbb{E}_t\left[d_{t+1}^p\right]$$

Doom Loops

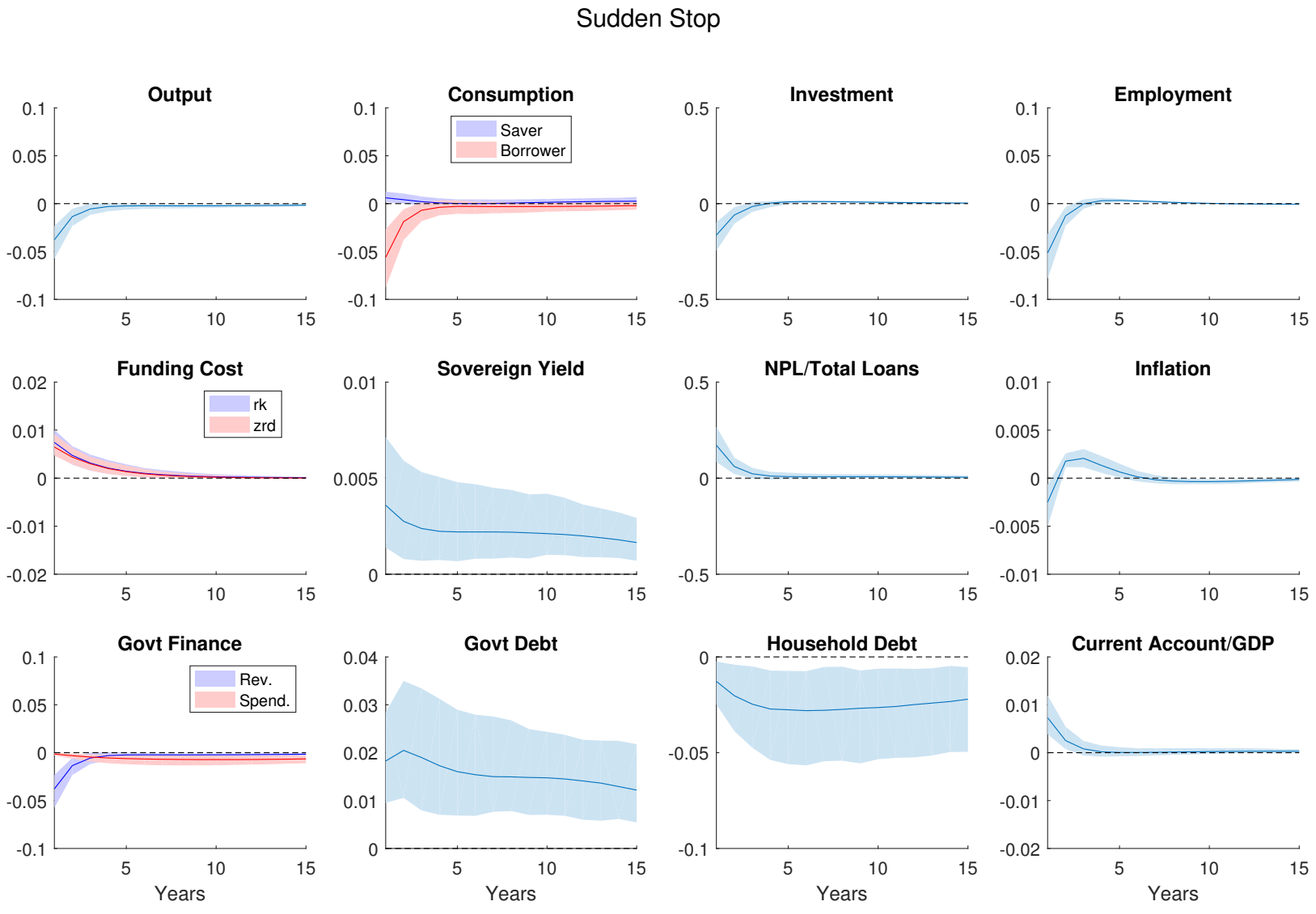
No direct doom loop, but indirect GE feedback loops:

- Sovereign risk shock ζ_t^{dg}:
  - Government funding costs increase $\rightarrow$ Government raises taxes and reduces expenditure $\rightarrow$ Output declines $\rightarrow$ Expected costs of default on private-sector loans increase $\rightarrow$ Funding costs for private sector increase and investment drops.
- Sudden stop ζ_t^{r}:
  - Funding costs for private sector increase $\rightarrow$ Output and investment drop $\rightarrow$ Fiscal revenues drop $\rightarrow$ Expected costs of default on sovereign loans increase $\rightarrow$ Government funding costs increase.

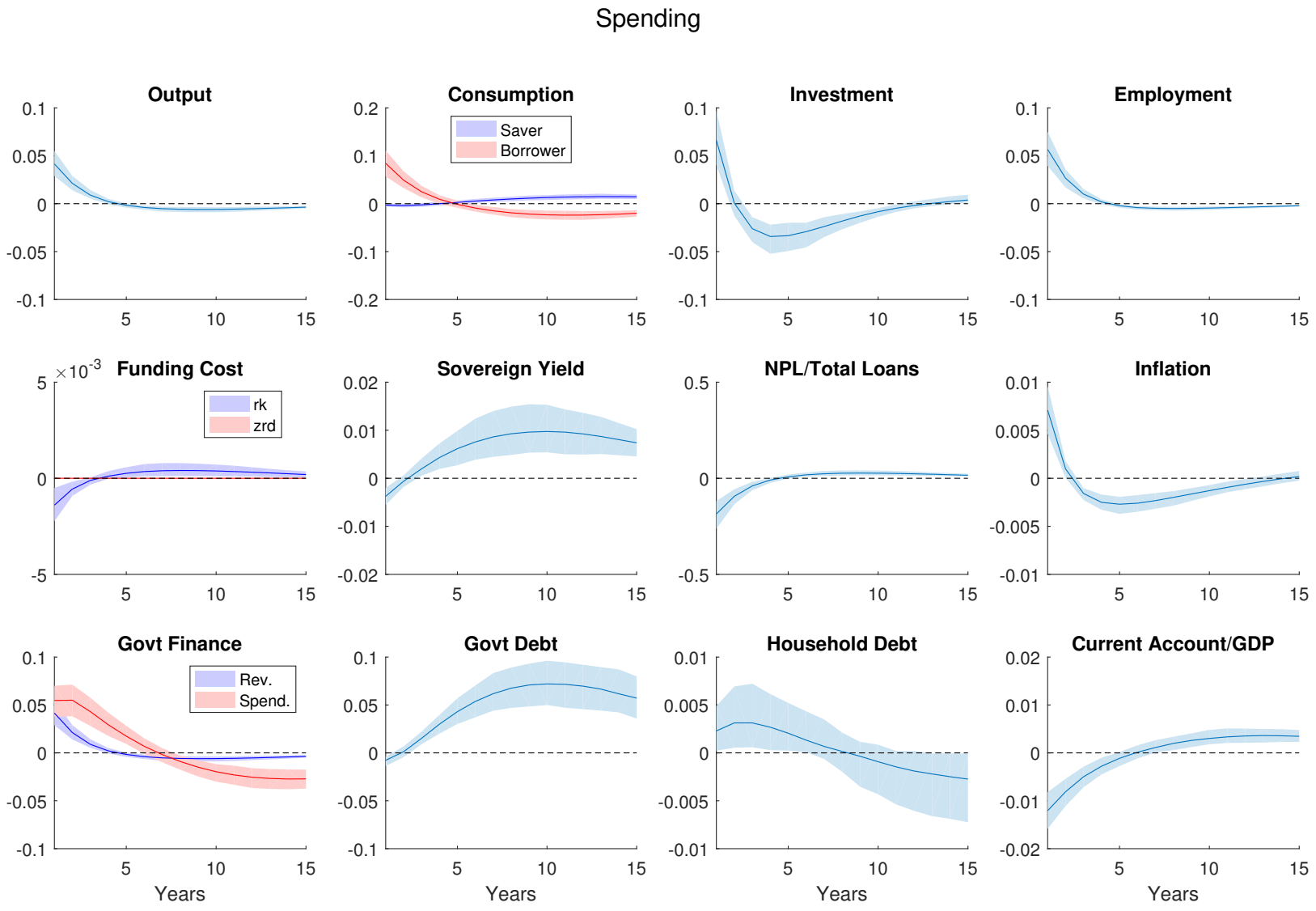
Impulse Response: Sovereign Risk Shock



Impulse Response: Sudden Stop



Impulse Response: Fiscal Shock



Bayesian Estimation of the Model

- Standard techniques (Herbst & Schorfheide (2015))
- Period: 1999 to 2015
- Calibrate steady state parameters
- Estimate dynamic parameters

Observable	Description	Shock	Shock Description
$G_t + T_t$	Government spending	ζ_t^{spend}	Govt. spending shock
$\tau_t Y_t$	Government revenues	ζ_t^{tax}	Tax rate shock
R_t^g	Greek government spread over EZ average	ζ_t^{dg}	Sovereign risk shock
R_t^k	SME spread over EZ average	ζ_t^{r}	Funding cost shock
$\exp\left(d_t^p\right)$	Non-performing loans/total loans, $def = npl$	ζ^{def}	Private default shock
Π_t	Greece CPI - EZ CPI	$\zeta^{\pi h}$	PPI cost push shock
B_t^h	Household debt	ζ_t^{bh}	Household credit shock
Π_t^w	Greek Wage Inflation - EZ Wage Inflation	ζ^{w}	Wage inflation shock

Table: **Observables and Shocks**

Calibrated Parameters-I

Parameter	Description	Value
β	Discount Factor	0.97
α	Capital Share	1/3
ε_h	Elasticity between H and F	1
ε_f	Elasticity between exports	1
φ	Inverse labor supply elasticity	1
γ	Risk Aversion	1
ϑ	Price Stickiness	0.5
ε	Elasticity of Substitution Goods	6
ϑ_w	Wage Stickiness	0.5
ε_w	Elasticity of Substitution Labor	6
ε_r	Elasticity of R to NFA	0.0001
φ_k	Adjustment Cost	1
δ	Depreciation	0.07
FC	Fixed cost of production, 10% of Y	0.0955

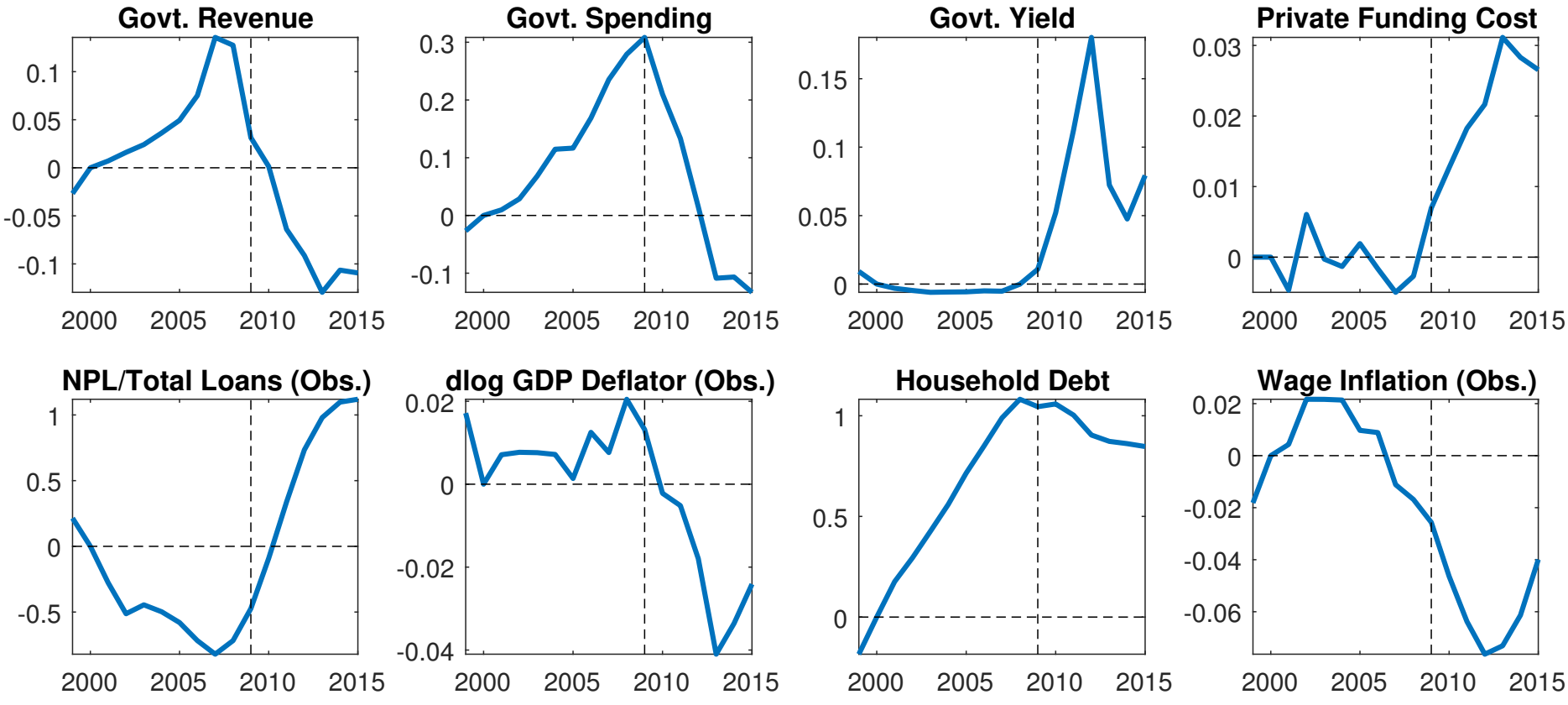
Calibrated Parameters-II

Parameter	Description	Value
ϖ	Openness (?)	0.3
χ	Fraction of Impatient (?)	0.65
Δ	Annual lending spread of 2%	1.02
$\frac{\bar{B}^h}{Y}$	Household debt to GDP of 50%	0.5
$\frac{B^g}{Y}$	Government debt to GDP of 120%	1.2
$\frac{G}{Y}$	Government consumption to GDP of 20%	0.2
$\frac{T}{Y}$	Public social expenditure to GDP of 20%	0.2
$\bar{d}^h$	Steady state default rate for Households	5.4%
$\bar{d}^k$	Steady state default rate for Corporates	5.4%
$\frac{B^k}{Y}$	Corporate debt to GDP of 50%	0.5
ψ_{sk}	Working Capital Constraint	1
τ	Tax rate, budget balance in SS	0.436
L	Leverage scaling	1

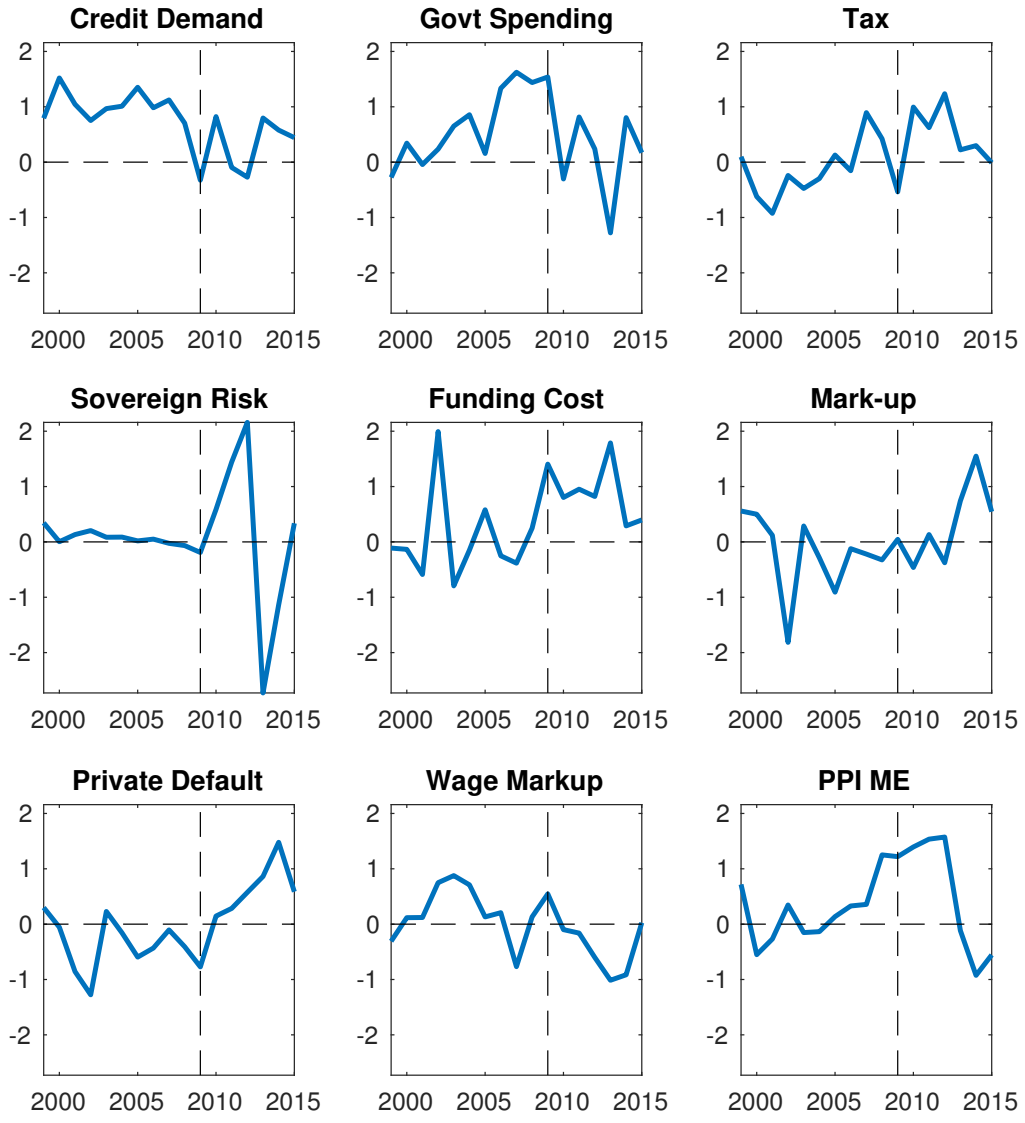
Calibrated Parameters-III

Parameter	Description	Value
F_b	Elasticity of govt. spending to public debt	0.05
F_n	Elasticity of govt. spending to employment	0.025
F_r	Elasticity of govt. spending to the int. rate	0.5
F_l	Persistence of govt. spending	0.75

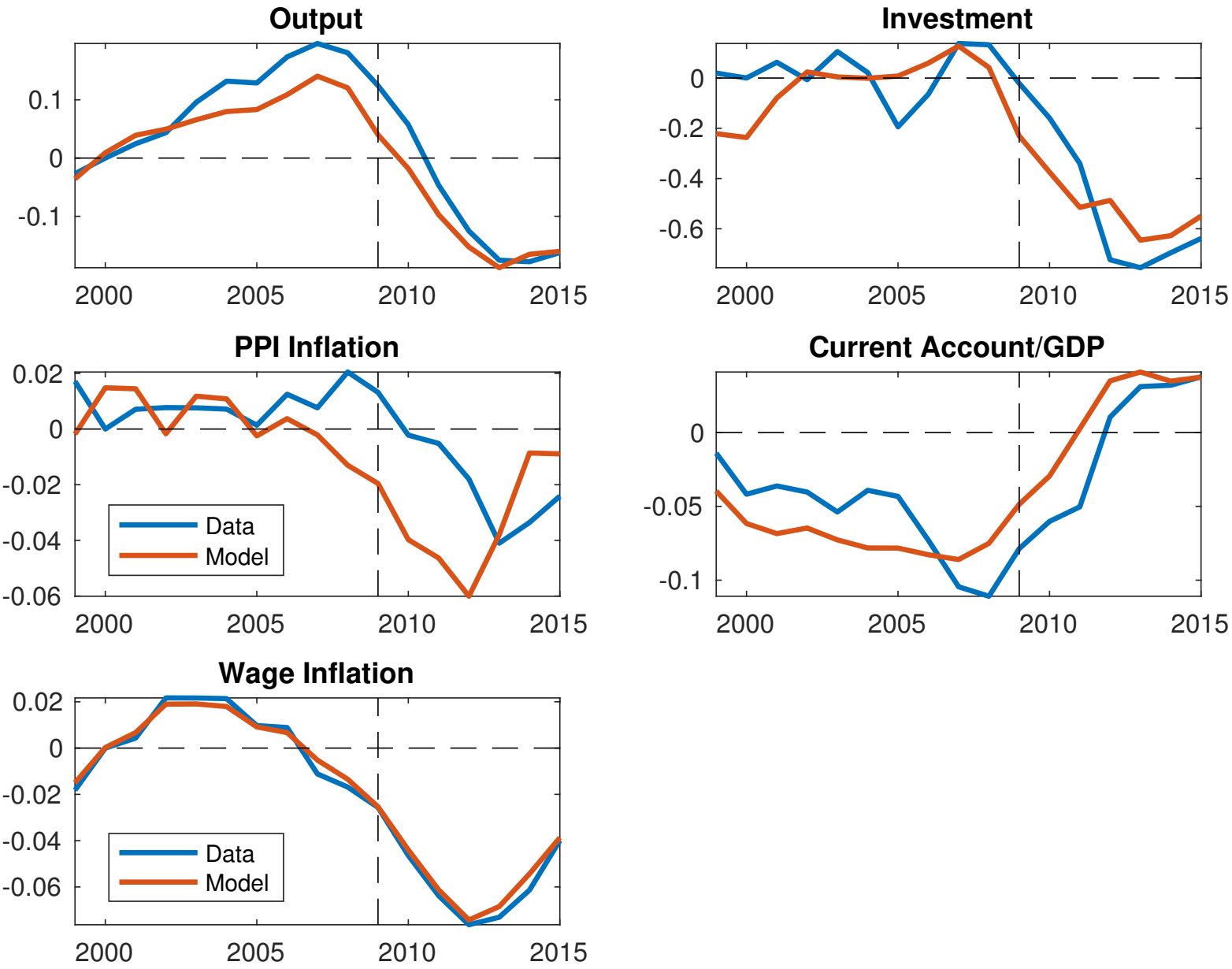
Data Inputs


Govt. Revenue
0.1
0.05
0
-0.05
-0.1
2000
2005
2010
2015
Govt. Spending
0.3
0.2
0.1
0
-0.1
2000
2005
2010
2015
Govt. Yield
0.15
0.1
0.05
0
2000
2005
2010
2015
Private Funding Cost
0.03
0.02
0.01
0
2000
2005
2010
2015
NPL/Total Loans (Obs.)
1
0.5
0
-0.5
2000
2005
2010
2015
dlog GDP Deflator (Obs.)
0.02
0
-0.02
-0.04
2000
2005
2010
2015
Household Debt
1
0.5
0
2000
2005
2010
2015
Wage Inflation (Obs.)
0.02
0
-0.02
-0.04
-0.06
2000
2005
2010
2015

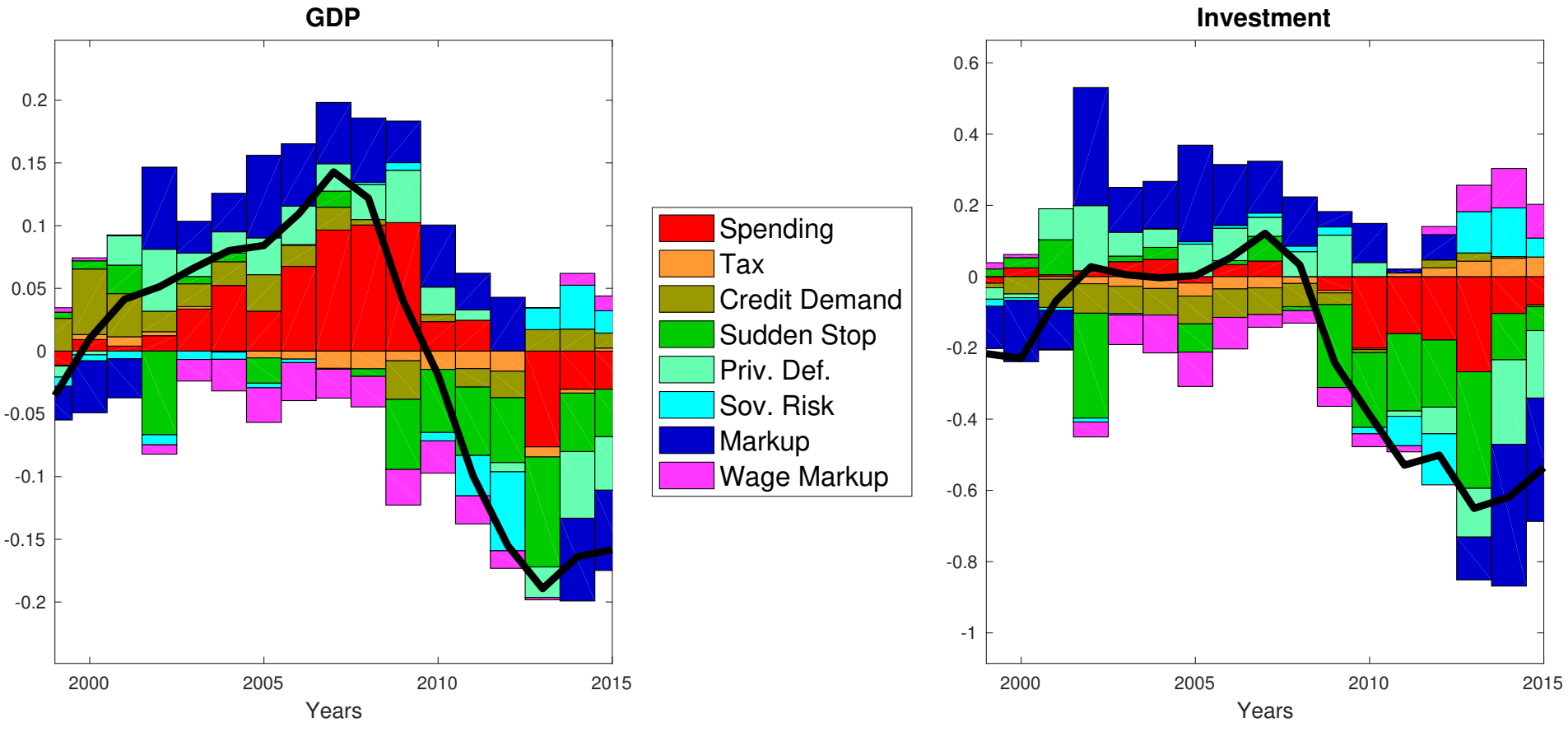
Estimated Shocks (posterior)



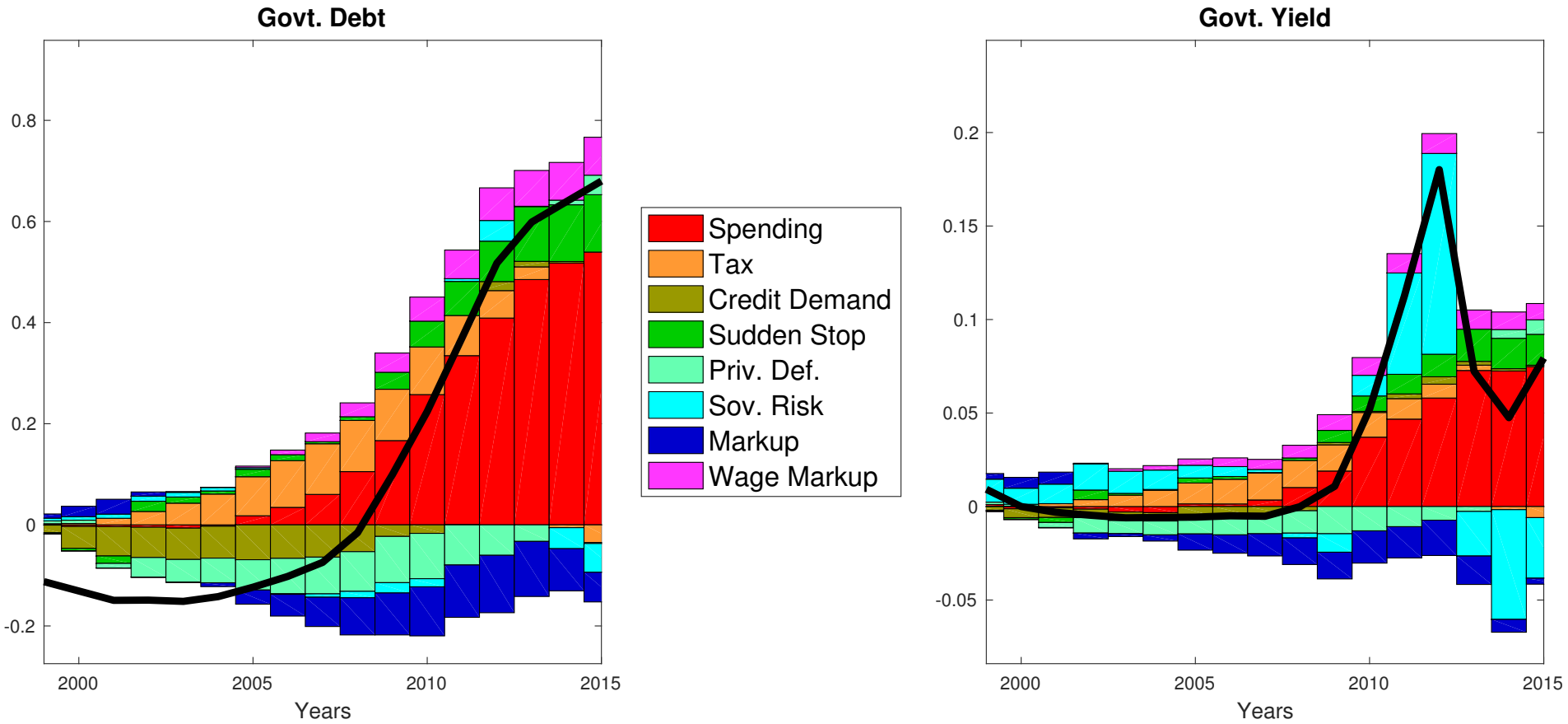
Fit of the Model



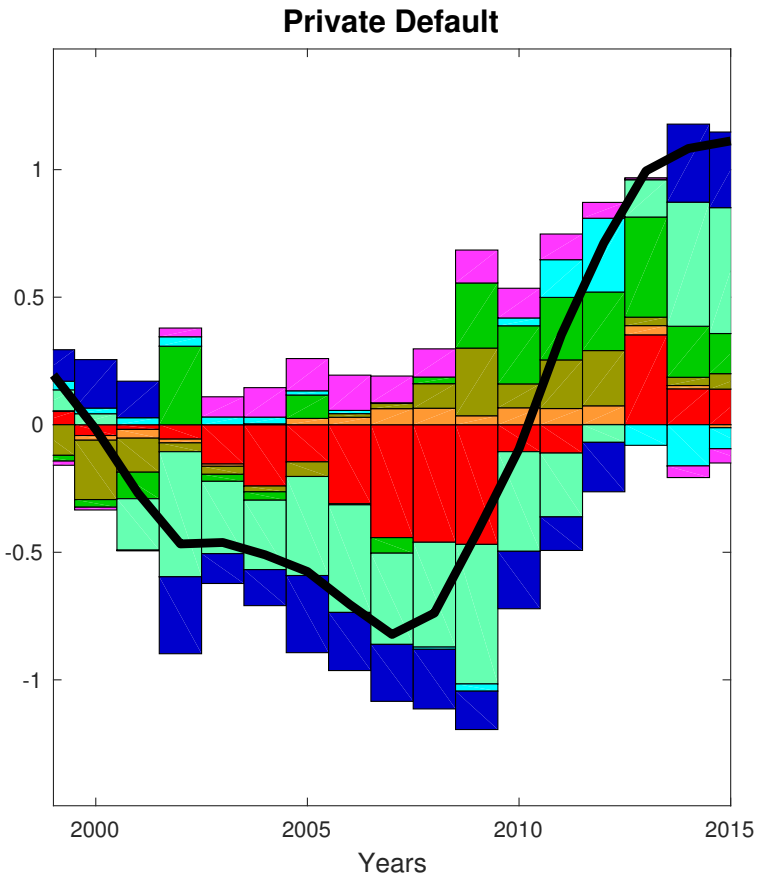
Decomposition of Output and Investment

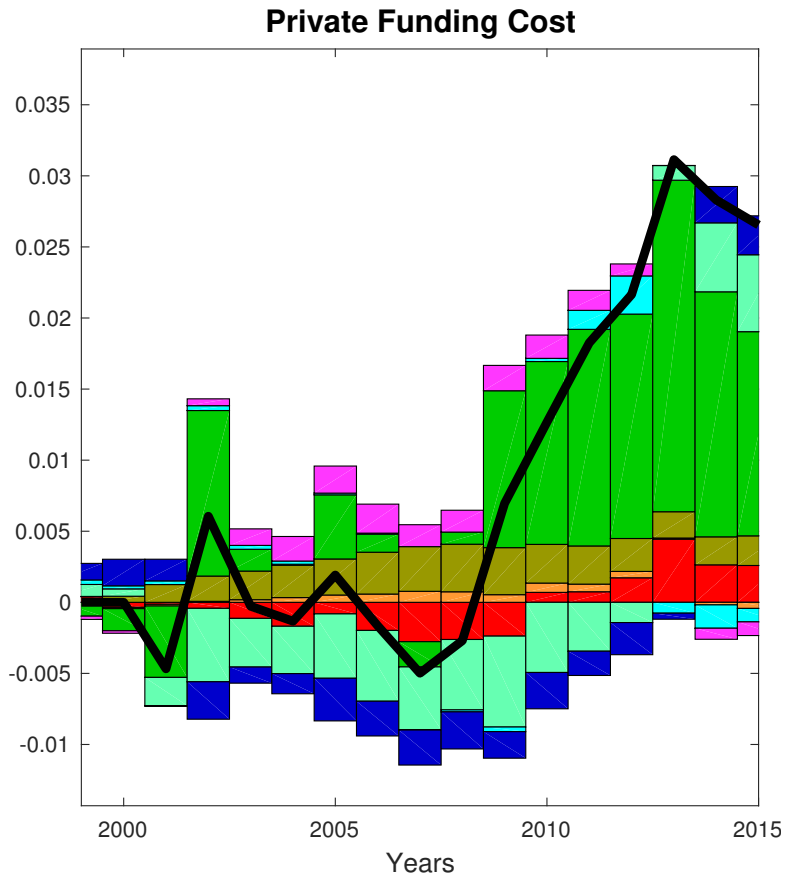


Decomposition of Sovereign Debt & Yield

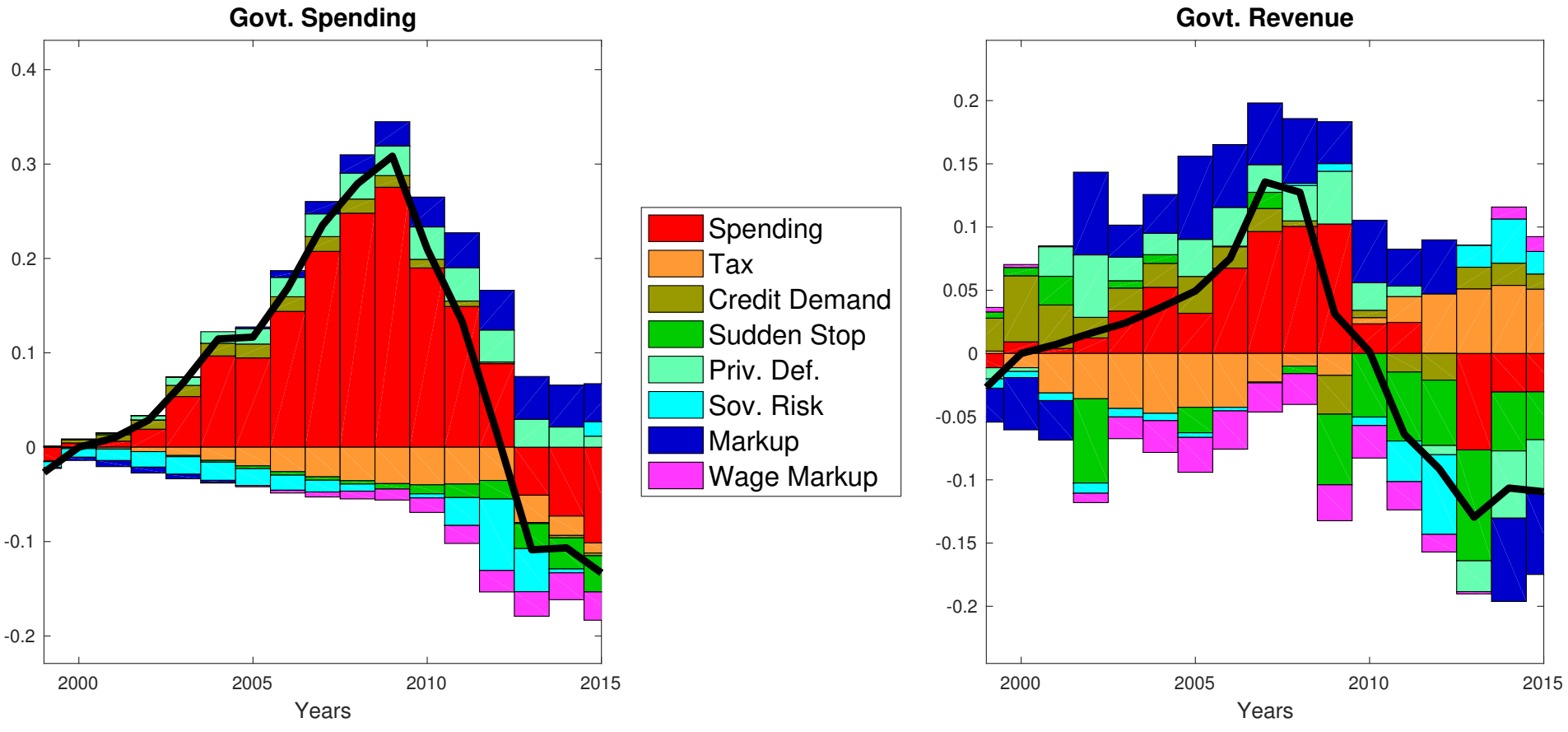


Decomposition of Private Default and Funding Costs

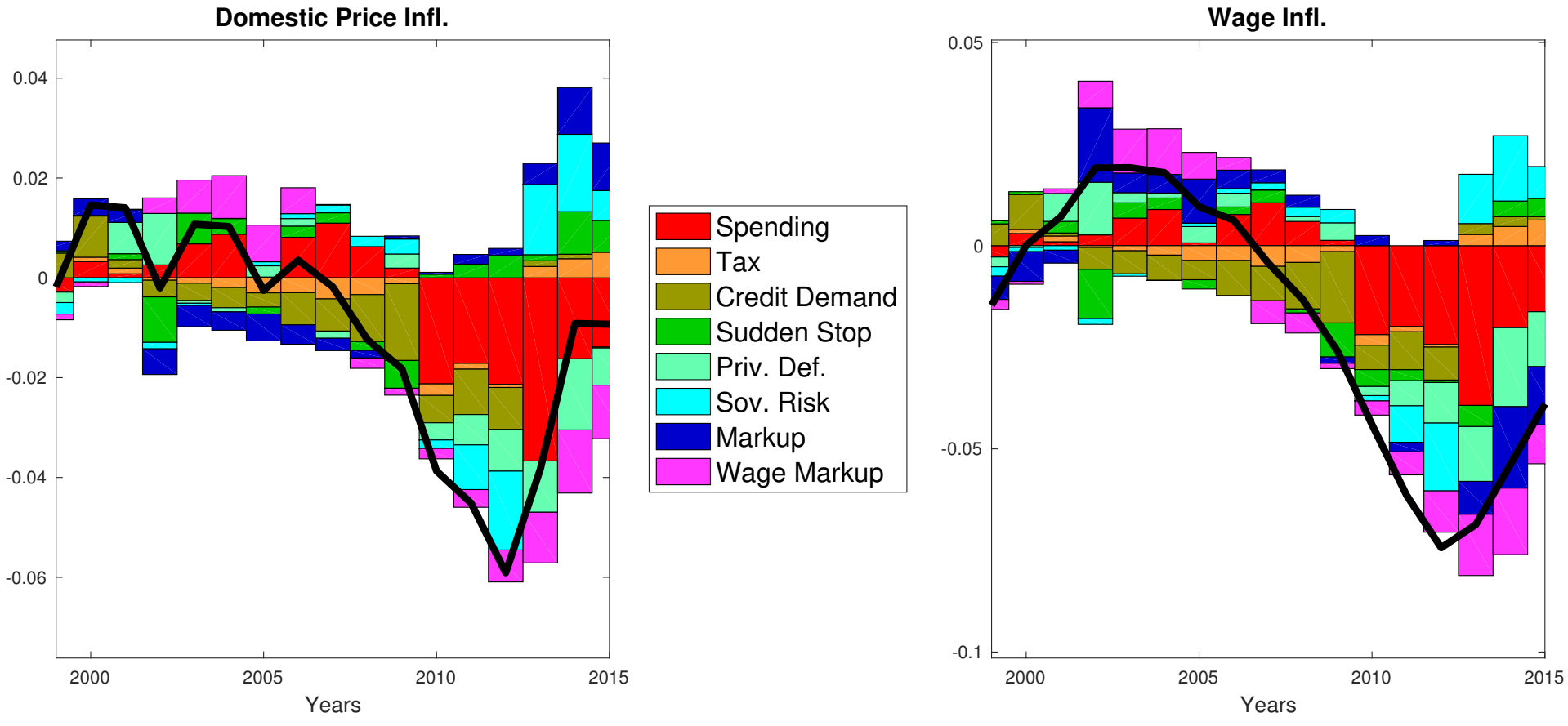




Decomposition of Government Spending and Revenues



Decomposition of Domestic Price and Wage Inflation



Key Lessons

'Murder on the Orient Express'

- Fiscal trajectory prior to 2009 unsustainable. Stimulates output initially, but depresses it later on.
- First phase of the crisis (2009-2013)
  - Sovereign risk
  - Sudden stop
- Second phase of the crisis (2013-..)
  - Non-performing loans
  - Price markups.

4 Counterfactual Exercises

Compare $\hat{x}^T = \Gamma\left(\hat{\Theta}, \{\hat{\varepsilon}_k^T\}_{k=1}^K\right)$ and $\tilde{x}^T = \Gamma\left(\tilde{\Theta}, \{\tilde{\varepsilon}_k^T\}_{k=1}^K\right)$.

1. Low leverage (EME leverage)
2. Banking union
3. Fiscal discipline
4. Price flexibility (Latvia)

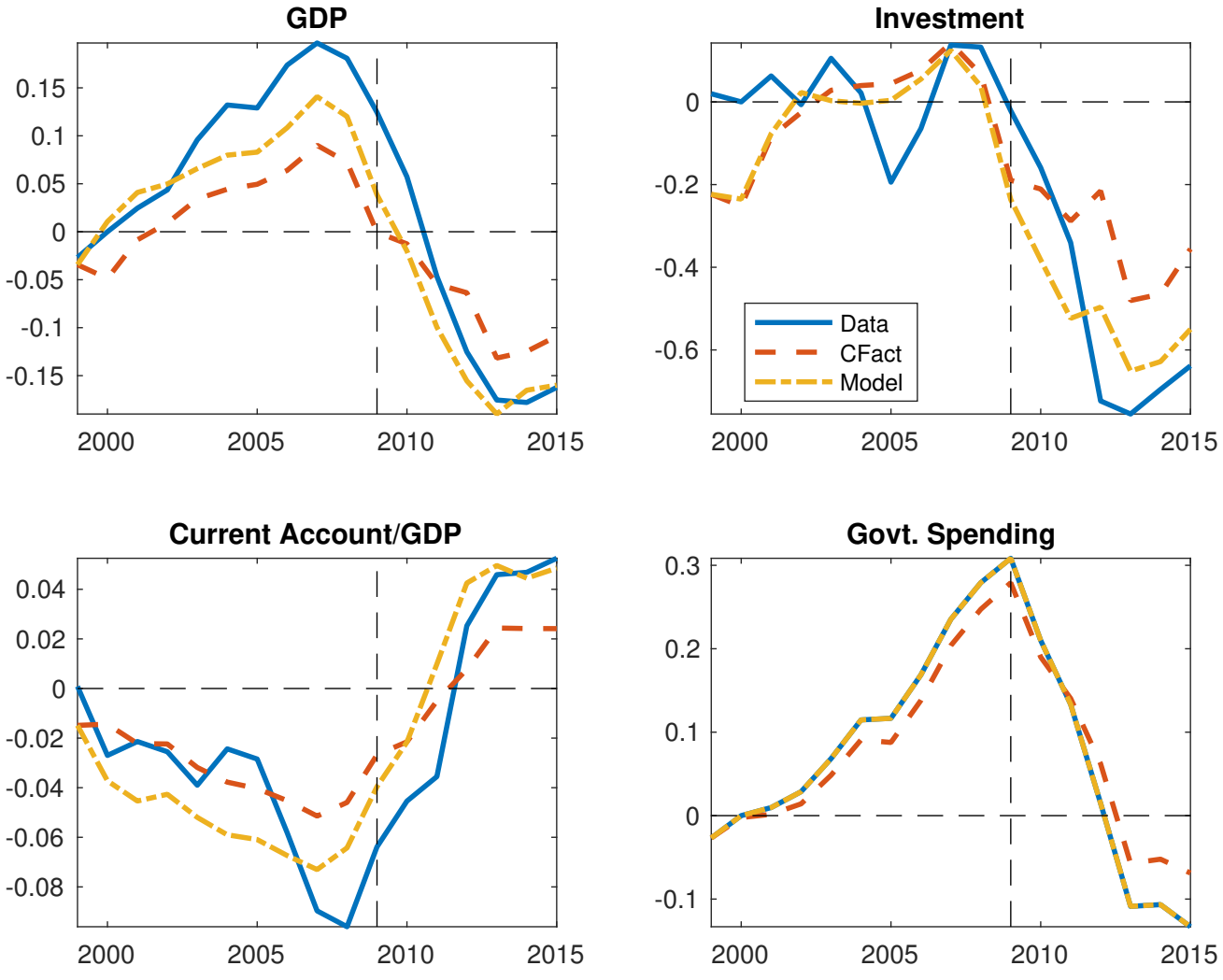
Counterfactual I: EME Leverage

	Greece	Typical EME	Min	Max
Credit / GDP	1.01	0.46	0.025	1.46
Sovereign Debt / GDP	1.38	0.343	0.063	0.68
Current Account /GDP	-0.083	-0.039	-0.10	+0.17

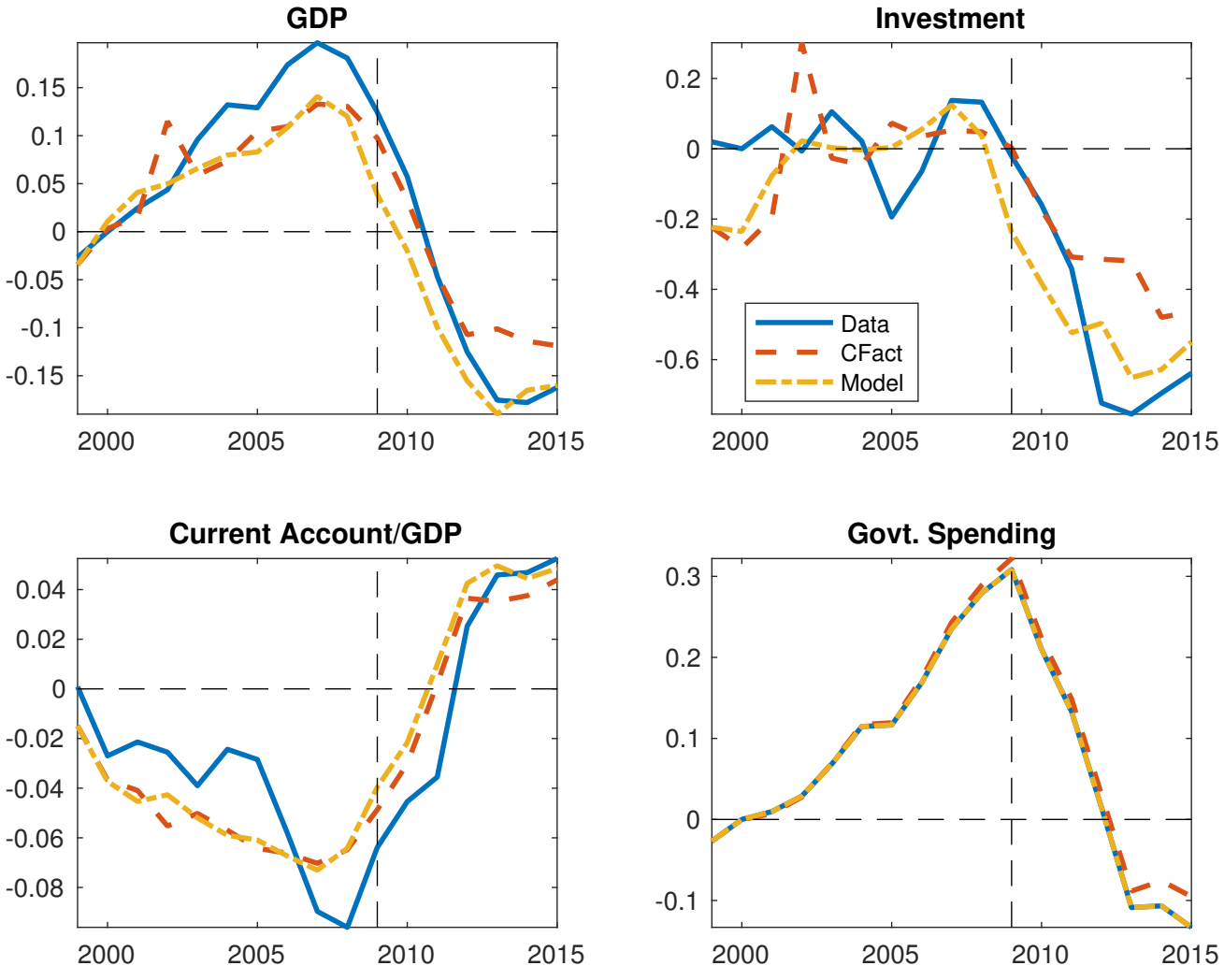
Table: **Leverage and Imbalances Before Sudden Stop**

Notes: Average from t-6 to t-2 where t is sudden stop.

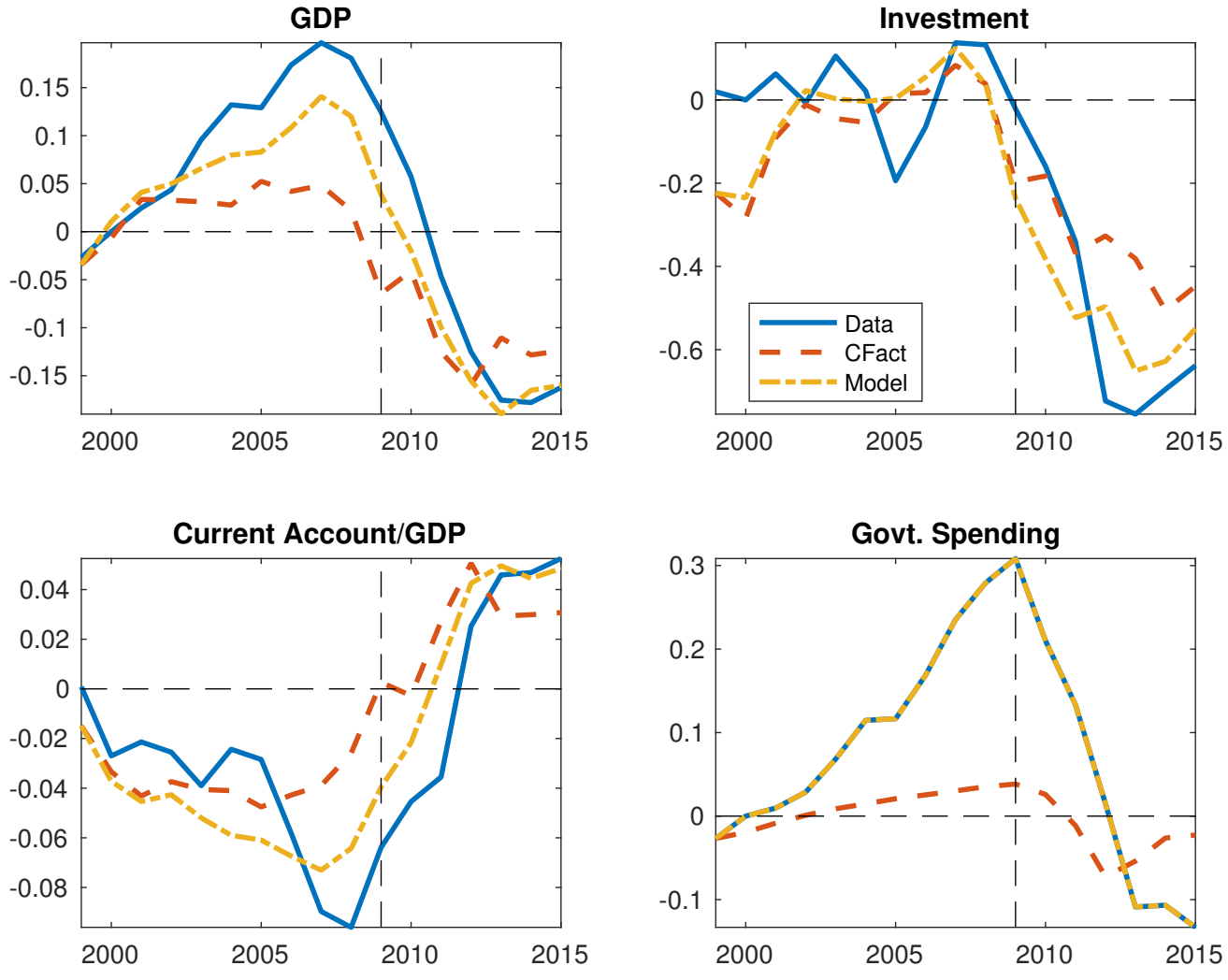
Counterfactual I: EME Leverage



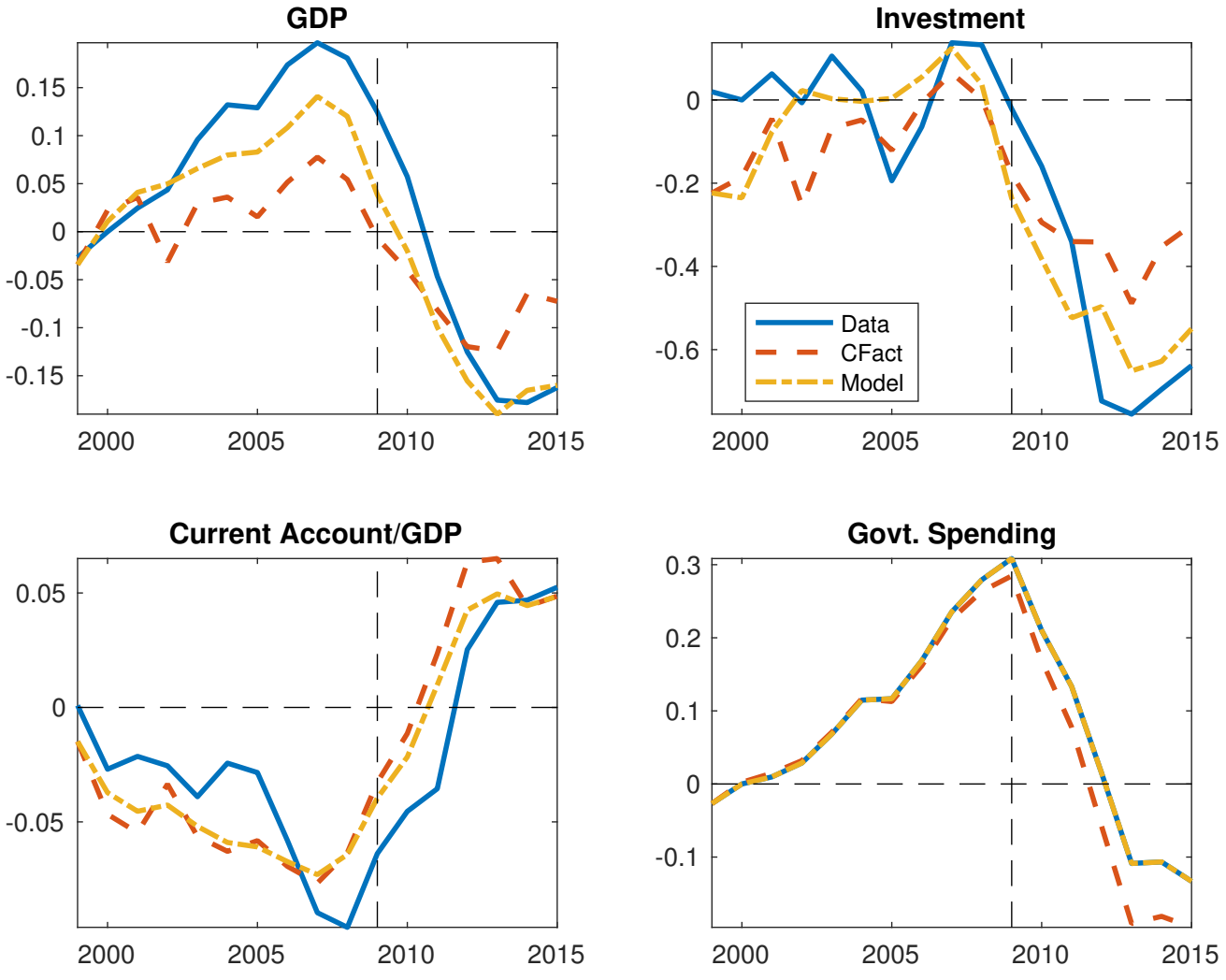
Counterfactual II: Banking Union



Counterfactual III: No Discretionary Spending



Counterfactual V: Low Price Stickiness



Conclusion: What Would Have Helped?

- What we can say
  - Exposure Y+10%, I+15%
  - Banking union Y+10%, I+30%
  - Sound fiscal Y+15%, I+20%
  - More flexible prices Y+15%, I+20%
- Open issues
  - Uncertainty (political, EZ risk)?
  - Early sovereign default?
  - Devaluation?