A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk

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Questions

1. Did financial sector bailouts ignite sovereign credit risk in the developed economies?
   - were there important immediate costs to the bailouts (as opposed to just distortions of future incentives)
2. What mechanisms underlie the relationship between financial sector and sovereign credit risk?
   - transmission of risks (spillover) between the sectors
   - trade-off between financial sector and sovereign credit risk
3. Does sovereign credit risk also feedback onto financial sector credit risk?

Motivation:
Bailout of Irish Banks

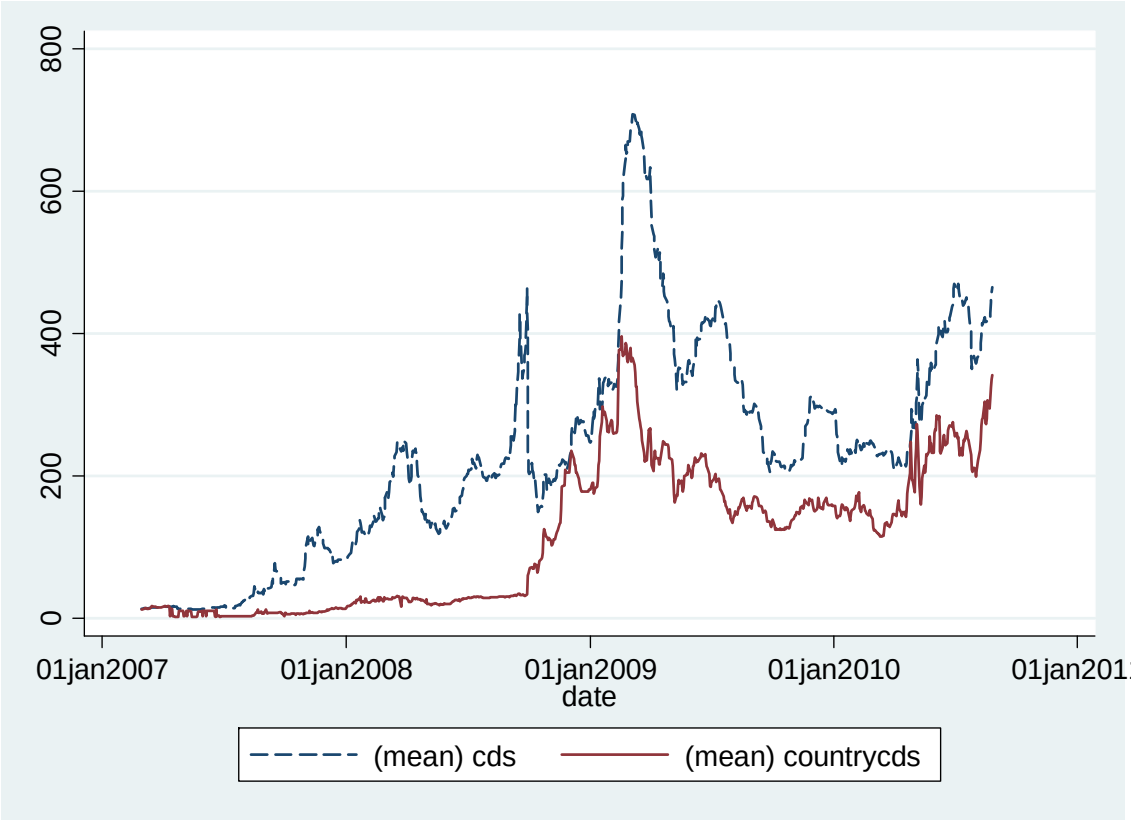
From Financial Sector Credit Risk to Sovereign Credit Risk

- On September 30, 2008 the government of Ireland announced a guarantee of all deposits of its six biggest banks
- Credit default swap (CDS) fee for buying protection on Irish banks fell from 400 bps to 150 bps
- From the standpoint of stabilizing the financial sector, the end goal of the guarantees appeared to have been met
- But at what cost?
- What impact would these provisions have on the credit risk of the government of Ireland?

Bailouts and Risk Transfer

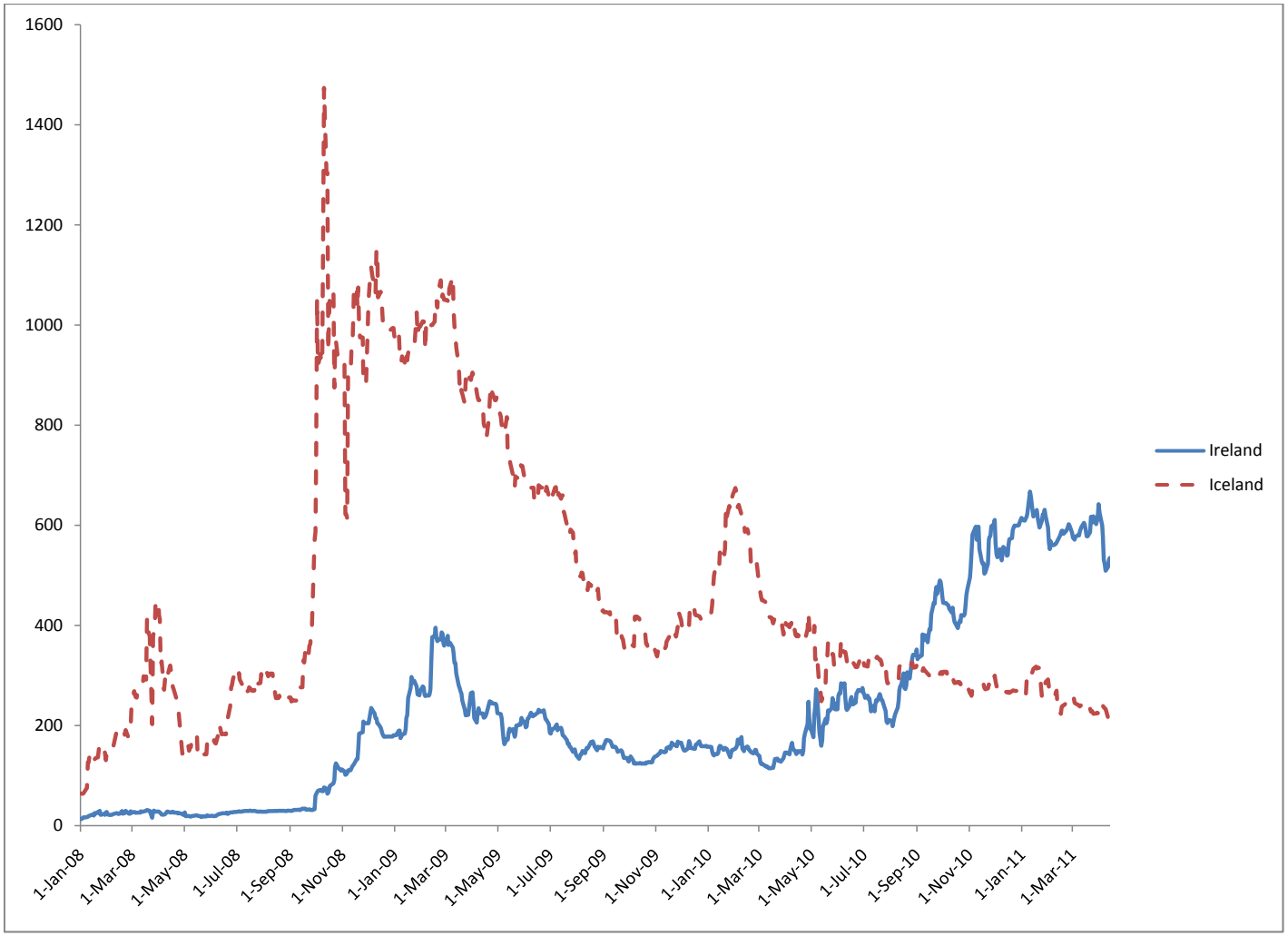
- Just one of the Irish banks, Anglo Irish, had cost the government up to Euro 25 Billion or 11.26% of GDP by Aug'10
- Ireland received 85 Billion Euro rescue package by European Union and IMF in Nov'10 and now needs another 24 Billion Euro for lenders
- Total is approximately 70% of 2010 GDP
- Ireland CDS spread now above 600 bps

A Motivating Example: The Case of Ireland

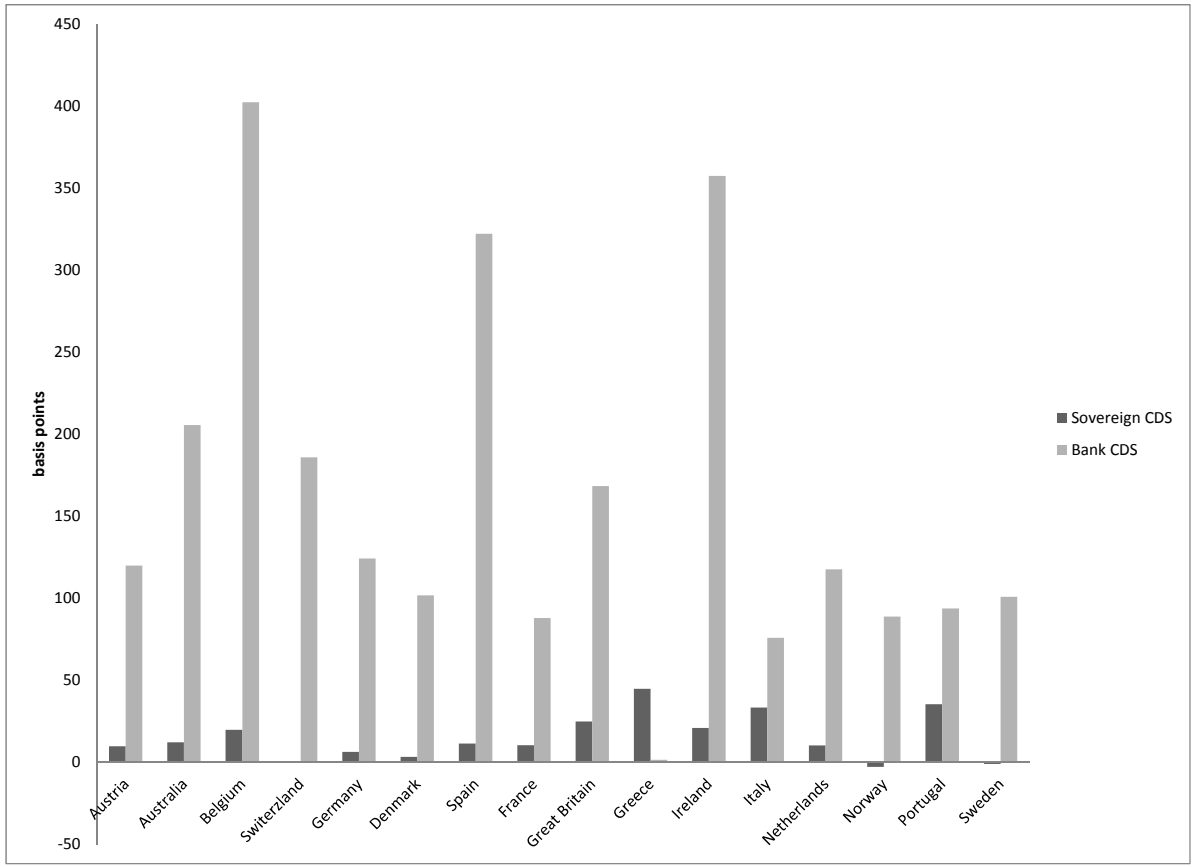


- Chart similar across many countries:
  1. sovereign CDS close to 0 through first-half 2008
  2. post bailout announcement (9/30/2008): sovereign CDS jumps up, bank CDS drops down
  3. subsequent positive comovement

Did Ireland have a choice? – Iceland vs. Ireland CDS



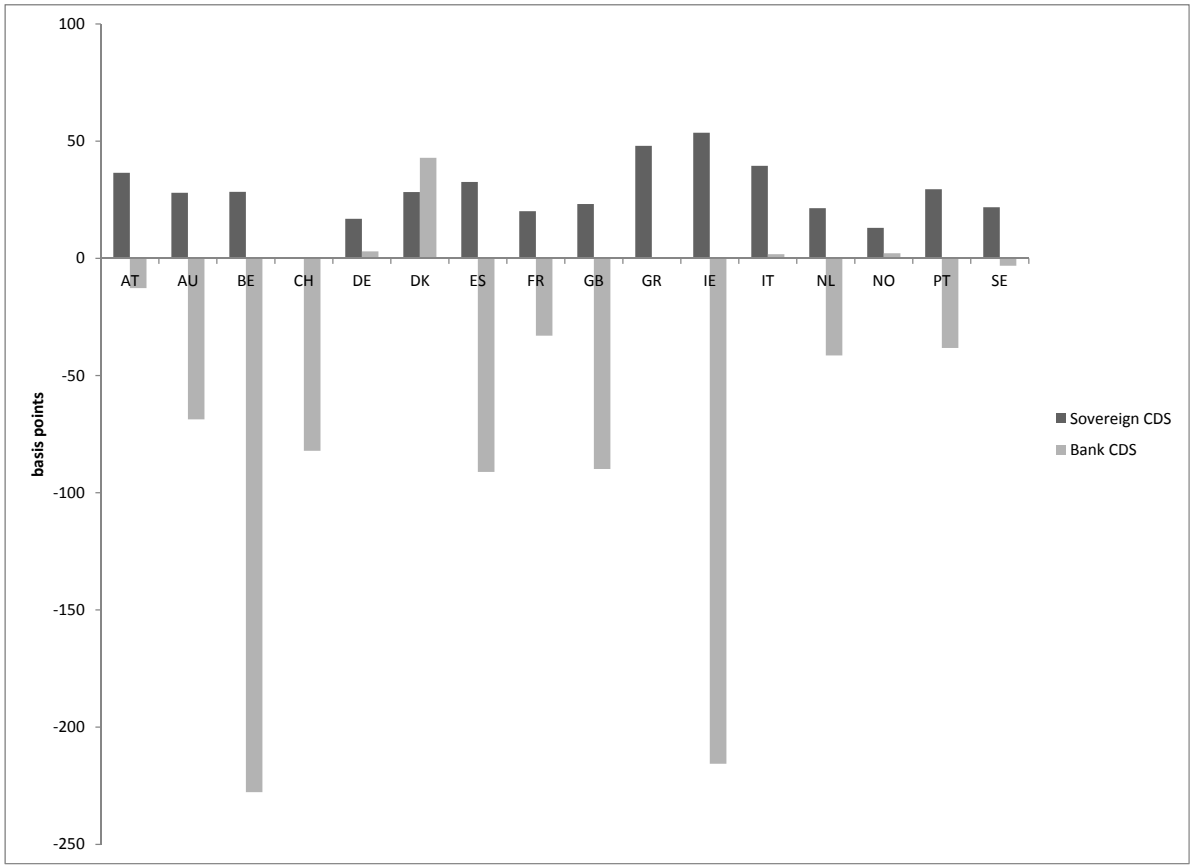
Pre-Bailouts: Europe



3/1/2007 – 8/31/2008

- bank CDS has increased substantially
- not much change in sovereign CDS

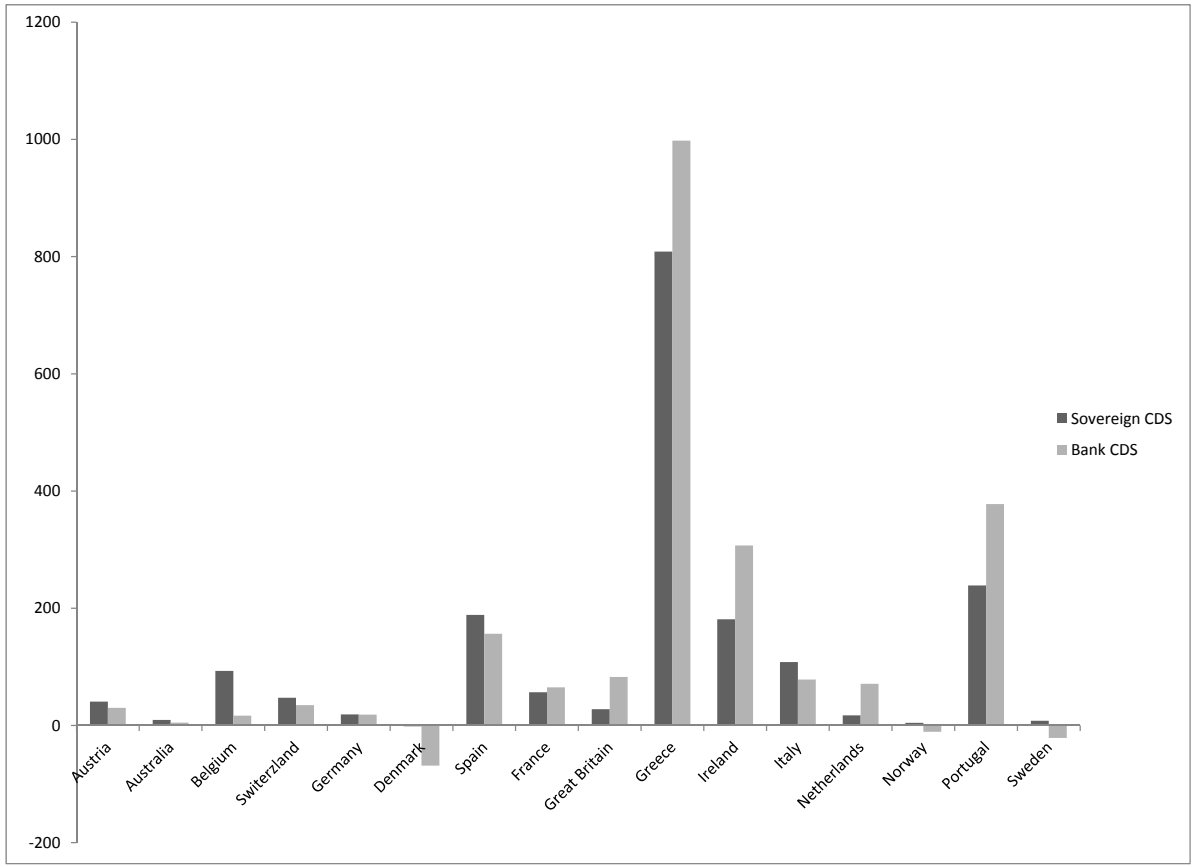
During the Bailout Period



9/26/2008 – 10/21/2008

- bank CDS decreases substantially
- strong increase in sovereign CDS

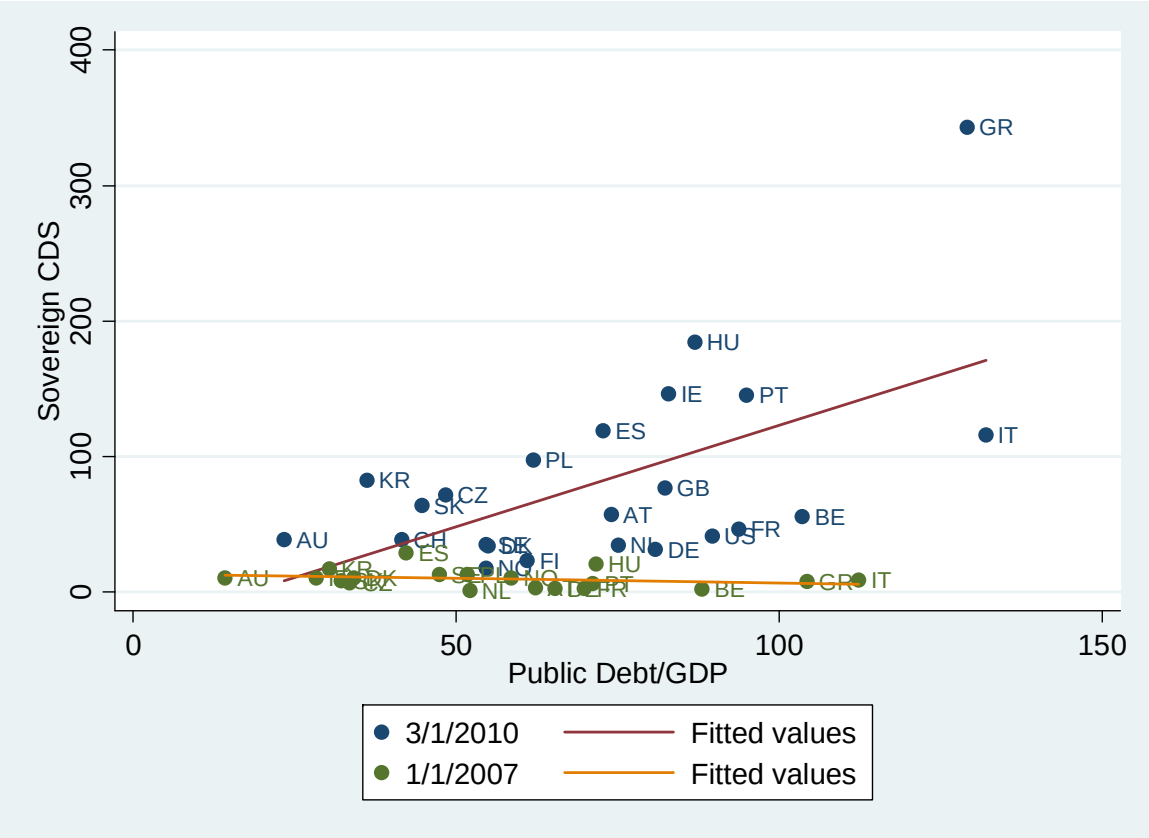
Post Bailout



10/22/2008 – 6/30/2010

- positive comovement
- a merger of financial sector and and sovereign?

Pre- and Post-Bailout Sov CDS and Public Debt



Sov. CDS vs. Debt/GDP

This Paper

- Models trade-off between sovereign and financial sector credit risk
- Government can transfer resources to financial sector
  - Transfer alleviates under-provision of financial services (debt overhang)
  - Funding the transfer induces underinvestment in corporate sector and dilutes existing sovereign bondholders
- Solve for optimal transfer ("bailout") and resulting sovereign bond price (CDS) in equilibrium
  1. Under certainty about future output and no-default
  2. Allowing for strategic default
  3. Under uncertainty about future output
- Empirical evidence from financial crisis of 2007 to 2010

Model

- Three dates: t = 0, 1, 2
- Sectors: Financial, Corporate, and Government

Financial sector:

$$\max_{s_0^s} E_0\left[\left(w_s s_0^s - L_1 + \tilde{A}_1 + A_G + T_0\right) \times 1_{\{-L_1+\tilde{A}_1+A_G+T_0>0\}}\right] - c(s_0^s)$$

1. Produces financial services s_0^s for per-unit wage w_s at cost of $c(s_0)$
   - an input to corporate sector production
   - revenue captured only if solvent at t=1 (otherwise goes to debtholders)

2. Incentive to produce depends on $p_{solv} = E_0\left[1_{\{-L_1+\tilde{A}_1+A_G+T_0>0\}}\right]$
   - L_1 are liabilities due at t=1
   - $\tilde{A}_1$ uncertain payoff of assets at t=1
   - A_G a fraction k_A of outstanding sovereign debt
   - crisis –> low p_{solv} (debt-overhang)–> under-provision of financial services
   - T_0 is value of govt transfer (bailout)

Corporate Sector

Corporate sector:

$$\max_{s_0^d,\, K_1} E_0\left[f(K_0, s_0^d) - w_s s_0^d + (1-\theta_0)\tilde{V}(K_1) - (K_1 - K_0)\right]$$

1. Buys s_0^d financial services to produce output $f(K_0, s_0^d)$ at t=1
2. Makes investment K_1 at t=1 in project with uncertain payoff $\tilde{V}(K_1)$ at t=2
   - $V(K_1) = E_0\left[\tilde{V}(K_1)\right] = K_1^\gamma,\ 0 < \gamma < 1$
3. Tax rate θ_0 set at $t = 0$ and levied at $t = 2$
   - funds existing govt debt and new transfer T_0
   - distorts incentive to invest $\rightarrow$ underinvestment:

$$\frac{dK_1}{d\theta_0} = \frac{V'(K_1)}{(1-\theta_0)V''(K_1)} < 0$$

Example: HP threatens to reduce investment in Ireland if taxes hiked to fund bailout (11/21)

- expected tax revenue $\mathcal{T} = \theta_0 V(K_1)$
- $\mathcal{T}$ rises in θ_0 then falls (Laffer curve)

The Government's Problem

1. Risk-Neutral representative consumer owns bonds and equity

$\Rightarrow$ Government's s objective is to maximize expected total output

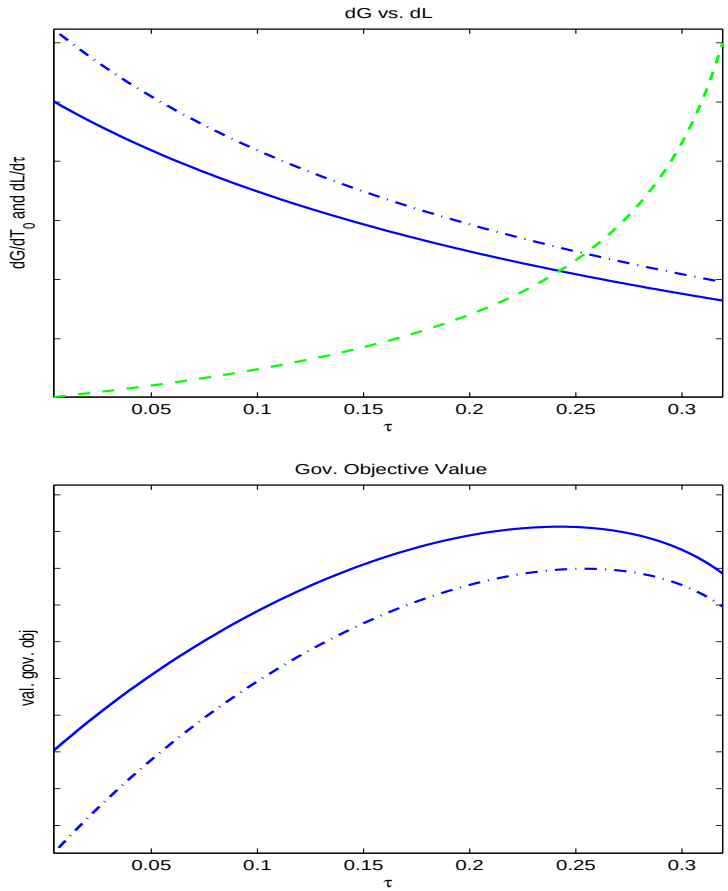
Uses Transfer (Bailout) to alleviate under-provision of financial services (debt-overhang)

2. Funds the Transfer and Existing Govt Debt with Taxes:
   - Existing Debt: N_D outstanding bonds with face value 1
   - Transfer: N_T new bonds issued $\rightarrow \quad T_0 = P_0 N_T$
   - Defaults if: $\theta_0 \tilde{V}(K_1) < N_D + N_T \Rightarrow$ deadweight loss of D

3. Govt chooses tax rate θ_0 and new bond issuance N_T to maximize total output:
   - subject to equilibrium conditions and price P_0
   - Insolvency ratio $\quad H = \dfrac{N_T + N_D}{\mathcal{T}} = \dfrac{N_T + N_D}{\theta_0 V(K_1)}$
   - rewrite using $\mathcal{T}$ and H instead of θ_0 and N_T

Marginal Gain and Loss of Raising $\mathcal{T}$ (Tax Revenue)

Consider first certainty about future output, $\tilde{V}(K_1) = V(K_1)$, and no default $H = 1$



- marginal gain: increased $T_0 \rightarrow$ increased s_0
- marginal loss: increased $\mathcal{T} \rightarrow$ greater underinvestment loss
- dashed line: increased L_1 (more severe debt-overhang) $\rightarrow$ increased marginal gain

Optimal $\mathcal{T}$ under Certainty and No Sovereign Default

We prove that under sufficient conditions:

1. As $L_1 \uparrow$ (more severe debt-overhang) $\Rightarrow \hat{\mathcal{T}} \uparrow$ and $\hat{T}_0 \uparrow$

   – As financial sector liabilities increase, tax revenues collected by the government increase as does the bailout

2. As $N_D \uparrow$ (greater existing govt debt) $\Rightarrow \hat{\mathcal{T}} \uparrow$ *but* $\hat{T}_0 \downarrow$

   – When pre-existing govenment debt is larger, post-bailout tax revenues collected are larger, but the bailout itself is smaller

Under some additional conditions:

3. factor share of fin sector $\uparrow \Rightarrow \hat{\mathcal{T}} \uparrow$ and $\hat{T}_0 \uparrow$

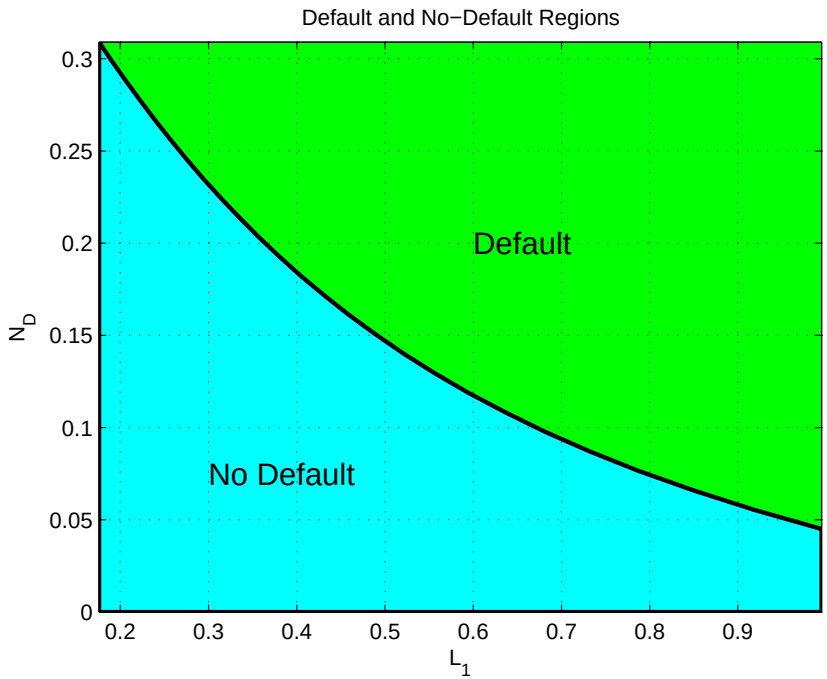
   – As financial sector's importance to overall output increases, tax revenues collected by the government increase as does the bailout

Strategic Sovereign Default Under Certainty

1. Under strategic default, optimal to set $N_T \to \infty$ ($H \to \infty$)
2. Captures full tax revenue by diluting existing bondholders to zero

$\Rightarrow$ greater T_0 ($\uparrow s_0$) with lower θ_0 ($\downarrow$ underinvestment)

3. But suffer dead-weight loss D



- k_A [$-$] fin sector sovereign holdings, 'collateral damage'
- fin. sector factor share [$+$]
- D [$-$] dead-weight loss, damage to reputation domestically and internationally

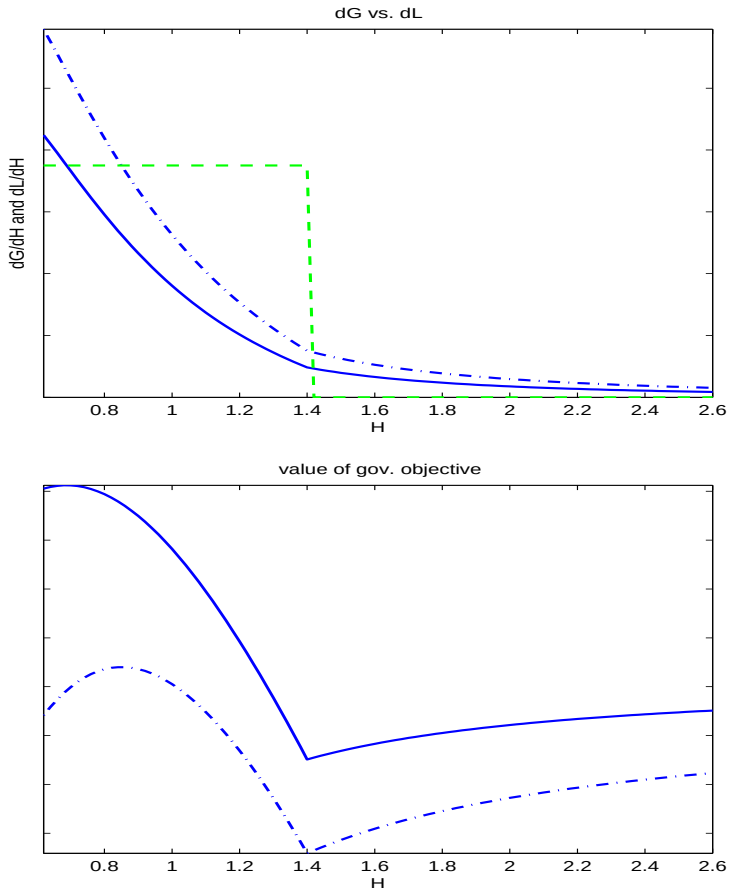
Price, Probability of Default, and Transfer under Uncertainty

Uncertain output: $\tilde{V}(K_1) = V(K_1)\tilde{R}_V$

1. $p_{def} = \text{prob}\left(\tilde{R}_V < H\right)$
2. $P_0 = E_0\left[\min\left(1, \frac{1}{H}\tilde{R}_V\right)\right]$
3. $T_0 = (\mathcal{T} - \frac{N_D}{H})E_0\left[\min\left(H, \tilde{R}_V\right)\right]$

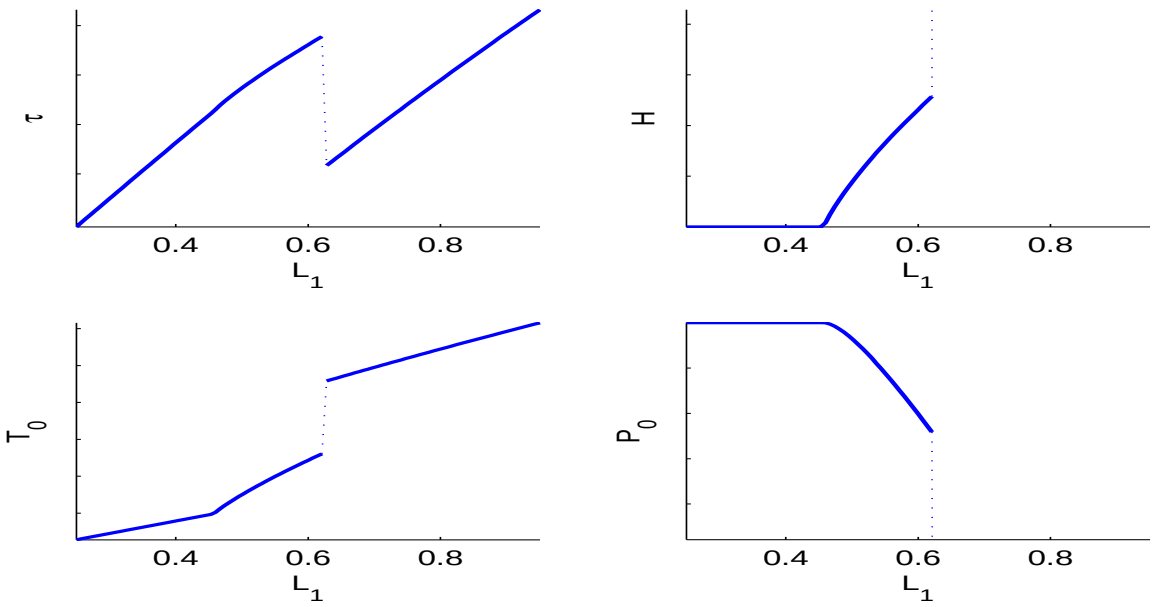
- Sovereign varies H continuously
- higher financial sector liabilities lead to an increase in the government's insolvency ratio and probability of default (higher CDS)
- ($\uparrow H$) The sovereign is 'sacrificing' its creditworthiness ($p_{def} \uparrow$) to increase the transfer
- Hence, a more levered financial sector implies both higher tax revenue collected *and* a higher insolvency ratio

Marginal Gain and Loss of Raising H



- dashed line: increased L_1 (more severe debt-overhang)
  $\rightarrow$ increase in H to increase T_0
  $\rightarrow$ increase in p_{def}
  but total default not (yet) optimal

Comparative Statics for Financial Sector Liabilities L_1



- $\mathcal{T}$ increases in L_1
- High L_1 ('crisis') $\rightarrow$ $H \uparrow$ (sovereign 'sacrifices' creditworthiness for bailout)
- $H \uparrow$ increases T_0 while $P_0 \downarrow$
- dotted line shows when total default becomes optimal
  - default allows for larger T_0 with smaller $\mathcal{T}$

Government 'Guarantee'

- Debtholders of Financial sector may liquidate/run if they fear losses will be large in case of insolvency:

$$\tilde{A}_1 + T_0 < (1 - y)L$$

- To prevent liquidation, govt 'promises' to pay bondholders (from tax revenues)

$$\max(yL - \tilde{A}_1 + T_0, 0)$$

- This 'guarantee' is pari-passu with other government claims.

  $\Rightarrow$ Equivalent to issuing $yL - \tilde{A}_1 + T_0$ new govt bonds

- Greatly affects (recovery) value of fin sector bondholders
  - the guarantee's value fluctuates with sovereign bond price
  - the guarantee channel of sovereign credit risk affects bank debt over and above its effect on bank equity/assets

Two-Way Feedback Credit Risk

Financial Sector $\rightarrow$ Sovereign

- deterioration in financial sector solvency (i.e., greater L_1) $\rightarrow$ decrease in sovereign creditworthiness ($H \uparrow$), potentially default

Sovereign $\rightarrow$ Financial Sector

- high debt (N_D) sovereign $\rightarrow$ low transfer (T_0) $\rightarrow$ low p_{solv} post-transfer
- large exposure to value of sovereign debt:
  - direct holdings of sovereign debt

    – transmit sovereign shocks directly to value of both financial sector debt and equity
  - value of government 'guarantee'

    – transmit sovereign shocks disproportionately to financial sector debt relative to equity

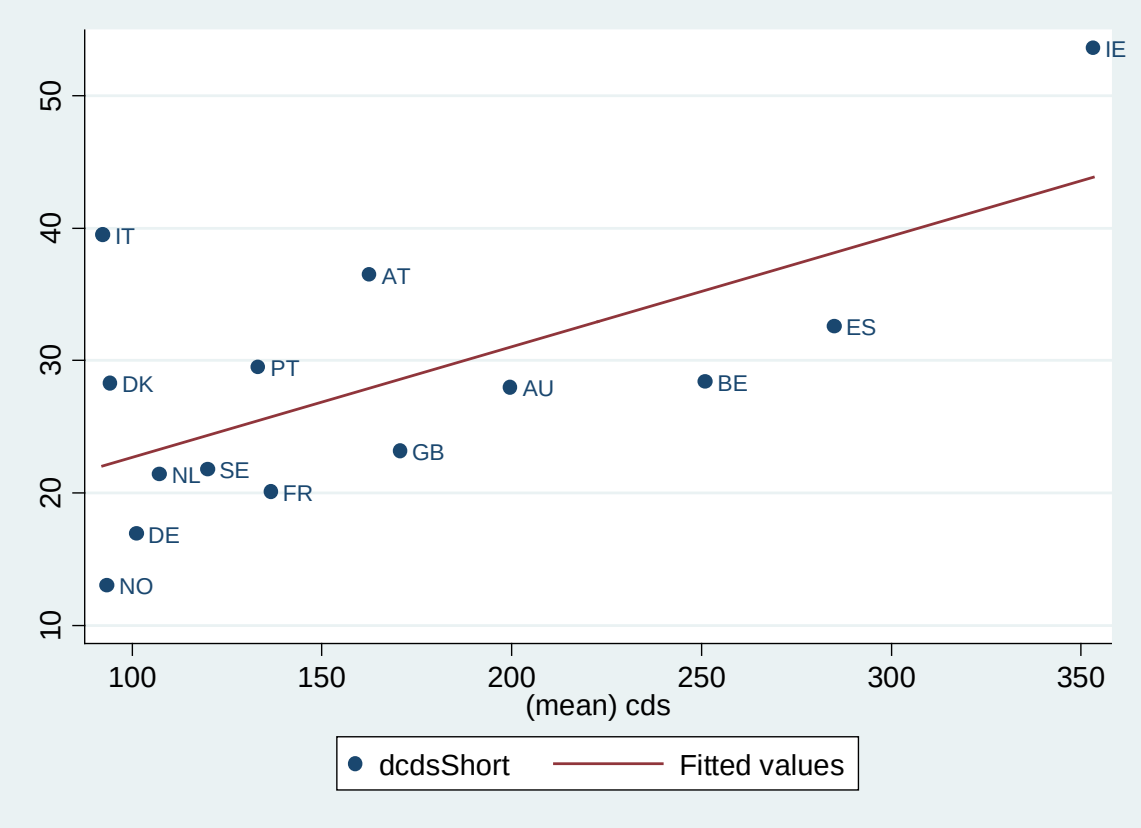
Empirical Strategy

- Use 2007-2010 financial crisis as natural setting for establishing two-way feedback between financial sector and sovereign credit risk

1. Pre-bailout phase (2007 - 9/2008)
   - a negative shock to bank balance sheets
2. Bailout period (end 9/2008 - 10/2008)
   - bailouts increase sovereign credit risk and reduce bank credit risk
3. Post-bailout period (11/2008 - 2010)
   - positive correlation of financial and sovereign credit risk
   - direct feedback channel between sovereign and financial credit risk

- Emergence of positive debt-ratio to CDS correlation
- Establish direct sovereign-financial credit channel using existence of 'guarantees'
  - control for bank equity return
  - market-wide factors: volatility (VDAX), 'local' movements in CDS market (iTRAXX)
  - daily fixed-effects
- Sovereign bond holdings data

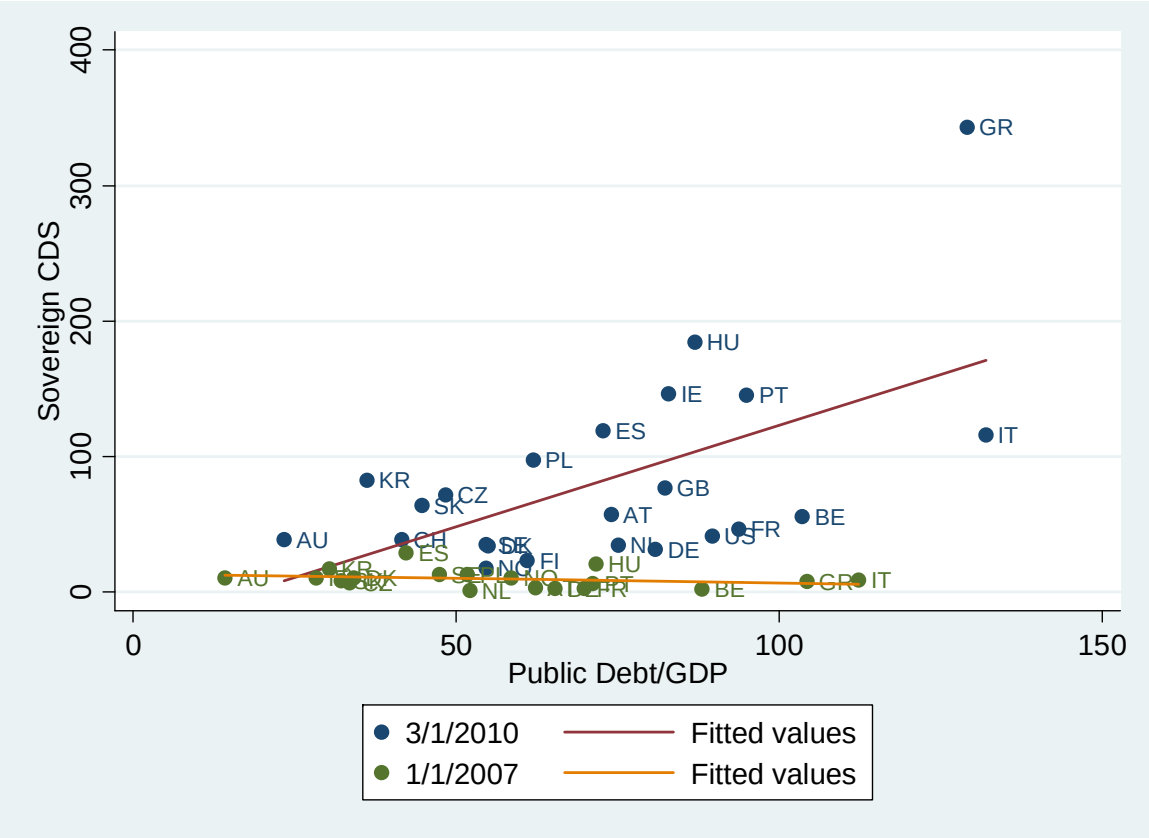
Correlation of Sovereign CDS change and Pre-bailout Bank CDS



Sov. CDS change vs. Pre-bailout Bank CDS

- Pre-bailout: 21 Sep 2008
- Sovereign CDS change: End of Sep 2008 to End of Sep 2009

Correlation of Sovereign CDS and Public Debt: Pre and Post-Crisis

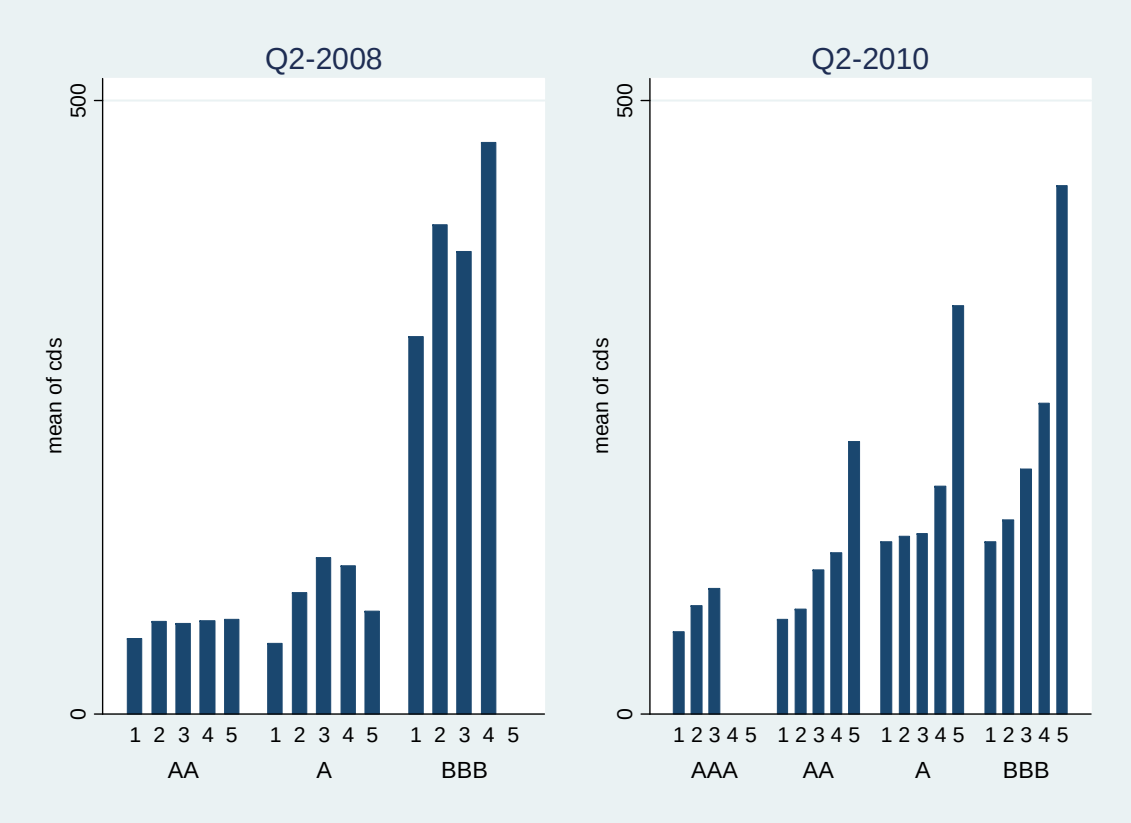


Sov. CDS vs. Debt/GDP

- Pre-Crisis: low-H region, not much relationship
- Post-Crisis: sovereigns increase H, relationship becomes apparent

	Log (Sovereign CDS)				% Public Debt	
	Pre-Bailout		Post-Bailout		Around Bailout	Post-Bailout
	1/1/2008		3/31/2010		Δ 2010-2008	3/31/2010
% Public Debt (June 2008)	0.006	0.005	0.015*	0.013+		1.107**
	(0.004)	(0.005)	(0.006)	(0.007)		(0.144)
Log (Average Bank CDS Sep 2008)		0.311		0.965*	20.118+	21.726+
		(0.208)		(0.357)	(10.168)	(11.555)
Constant	2.137**	0.601	3.112**	-1.593	-86.920	-101.548
	(0.320)	(1.154)	(0.401)	(2.019)	(49.456)	(60.923)
Observations	15	14	17	15	15	15
R-squared	0.134	0.171	0.261	0.488	0.364	0.843

Feedback Sovereign CDS → Bank CDS



- Spain: 247 bps, Germany: 43 bps (6/1/10)
- Santander (Spain): Rating AA, CDS: 207 bps (6/1/10)
  - Most profitable Euro bank 3yrs. end 2009 (26.9B Euro profit)
  - Mkt. cap 79B Euros (biggest in Europe)
  - Spain account for only 22% of profits
- WestLB (Germany): Rating BBB+, CDS: 158 bps (6/1/10)

Feedback Sovereign CDS → Financial Sector CDS (levels)

	Log(Bank CDS)								
Period	Pre-Bailout (Jan 07-Aug 08)			Around Bailout (Sep-Oct 08)			Post-Bailout (Nov 08-Sep 10)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log(Sovereign CDS)	0.061+	0.049	0.045	0.130	0.039	0.112	0.443**	0.589**	0.525**
	(0.037)	(0.048)	(0.053)	(0.111)	(0.196)	(0.202)	(0.060)	(0.075)	(0.070)
Log(CDS Market Index)	1.415**			1.133**			0.544**		
	(0.073)			(0.094)			(0.069)		
Log(Volatility Index)	-0.148+			-0.435**			-0.099		
	(0.076)			(0.147)			(0.060)		
Week Fixed Effects	N	Y	Y	N	Y	Y	N	Y	Y
Bank Fixed Effects	N	Y	Y	N	Y	Y	N	Y	Y
Bank Stock Return	N	N	Y	N	N	Y	N	N	Y
Observations	3,633	3,633	2,859	606	606	455	7,012	7,012	5,210
Banks	83	83	62	71	71	53	83	83	59
R-squared	0.916	0.944	0.960	0.834	0.866	0.864	0.858	0.885	0.880

Feedback Sovereign CDS → Financial Sector CDS (changes)

	Δ Log(Bank CDS)								
Period	Pre-Bailout (Jan 07-Aug 08)			Around Bailout (Sep-Oct 08)			Post-Bailout (Nov 08-Sep 10)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Log(Sovereign CDS)	0.023*	0.015	0.019	0.026	-0.403+	-0.430	0.163**	0.079**	0.080**
	(0.010)	(0.014)	(0.015)	(0.082)	(0.232)	(0.287)	(0.019)	(0.030)	(0.027)
Δ Log(CDS Market Index)	0.860**			0.932**			0.689**		
	(0.041)			(0.094)			(0.027)		
Δ Volatility Index	0.214			-0.539**			0.122*		
	(0.155)			(0.081)			(0.050)		
Week FE	N	Y	Y	N	Y	Y	N	Y	Y
Interactions	N	N	Y	N	N	Y	N	N	Y
Observations	3,508	3,508	3,508	577	577	577	7,086	7,086	7,086
Banks	84	84	84	71	71	71	84	84	84
R-squared	0.171	0.253	0.387	0.134	0.308	0.504	0.316	0.384	0.441

- Sovereign credit risk is important, even after controlling for:
  1. bank equity return (bank and asset quality)
  2. volatility
  3. CDS-market movements
  4. bank/day fixed-effects

Feedback Sovereign CDS → Financial Sector Equity (changes)

	Bank Stock Return								
Period	Pre-Bailout (Jan 07-Aug 08)			Around Bailout (Sep-Oct 08)			Post-Bailout (Nov 08-Sep 10)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Log(Sovereign CDS)	-0.011**	-0.002	-0.002	-0.040	0.041	0.114	-0.177**	-0.054*	-0.068**
	(0.004)	(0.002)	(0.002)	(0.035)	(0.075)	(0.114)	(0.026)	(0.026)	(0.026)
Δ Log(CDS Market Index)	-0.106**			-0.474**			-0.243**		
	(0.015)			(0.078)			(0.017)		
Δ Volatility Index	-0.368**			-0.317**			-0.761**		
	(0.070)			(0.082)			(0.057)		
Week FE	N	Y	Y	N	Y	Y	N	Y	Y
Bank FE	N	N	Y	N	N	Y	N	N	Y
Interactions	N	N	Y	N	N	Y	N	N	Y
Observations	2,895	2,895	2,895	446	446	446	5,324	5,324	5,324
Banks	65	65	65	54	54	54	60	60	60
R-squared	0.070	0.240	0.311	0.118	0.212	0.564	0.285	0.488	0.533

Feedback Sovereign CDS → Financial Sector CDS (guarantee channel)

	Δ Log(Bank CDS)								
Period	Pre-Bailout (Jan 07-Aug 08)			Around Bailout (Sep-Oct 08)			Post-Bailout (Nov 08-Sep 10)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Log(Sovereign CDS)	0.019*	0.008	0.014	-0.020	-0.236	-0.235	0.150**	0.100**	0.105**
	(0.009)	(0.013)	(0.015)	(0.096)	(0.153)	(0.200)	(0.025)	(0.034)	(0.030)
Bank Stock Return	-0.142	-0.062	0.716**	-0.255+	-0.295*	3.981*	-0.174**	-0.154**	-0.260**
	(0.118)	(0.106)	(0.205)	(0.132)	(0.147)	(1.769)	(0.034)	(0.036)	(0.042)
Δ Log(CDS Market Index)	0.929**			0.848**			0.662**		
	(0.043)			(0.123)			(0.032)		
Δ Volatility Index	0.043			-0.711**			0.030		
	(0.120)			(0.096)			(0.051)		
Week FE	N	Y	Y	N	Y	Y	N	Y	Y
Interactions	N	N	Y	N	N	Y	N	N	Y
Observations	2,745	2,745	2,745	437	437	437	5,278	5,278	5,278
Banks	63	63	63	53	53	53	60	60	60
R-squared	0.224	0.308	0.481	0.208	0.403	0.728	0.359	0.424	0.491

Feedback Sovereign CDS → Financial Sector CDS (bank capitalization)

	Δ Log(Bank CDS)								
Period	Pre-Bailout (Jan 07-Aug 08)			Around Bailout (Sep-Oct 08)			Post-Bailout (Nov 08-Sep 10)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Log(Sovereign CDS)*Tier 1	0.726	0.208	0.520	-7.793*	-8.666*	-7.444	-2.117	-2.077	-3.407*
	(0.569)	(0.365)	(0.566)	(3.152)	(4.202)	(7.930)	(1.493)	(1.418)	(1.543)
Δ Log(Sovereign CDS)	-0.041	-0.009	-0.026	0.551+	0.404	0.290	0.355**	0.300*	0.411**
	(0.043)	(0.035)	(0.053)	(0.299)	(0.420)	(0.717)	(0.125)	(0.130)	(0.136)
Tier 1	-0.190	-0.097		0.333	0.624		-0.032	-0.023	
	(0.243)	(0.268)		(0.715)	(0.729)		(0.083)	(0.096)	
Other Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	N	Y	Y	N	Y	Y	N	Y	Y
Interactions	N	N	Y	N	N	Y	N	N	Y
Observations	2,160	2,160	2,160	336	336	336	4,224	4,224	4,224
Bank	49	49	49	41	41	41	48	48	48
R-squared	0.205	0.290	0.470	0.225	0.414	0.702	0.352	0.422	0.484

Feedback from Sovereign to Financial Sector: Stress Tests

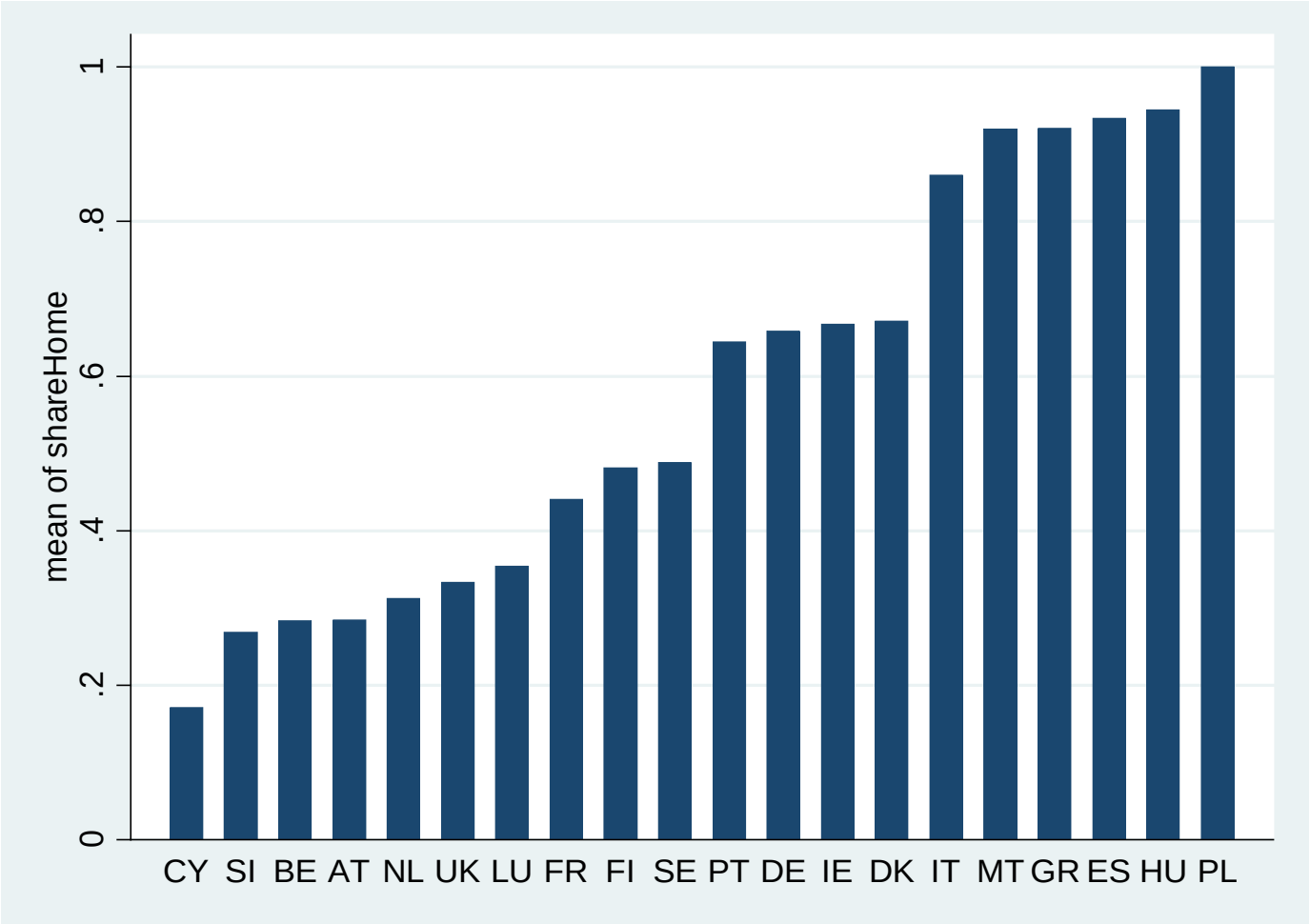
- European Bank Stress Tests
  - Collect bank-level sovereign holdings data as of March 31st, 2010
- Shows banks have substantial sovereign debt holdings
  - Strong 'Home bias' in sovereign holdings : 69.4%
- Use reported positions to examine co-movement of sovereign and bank CDS
  - Compute sovereign exposure with holdings as weight
  - Exclude home-holdings to avoid bias from economic shocks in home country

Size of Sovereign Bond Holdings of Banks

Sovereign Holdings
Euro Bank Stress Tests Sample, March 31, 2010

	N (1)	Mean (2)	Std.Dev (3)	50th Percentile (4)	5th Percentile (5)	95th Percentile (6)
Bank Characteristics						
Risk-weighted Assets (EUR million)	91	126,337	179,130	63,448	3,269	493,307
Tier 1 Capital Ratio (%)	91	10.2	2.4	9.8	7.2	14.4
Sovereign Exposure						
Sovereign Holdings (gross, EUR million)	91	20,668	27,948	7,930	105	81,765
Sovereign Holdings (net, EUR million)	91	19,719	27,329	6,960	105	78,959
Home Sovereign Holdings (gross, EUR million)	91	11,493	14,422	5,774	182	42,800
Home Sovereign Holdings (net, EUR million)	91	11,023	13,956	5,348	117	42,800
Home Share (%)	91	69.4	30.0	81.6	18.9	100
Greek Sovereign Holdings	91	669	2,844	0	0	5,601
Share Banking Book (%)	91	84.9	19.9	92.2	35.4	100.0

Home Bias in Sovereign Bond Holdings



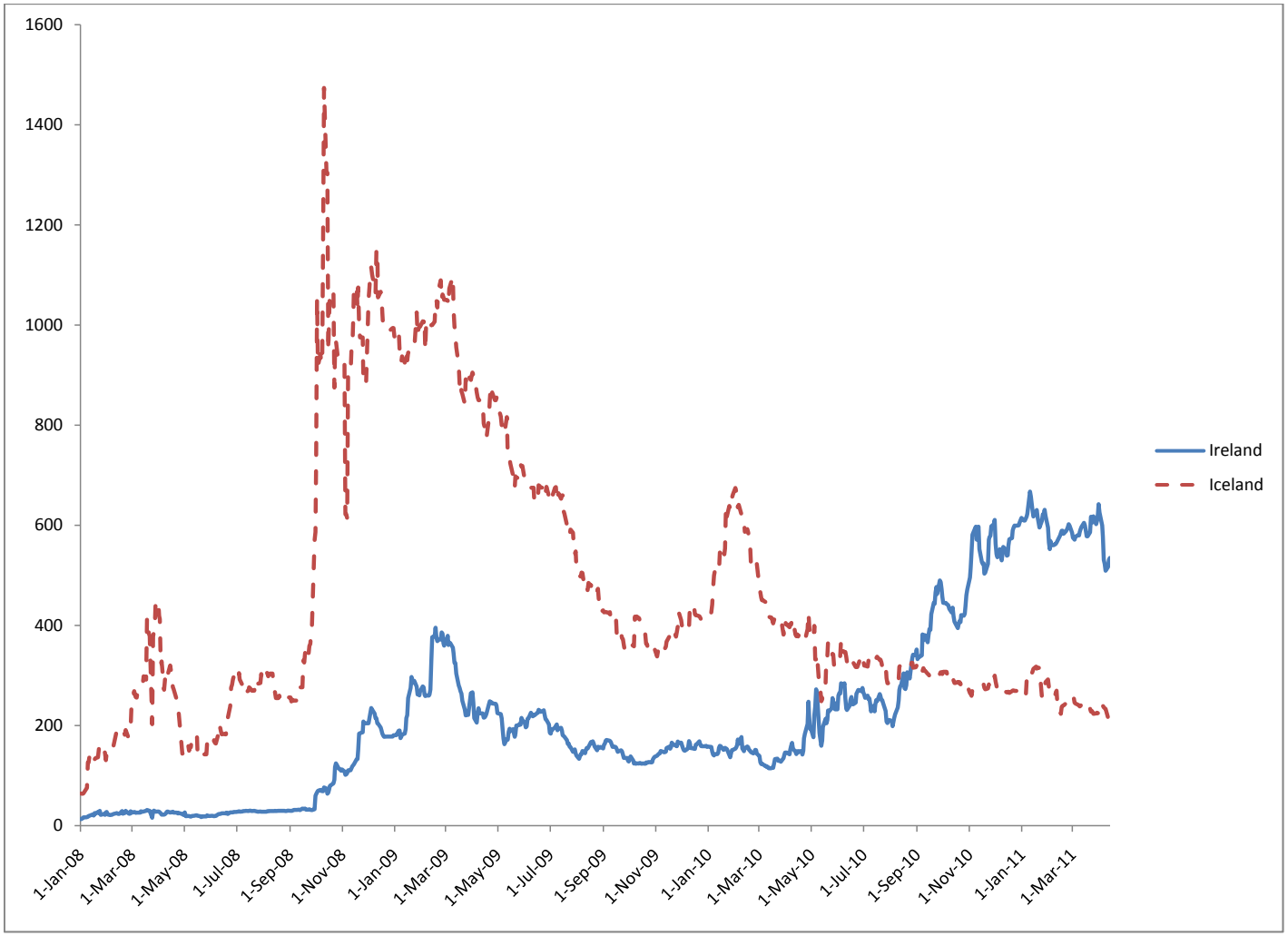
Co-movement of Bank CDS and Foreign Sovereign CDS

	Change in Bank CDS					
Sample	All	All	All	All	All	Excluding Germany
	(1)	(2)	(3)	(4)	(5)	(6)
Change in Sovereign Exposure	0.325**	0.326**	0.261**	0.141**	0.135**	0.137**
	(0.027)	(0.028)	(0.027)	(0.049)	(0.046)	(0.046)
Bank FE	N	Y	N	N	Y	Y
Week FE	N	N	Y	N	N	N
Day FE	N	N	N	Y	Y	Y
Observations	2,317	2,317	2,317	2,317	2,317	2,317
Banks	51	51	51	51	51	0.357
R-squared	0.173	0.188	0.228	0.342	0.357	0.357
Adjusted R-Squared	0.173	0.170	0.224	0.329	0.329	0.329

Conclusion

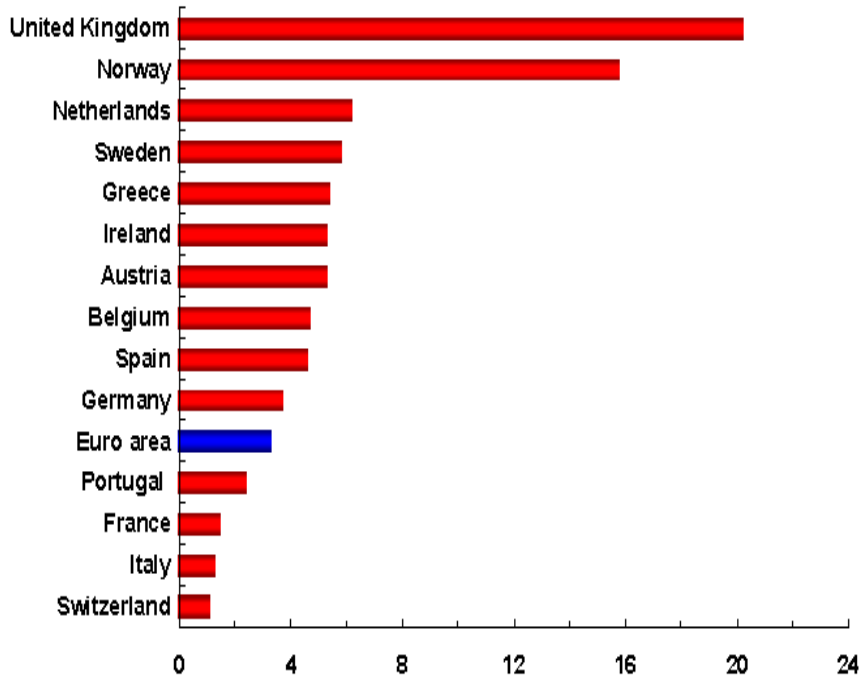
- Future costs of bailouts (e.g., moral hazard) are far from being the only important ones
- Costs are clear and present
  - Gov. Budget constraint has tightened (gov. pockets are finite)– the elimination of slack is priced by the markets
  - Given these costs, the restructuring of financial sector debt should be considered more seriously
  - Sovereign debt more sensitive to growth shocks, shocks feed back onto financial sector
  - Reinhart and Rogoff(2009a, b) – perverse growth dynamics beyond 90% debt/GDP Ratio
- Future Research:
  1. Additional empirical and theoretical research on dynamics of financial sector and sovereign credit risks
  2. Integrate with research on fiscal and monetary policy

Do the sovereigns have a choice? – Iceland vs. Ireland CDS



Up-Front Estimates of Bailout Costs

Figure 4. Up-front Government Financing Need to Shore Up the Financial Sector 1/
(Percent of 2008 GDP)



Source: IMF (2009a).
1/ Includes capital injections, purchase of assets, and lending by treasury that require up-front government outlays.