Real Effects of Financial Distress: The Role of Heterogeneity[1]

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[1]Disclaimer: The views expressed are those of the authors and do not reflect the Bank of Portugal or the Eurosystem.

Motivation

- Differential response of firms to shocks often used as identification strategy
  - Gertler & Gilchrist (1994),..., Almeida et al. (2012), Benmelech et al. (2017)
  - e.g., highly leveraged firms, those w/ shorter term debt more sensitive
- Limited empirical/theoretical foundation for these strategies
  - Crouzet & Mehrotra (2017), Ottonello & Winberry (2017)
  - e.g., highly leveraged less sensitive to (high frequency) monetary shock
- What are the heterogeneous effects of financial shocks and what do we make of them?

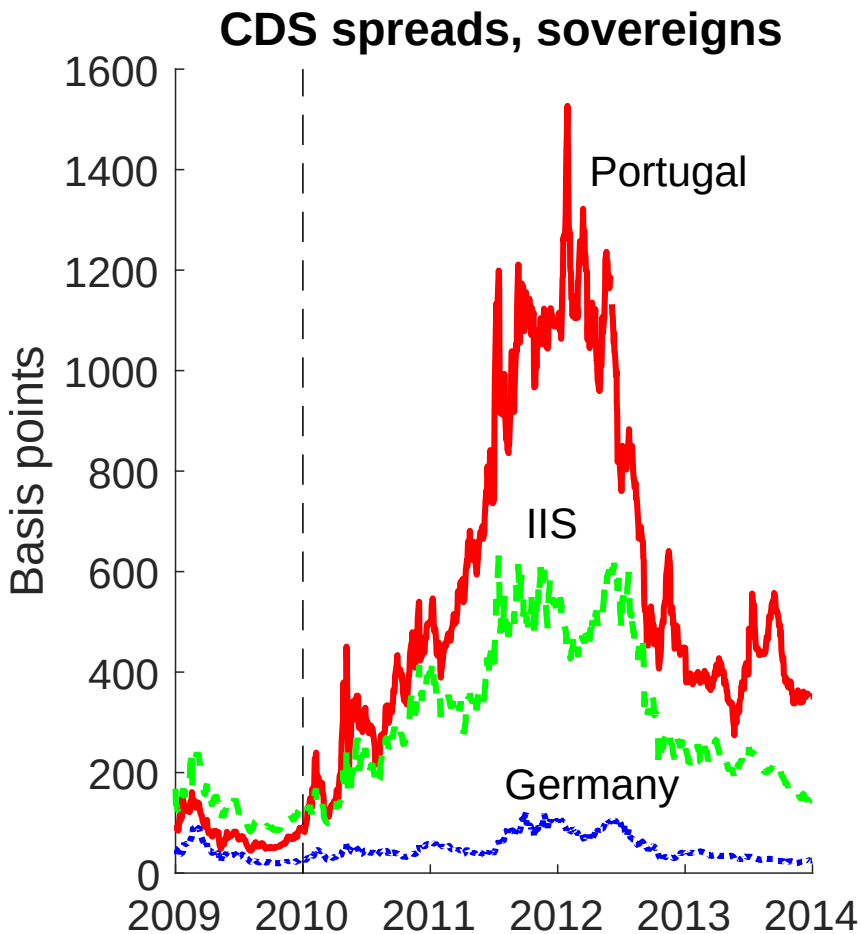
This Paper

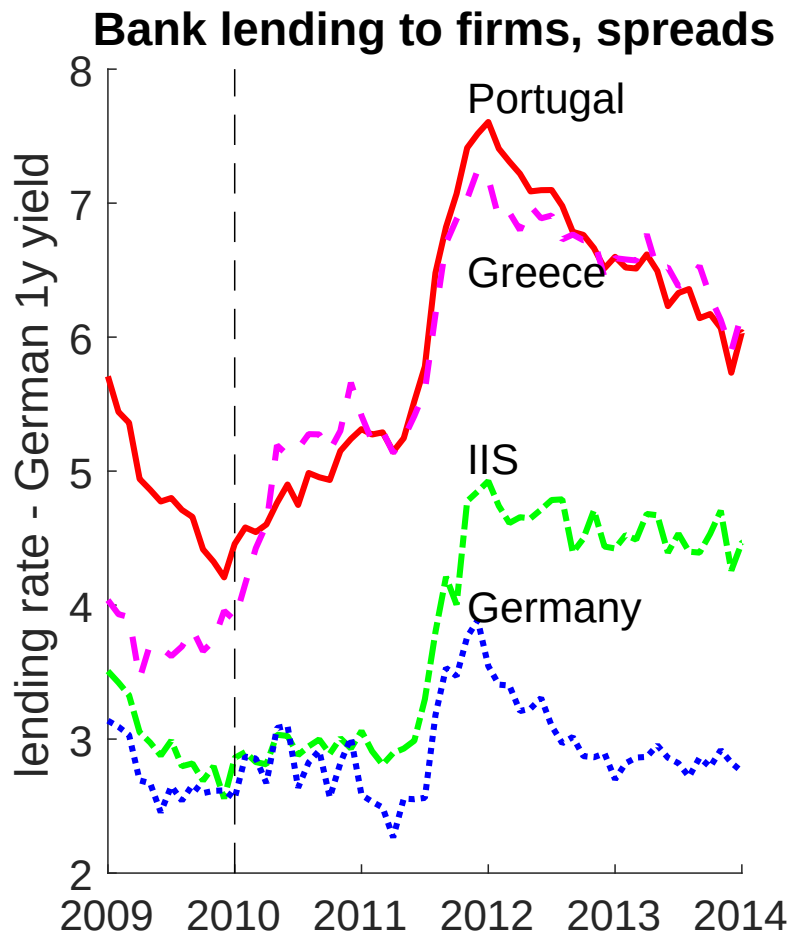
- Empirical contribution:
  - use Portuguese micro-data during sovereign crisis to identify a financial shock
  - measure the heterogeneous responses of firms to the financial shock
- Theoretical contribution:
  - characterize the heterogeneous responses in "standard models"

Summary of Results

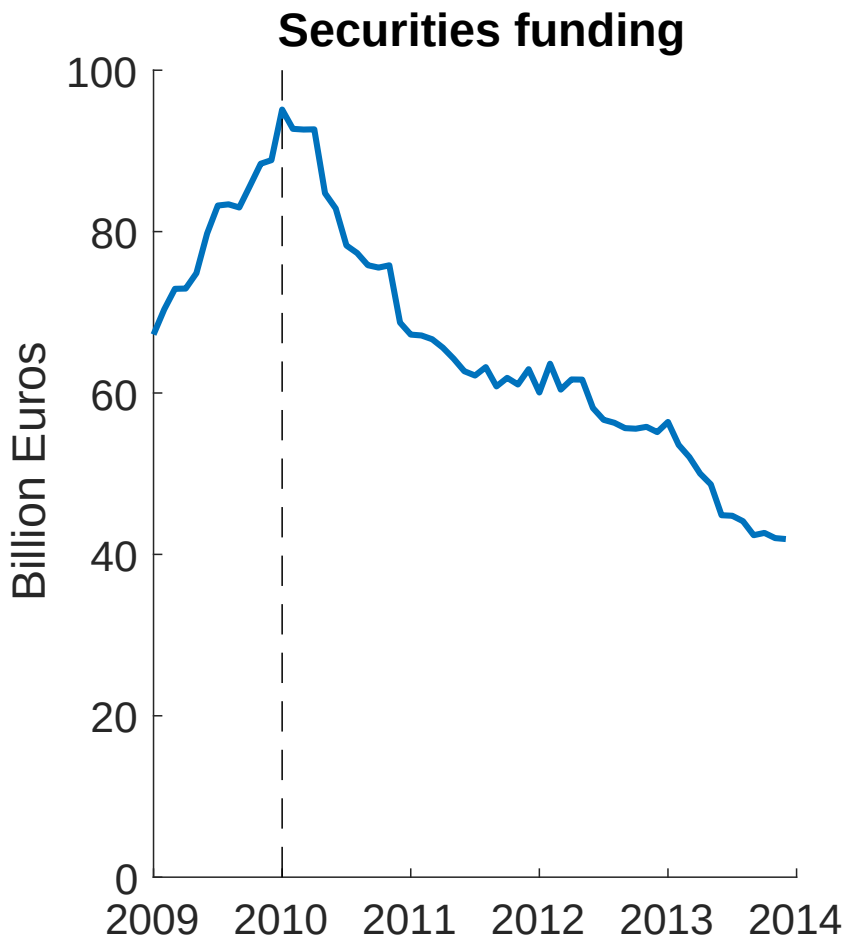
- Empirical results:
  - highly leveraged firms/ those with a larger share of short term debt contracted more after a financial shock
  - a highly leverage declined by 1.7pp more in terms of employment, 7.2pp (assets), 13.8pp (total debt), 3.9pp (intermediates), ...
- Theoretical results:
  - presence of long-term investment projects, frictions to the issuance of long-term debt needed to rationalize these empirical findings

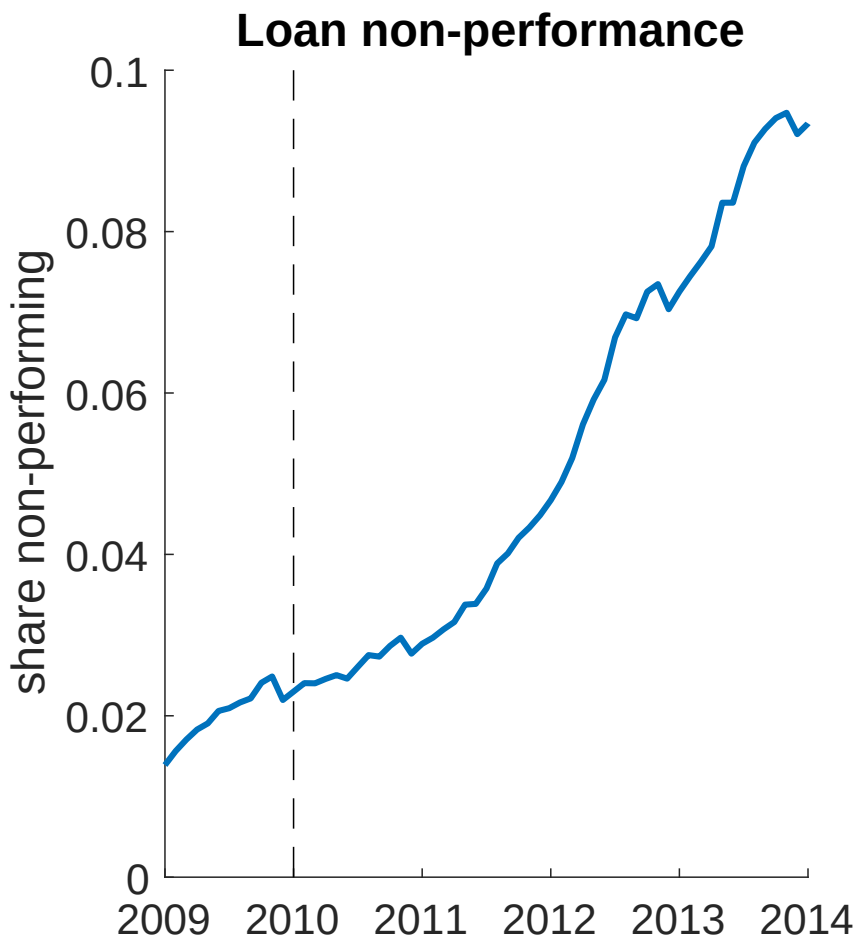
Portuguese Sovereign Crisis





Portuguese Sovereign Crisis (cont'd)





The Microdata

- A unique dataset for the Portuguese economy by using three different data sources:
  - The **Central Credit Registry** (CRC) is managed by Bank of Portugal and contains detailed information reported by the banks concerning credit granted to NFCs and the situation of all such credits.
  - The **Central Balance Sheet Database** (CBSD) is based on accounting data of individual firms.
  - The **Monetary & Financial Statistics** (MFS) which provides detailed monthly information on the banks' balance sheets.

Identifying Financial Shocks

sovereign crisis $\times$ sovereign exposure of firms' lenders

- sovereign exposure of banks

$$sov_{b,Q4:09} = \text{(sovereign bond holdings of bank 'b')/(assets of 'b')}$$

- average sovereign exposure of firms

$$sov_{i,09:Q4} = \sum_{b \epsilon B_i} s_{i,b,09:Q4} * sov_{b,09:Q4}$$

- $s_{i,b}$ is the share of bank 'b' in the total borrowing of firm 'i'.
- Following Khwaja & Mian (2008), Chorodow-Reich (2014), Acharya et al. (2018), Bottero et al. (2015) ...

▸ Firm Exp ▸ Relationships

Descriptive Statistics: Financial Institutions

	High Sov Share		Low Sov Share		
Variables	**Mean**	**SD**	**Mean**	**SD**	**P Value**
Age	19.24	4.73	18.79	5.01	0.79
Firmsize	15.32	0.78	15.68	0.91	0.24
ST debt share	0.27	0.09	0.23	0.09	0.21
Leverage	0.62	0.24	0.79	0.32	0.13
Profitability	0.01	0.01	0.01	0.05	0.75
NPL ratio	0.02	0.01	0.03	0.05	0.57
No. of banking groups	15		18		

Desc. Stat.: Financial Institutions (cont'd)

	High Sov Share		Low Sov Share		P Value
Variables	**Mean**	**SD**	**Mean**	**SD**	**(t-test)**
Total Assets (bn)	18.3	35.2	11.5	21.4	0.44
Capital Ratio	15.17	8.80	14.59	6.98	0.83
Liquidity Ratio	16.54	17.08	10.87	14.97	0.31
Overdue/total loans	2.91	2.86	2.57	2.51	0.71
Corp. Share	27.90	15.01	30.41	21.65	0.59
Hhs. Share	19.84	14.55	30.39	28.56	0.20
Funding (securities/assets)	7.05	10.62	4.91	8.70	0.45
Funding (inter-bank/assets)	25.00	21.54	24.01	18.28	0.88
Funding (central bank/assets)	9.71	16.27	6.65	11.92	0.41
Loan to deposit	1.88	1.59	2.50	2.68	0.43
No. of banking groups		15		18	

Identifying Financial Shocks I

Firm Fixed Effects, Multiple Lenders

$$\%\Delta L_{i,b,Q4:10-Q4:09} = \alpha_i + \alpha_1 sov_{b,Q4:09} + \alpha_2 \cdot sov_{b,Q4:09} \cdot lev_{i,Q4:09}(4) + ... + \epsilon_{i,b}$$

and

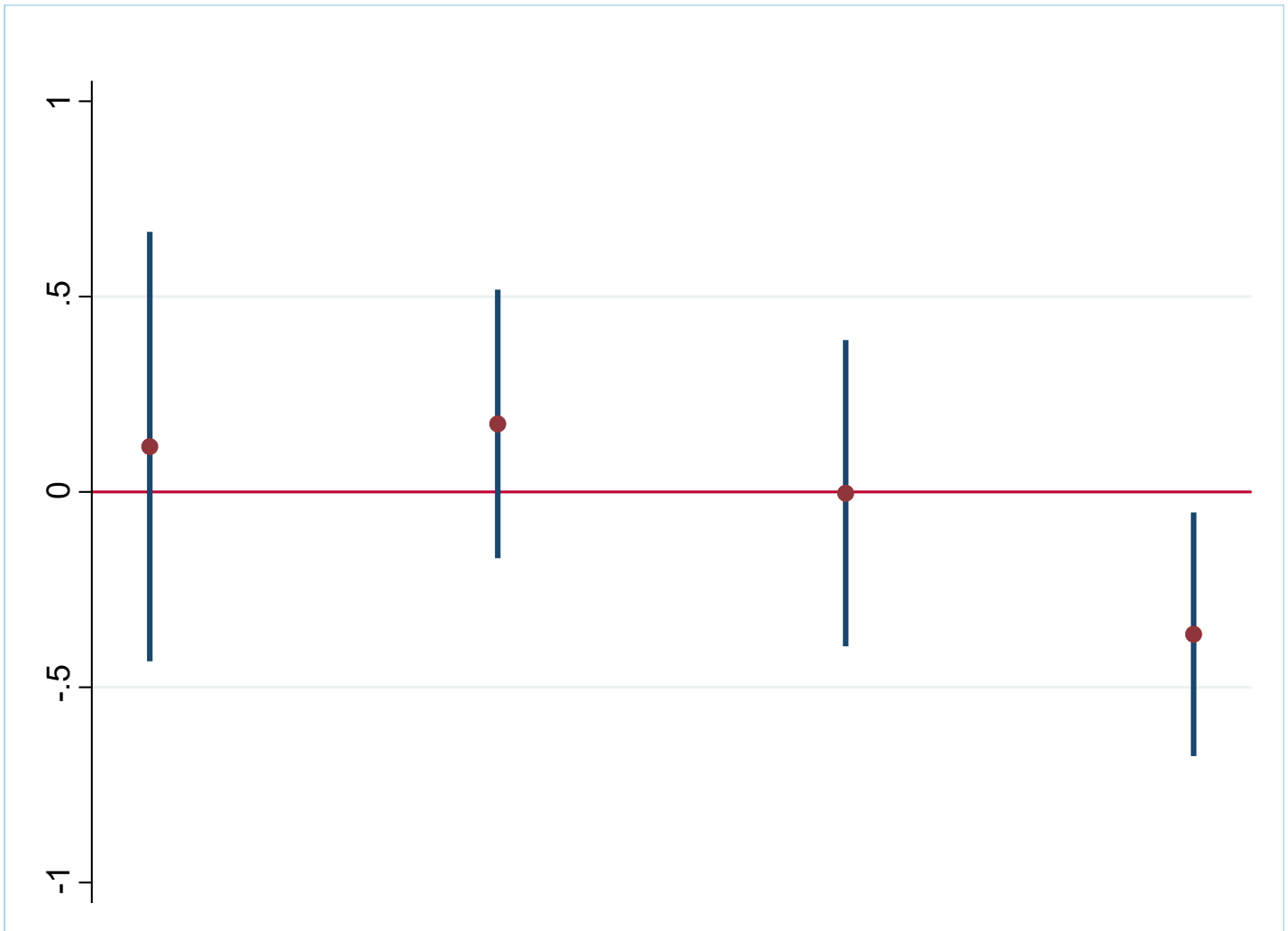
$$\%\Delta L_{i,b,Q4:10-Q4:09} = \alpha_i + \alpha_1 sov_{b,Q4:09} + \alpha_2 \cdot sov_{b,Q4:09} \cdot stdebt_{i,Q4:09}(4) + ... + \epsilon_{i,b}$$

- $\%\Delta L_{i,b,Q4:10-Q4:09}$ is the loan growth rate in the (i-b)th firm-bank pair.
- $lev_{i,Q4:09}(q) = 1$ for firms having pre-crisis leverage in q^{th} quartile.
- $stdebt_{i,Q4:09}(q) = 1$ for firms having pre-crisis share of short term in q^{th} quartile.

Lending Effects

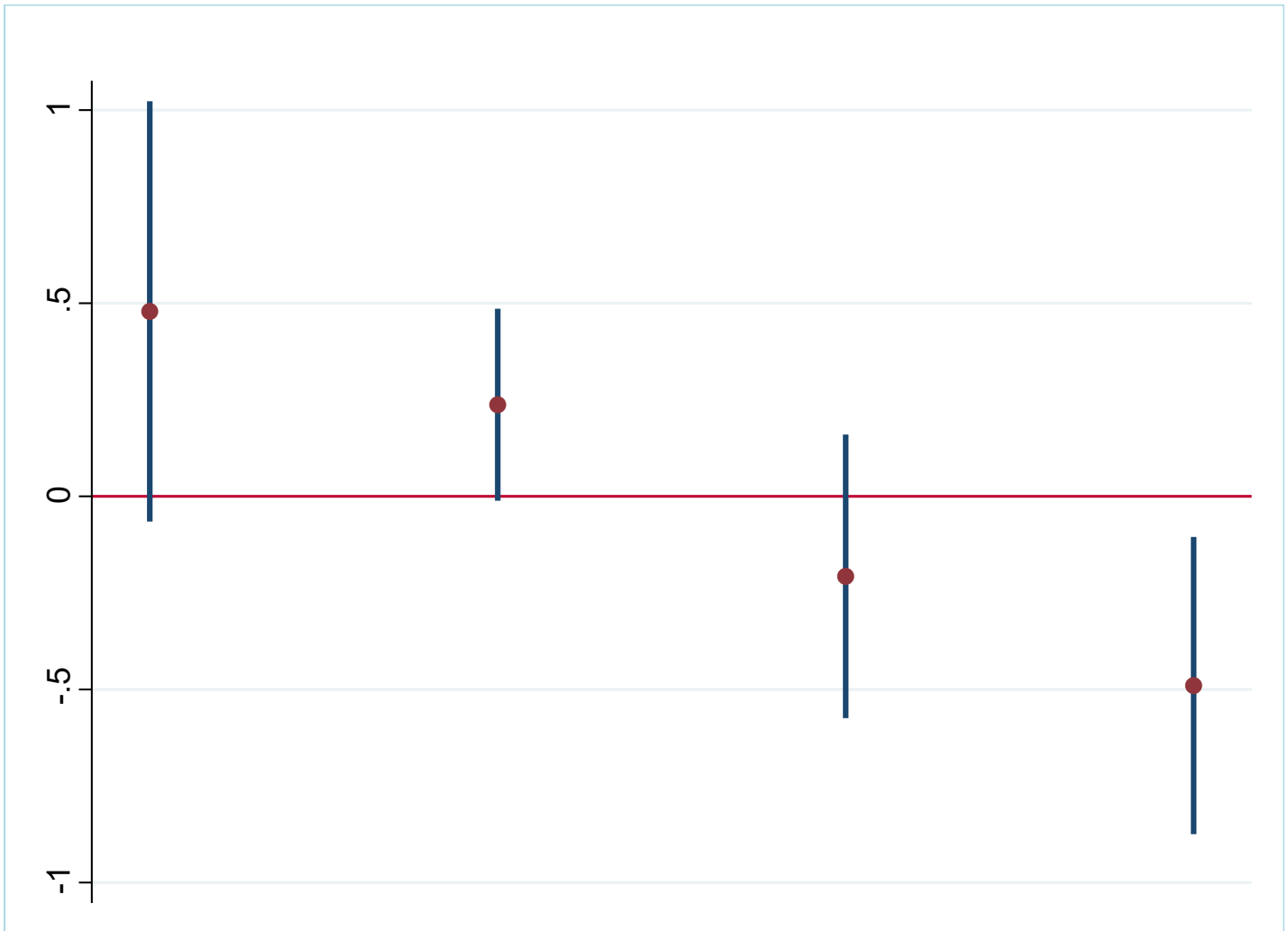
	(1) Leverage	(2) Leverage	(3) ST Debt	(4) ST Debt	(5) Lev (All)	(6) ST Debt (All)
Sov	0.135	0.353	0.206	0.442	0.280	0.391
	(0.409)	(0.473)	(0.393)	(0.470)	(0.393)	(0.411)
lev*sov	-0.412***	-0.360**			-0.279**	
	(0.146)	(0.155)			(0.140)	
stdebt*sov			-0.537***	-0.556***		-0.560**
			(0.163)	(0.187)		(0.223)
Constant					-0.423**	-0.440**
					(0.184)	(0.189)
Bank Controls	N	Y	N	Y	Y	Y
Firm FE	Y	Y	Y	Y	N	N
Observations	144,966	144,966	139,821	139,821	198,708	184,416
R-squared	0.362	0.367	0.360	0.364	0.004	0.005

Lending Effects by Quartiles: Leverage



$$\%\Delta L_{i,b,Q4:10-Q4:09} = \alpha_i + \sum_{q=1}^{4} \alpha(q) \cdot sov_{b,Q4:09} \cdot lev_{i,Q4:09}(q) + ... + \epsilon_{i,b}$$

Lending Effects by Quartiles: Debt Maturity



$$\%\Delta L_{i,b,Q4:10-Q4:09} = \alpha_i + \sum_{q=1}^{4} \alpha(q) \cdot sov_{b,Q4:09} \cdot stdebt_{i,Q4:09}(q) + ... + \epsilon_{i,b}$$

Real Effects

Employment, Fixed Assets, Total Debt and Intermediate Inputs

- We now estimate the following specific regressions:

$$\Delta V_{i,Q410-Q409} = \alpha_1 sov_{i,Q409} + \alpha_2 sov_{i,Q409} * lev_{i,Q409}(4) + ... + \epsilon_i$$

and

$$\Delta V_{i,Q410-Q409} = \alpha_1 sov_{i,Q409} + \alpha_2 sov_{i,Q409} * stdebt_{i,Q409}(4) + ... + \epsilon_i,$$

- V = employment, fixed assets, total debt, and intermediate inputs

Real Effects: Leverage

VARIABLES	(1) Gr_emp	(2) Gr_ast	(3) Gr_liab	(4) Gr_int
sov (α_1)	0.030	-0.279	0.233	0.024
	(0.083)	(0.248)	(0.206)	(0.078)
sov*lev (α_2)	-0.199*	-0.834***	-1.605***	-0.450***
	(0.112)	(0.207)	(0.410)	(0.142)
lev	0.023***	-0.009	0.001	0.050
	(0.008)	(0.161)	(0.027)	(0.085)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
P($\alpha_1 + \alpha_2 < 0$)	0.96	0.99	0.99	0.99
Observations	88,204	89,410	89,466	89,823

Clustered standard errors (bank level) are reported in the parentheses

* p<0.1, ** p<0.05, *** p<0.01

Real Effects: Maturity Structure

VARIABLES	(1) Gr_emp	(2) Gr_ast	(3) Gr_liab	(4) Gr_int
sov (α_1)	0.017	-0.392	0.097	-0.019
	(0.090)	(0.256)	(0.349)	(0.092)
sov* stdebt (α_2)	-0.140**	-0.265**	-0.289**	-0.218***
	(0.069)	(0.110)	(0.125)	(0.046)
stdebt	-0.023	-0.144	0.097***	0.000
	(0.017)	(0.160)	(0.036)	(0.044)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
P($\alpha_1 + \alpha_2 < 0$)	0.98	0.98	0.98	0.99
Observations	88,204	89,410	89,828	89,823

Clustered standard errors (bank level) are reported in the parentheses

* p<0.1, ** p<0.05, *** p<0.01

Economic Magnitudes

- A bank with sov. exp. in the 90^{th} ptile. cuts lending to a highly leverage firm by 3.5pp more than one in the bottom 10^{th} ptile.
- Comparing a firm with sovereign exposure in the 90^{th} ptile (9.3%) with a firm in the 10^{th} ptile (0.7%):
  - A highly leveraged firm contracts 1.7pp more, than it's lower leveraged counterpart, in terms of employment, 7.2pp (assets), 13.8pp (total debt), and 3.9pp (int. comm.).
- On aggregate, during the same period, employment contacted by 4.4pp, assets by 7.2pp, total debt by 13.8pp, and int. comm. by 1pp.
- Similar, but relatively smaller, effects on the debt maturity dimension.

Discussion/Robustness

- **Alternative measures of financial shocks?**
  - Exposure to non-performing loans, security funding.
- **What about bond holdings of other Eurozone countries?**
  - GIIPS, GP, and PS bond holdings.
- **What about analyzing alternative time windows?**
  - (i) Q4:08 vs. Q4:11 and (ii) average of Q4:08 and Q4:09 vs. Q4:10 and Q4:11.
- **Do banks that are more exposed to the sovereign have riskier clients?**
  - *Ex ante* Ex-ante risk uncorrelated to sovereign holdings, similar borrower characteristics and business model of high and low sov. banks, saturate the regressions with sector and location fixed effects.
- **How do foreign banks influence the analysis?**
  - Regressions re estimated excluding all foreign entities operating in Portugal and our results remain consistent in this specification as well.

Discussion/Robustness Contd.

- **Are the results being driven by a particularly vulnerable sector?**
  - Regressions re-estimated excluding the construction sector.
- **Alternative variable definitions?**
  - Use pure bank leverage as an alternative measure and also broaden the credit measure to include credit lines.
- **Using an alternative estimation methodology.**
  - Estimate WLS models. Weights: the importance of the firm in the credit market and the size of the firm.
- **Placebo regressions**
  - Two exercises: (i) hold the sovereign shares constant in Q4:07 and analyze growth rates between Q4:07 and Q4:08 and (ii) hold the sovereign shares constant at Q4:08 and analyze growth rates between Q4:08 and Q4:09.

Interpreting Empirical Results

Standard Model w/ Uninsurable Investment Risk

- Question: What do these results tell us about important ingredients in macro-finance models?

- Entrepreneur lives for three periods, owns a long term project, $\{y_t\}_{t=0}^{2}$, and has access to an additional risky investment in the interim period, zk.

- The new investment, and original long term investment, can be financed with ST and LT debt issuance: d_0^1, d_0^2, and d_1^1.

- The cost of credit in the interim period is uncertain, $r_1^1 \in [\underline{r}, \bar{r}]$.

- Key friction: uninsurable investment risk, firm specific term-premium.

- Related to Brunnermeier & Sannikov (2014), Arellano et al. (2016).

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Simple Model: Entrepreneurs' Problem

$$\max_{d_0^1, d_0^2, d_1^1, k, c_2} E_{r_1^1, z} \left[\log c_2 \right]$$

s.t.

$$d_0^1 + d_0^2 = d_0 = -y_0$$

$$k = y_1 - \left(1 + r_0^1\right) d_0^1 + d_1^1$$

$$c_2 = y_2 + zk - \left(1 + r_1^1\right) d_1^1 - \left(1 + r_0^2\right) d_0^2.$$

Simple Model: Investment Functions

- Interim policy function for investment

$$k(r_1^1, d_0, d_0^2, ...) = \bar{k}(r_1^1) \cdot \left[y_1 - \left(1 + r_0^1\right) d_0 + \frac{y_2}{1 + r_1^1} + \left(1 + r_0^1 - \frac{1 + r_0^2}{1 + r_1^1}\right) d_0^2 \right]$$

- Reduced form relationship between k, r_1^1, d_0 and d_0^2

$$\tilde{k}(r_1^1, d_0, d_0^2) = k(r_1^1, d_0, d_0^2, y_1, y_2, r_0^2, r_0^1)$$

and

$$\mathbb{E}_{r_1^1} \left\{ \frac{1 + r_0^1 - \frac{1+r_0^2}{1+r_1^1}}{y_1 - \left(1 + r_0^1\right) d_0 + \frac{y_2}{1+r_1^1} + \left(1 + r_0^1 - \frac{1+r_0^2}{1+r_1^1}\right) d_0^2} \right\} = 0.$$

Simple Model: Comparative Statics I

- Longer maturity, less sensitivity:

$$\frac{\partial}{\partial d_0^2}\left|\frac{\partial \log k}{\partial r_1^1}\right| < 0.$$

- If and only if $y_2 - \left(1 + r_0^2\right) d_0^2 > 0$ then, higher leverage, more sensitivity:

$$\frac{\partial}{\partial d_0}\left|\frac{\partial \log k}{\partial r_1^1}\right| > 0.$$

Simple Model: Comparative Statics II

- If entrepreneurs are heterogeneous with respect to d_0 and either y_1 or y_2

$$\frac{\partial}{\partial r_1^1}\left|\frac{\partial \log \tilde{k}}{\partial d_0}\right| = \frac{\partial}{\partial d_0^2}\left|\frac{\partial \log \tilde{k}}{\partial r_1^1}\right| = 0.$$

- If entrepreneurs are heterogeneous with respect to d_0 andr_0^2

$$\frac{\partial}{\partial d_0^2}\left|\frac{\partial \log \tilde{k}}{\partial r_1^1}\right| < 0.$$

and (provided $y_2 - \left(1 + r_0^2\right) d_0^2 > 0$)

$$\frac{\partial}{\partial d_0}\left|\frac{\partial \log \tilde{k}}{\partial r_1^1}\right| > 0.$$

Alternative Model

- Diminishing returns + collateral constraint, risk-neutrality
- If heterogeneity in leverage driven by initial net-worth (productivity)

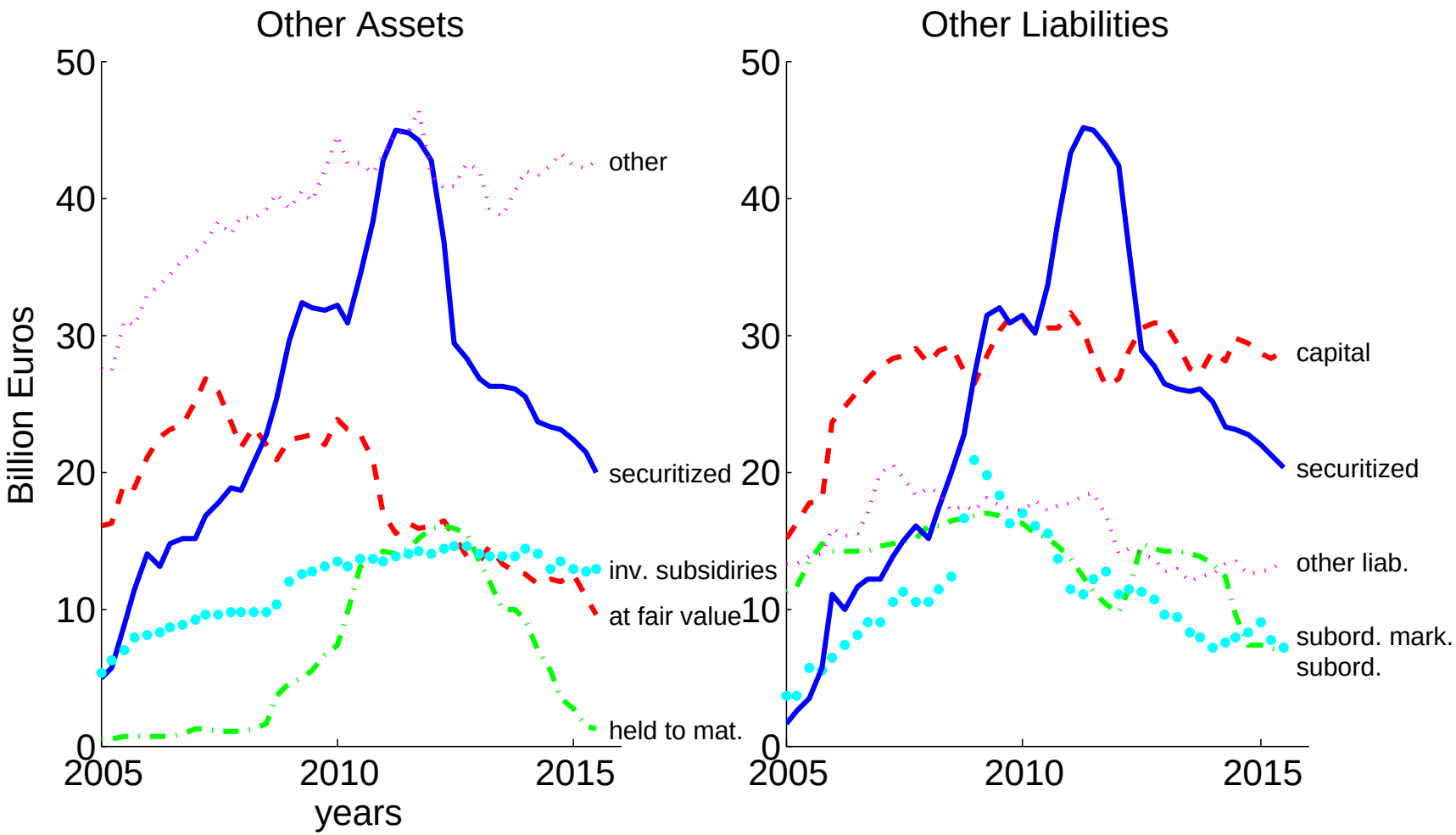
$$\frac{\partial}{\partial d_0}\left|\frac{\partial \log \tilde{k}}{\partial r_1^1}\right| < (>) 0.$$

- Related to Ottonello & Winberry (2017), Crouzet & Mehrotra (2017).

Conclusions

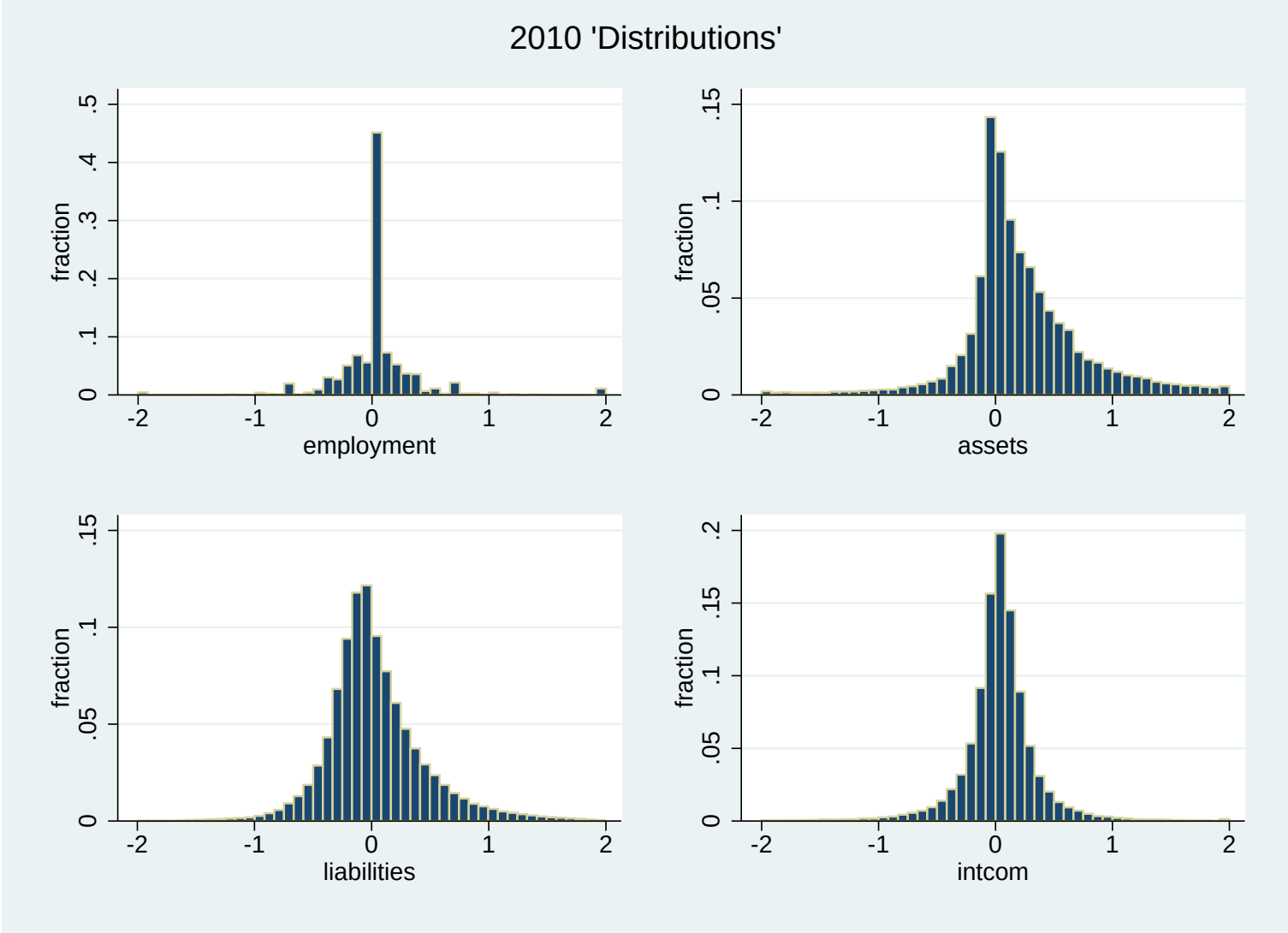
- Document importance of firm heterogeneity in terms of leverage and debt maturity structure to understand real effects on: employment, asset accumulation, intermediate input usage.
- Present simple model of firm heterogeneity to interpret the findings: Importance of modeling long term investments and frictions constraining long term borrowing.
- Big picture lesson: Evidence on heterogeneous responses is useful to test the importance of model elements, given an explicit structure.
  - Catherine et al. (2018), Sraer & Thesmar (2018).

Assets & Liabilities: Portuguese Banks



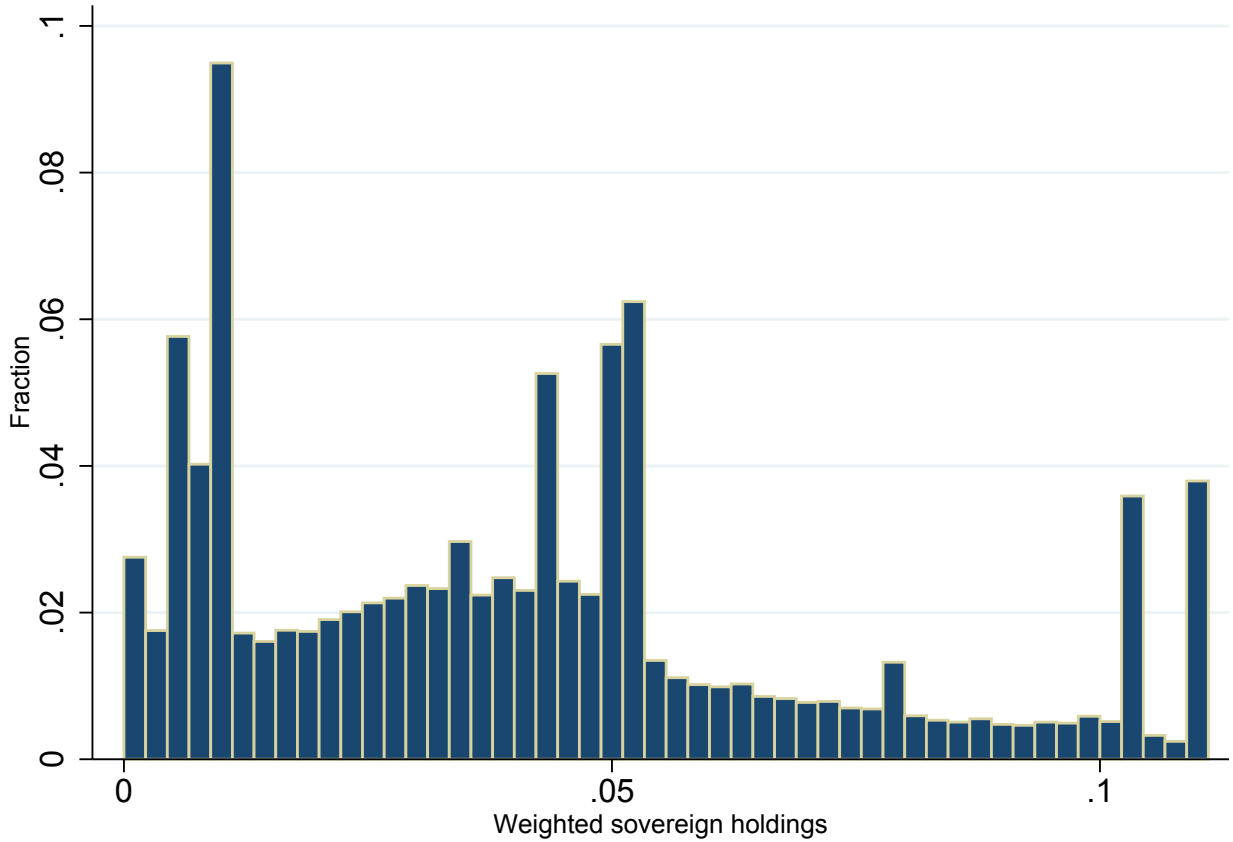
back

Distributions



Back

Firms' Sovereign Exposures



Note: The 90th percentile corresponds to a weighted sovereign holding of 9.3% while the 10th percentile corresponds to 0.7%

▸ Back

Persistent Relationships

	$Y_t = lead_t$	$Y_t = lead_t$	$Y_t = any_t$	$Y_t = any_t$
$Y_{t-1} = lead_{t-1}$	0.802***			
	[0.000]			
$Y_{t-1} = any_{t-1}$			0.867***	
			[0.000]	
$Y_{t-1} * 2006.year$		0.827***		0.876***
		[0.000]		[0.000]
$Y_{t-1} * 2007.year$		0.810***		0.856***
		[0.000]		[0.000]
$Y_{t-1} * 2008.year$		0.818***		0.859***
		[0.000]		[0.000]
$Y_{t-1} * 2009.year$		0.760***		0.864***
		[0.000]		[0.000]
$Y_{t-1} * 2010.year$		0.795***		0.876***
		[0.000]		[0.000]
$Y_{t-1} * 2011.year$		0.792***		0.864***
		[0.000]		[0.000]
$Y_{t-1} * 2012.year$		0.810***		0.870***
		[0.000]		[0.000]
Const	-0.001***	-0.001***	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
Time Effects	Y	Y	Y	Y
Number of obs.	84790059	84790059	84790059	84790059

Robust standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

▶ Back

Lending Effects: Fixed Effect Specification

- Analyze the change in lending à la Khwaja - Mian (AER, 2008).
- The model we estimate is:

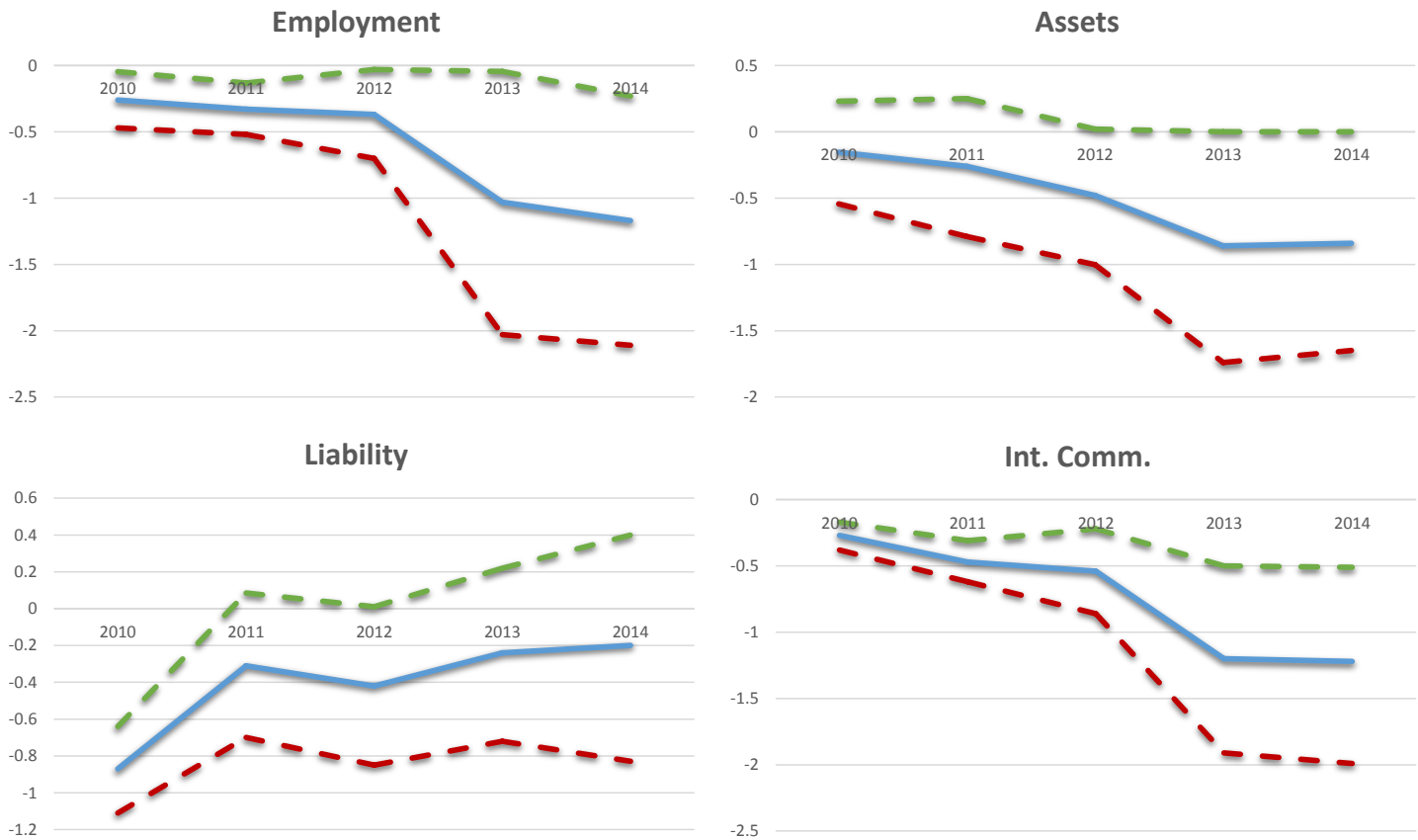
$$\%\Delta L_{i,j,Q4:10-Q4:09} = \alpha_0 + \alpha_1 sov_{j,Q4:09} + B_{j,Q4:09} + \alpha_i + \epsilon_j$$

- $\%\Delta L_{i,j,Q4:10-Q4:09}$ is the loan growth rate in the (i-j)th firm-bank pair.
- $sov_{j,Q4:09}$ is the sovereign bond holdings of bank 'j' in Q4:2009, as a fraction of total assets.
- $B_{j,Q4:09}$ are bank-specific controls (size, cap-ratio, liq-ratio).
- α_i are the firm fixed effects.

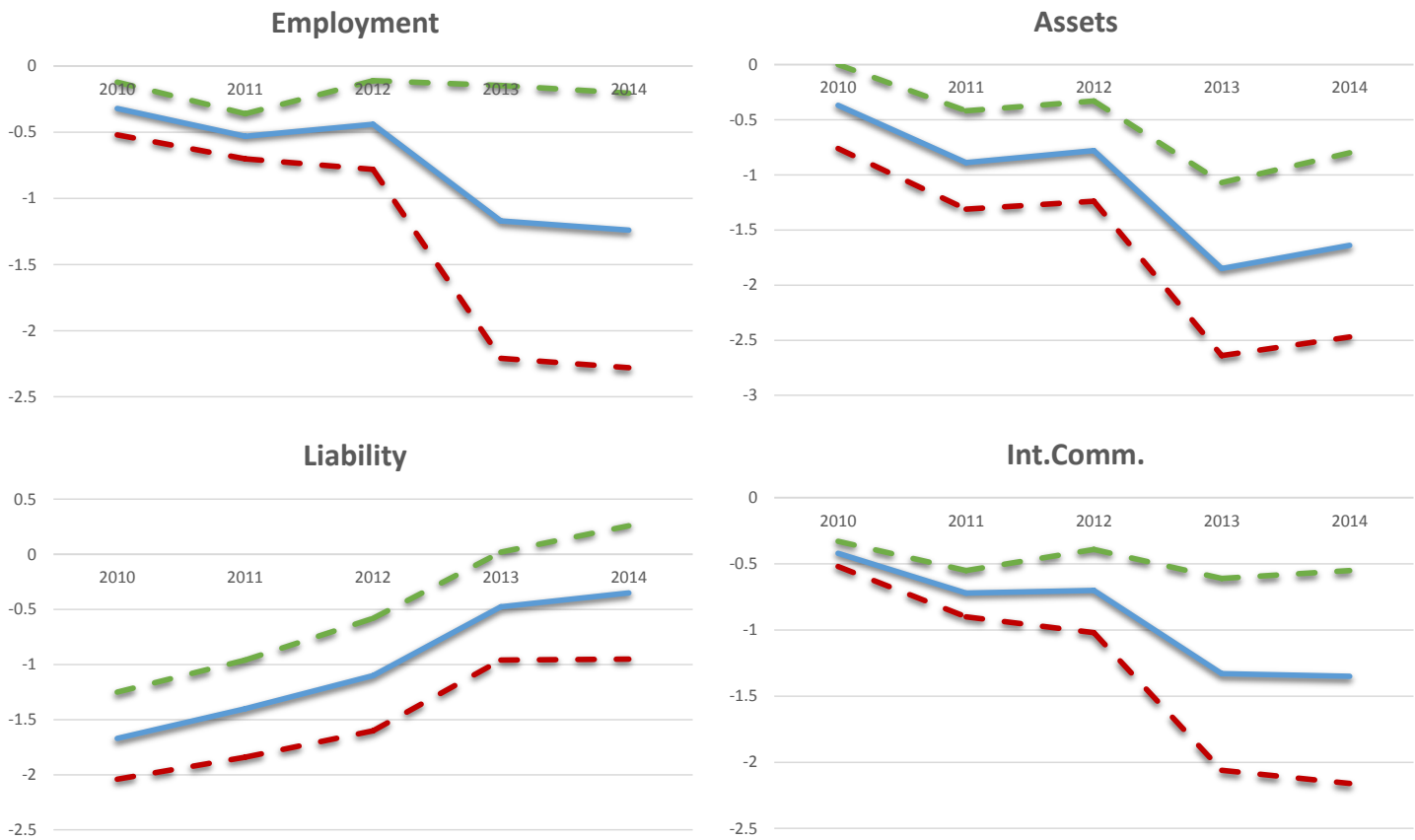
Sovereign Channel: Lending Effects

	(1) Leverage	(2) Leverage	(3) ST Debt	(4) ST Debt	(5) Lev (All)	(6) ST Debt (All)
Sov_exp.	0.135	0.353	0.206	0.442	0.280	0.391
	(0.409)	(0.473)	(0.393)	(0.470)	(0.393)	(0.411)
Highlev*sov_exp	-0.412***	-0.360**			-0.279**	
	(0.146)	(0.155)			(0.140)	
ST debt*sov_exp			-0.537***	-0.556***		-0.560**
			(0.163)	(0.187)		(0.223)
Cap_ratio		0.192		0.202	0.054	0.071
		(0.438)		(0.438)	(0.464)	(0.475)
Liq_ratio		1.108		1.089	0.973	0.946
		(1.124)		(1.133)	(1.116)	(1.163)
Bank_size		0.042**		0.043**	0.033**	0.035**
		(0.017)		(0.017)	(0.016)	(0.017)
Highlev					-0.025**	
					(0.010)	
ST debt						0.006
						(0.015)
Firm FE	Y	Y	Y	Y	N	N
Observations	144,966	144,966	139,821	139,821	198,708	184,416
R-squared	0.362	0.367	0.360	0.364	0.004	0.005

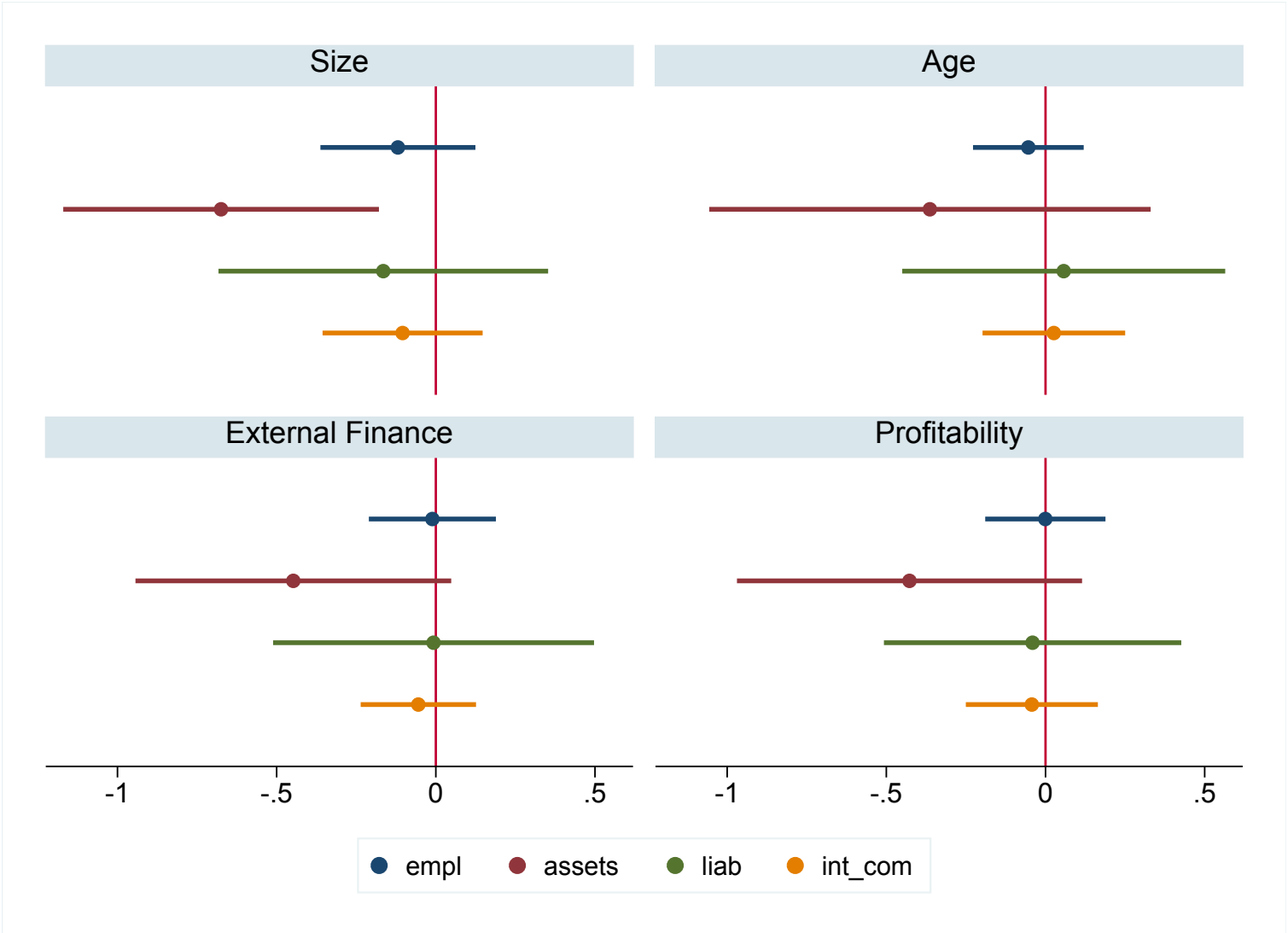
Spillover: Effects Over Time: Leverage



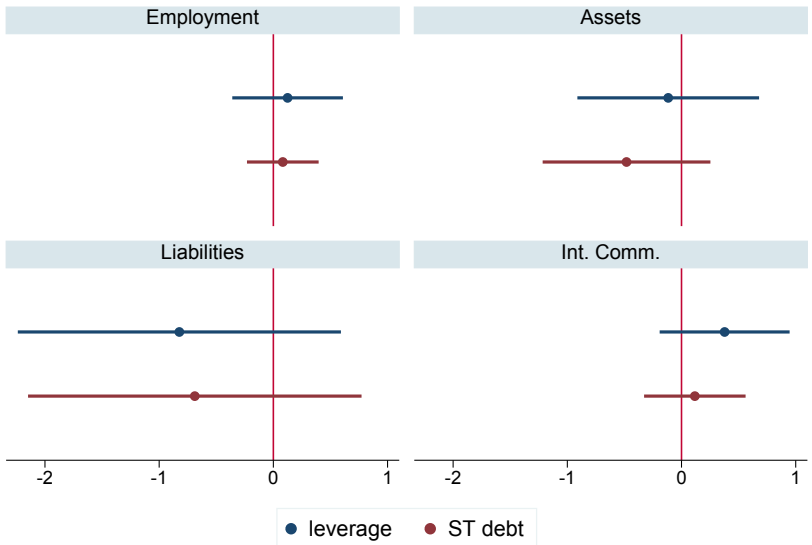
Spillover: Effects Over Time: ST Debt



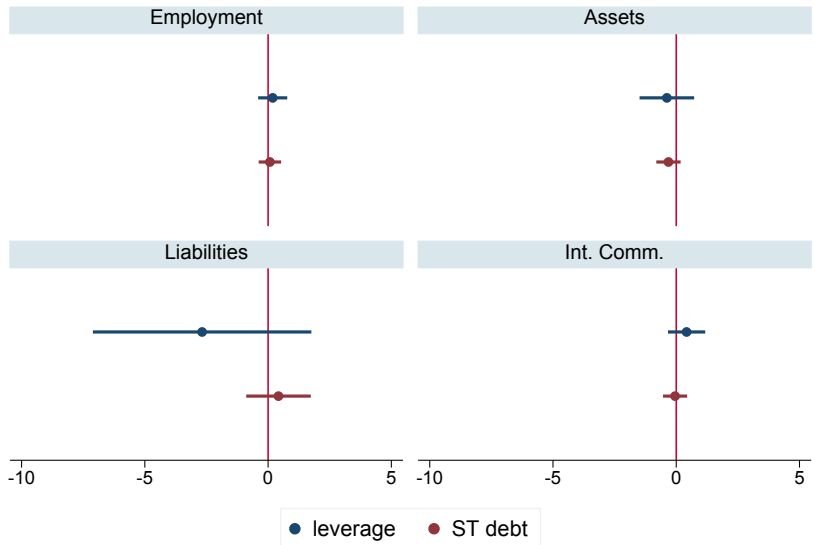
Other dimensions of heterogeneity



Placebo regresions



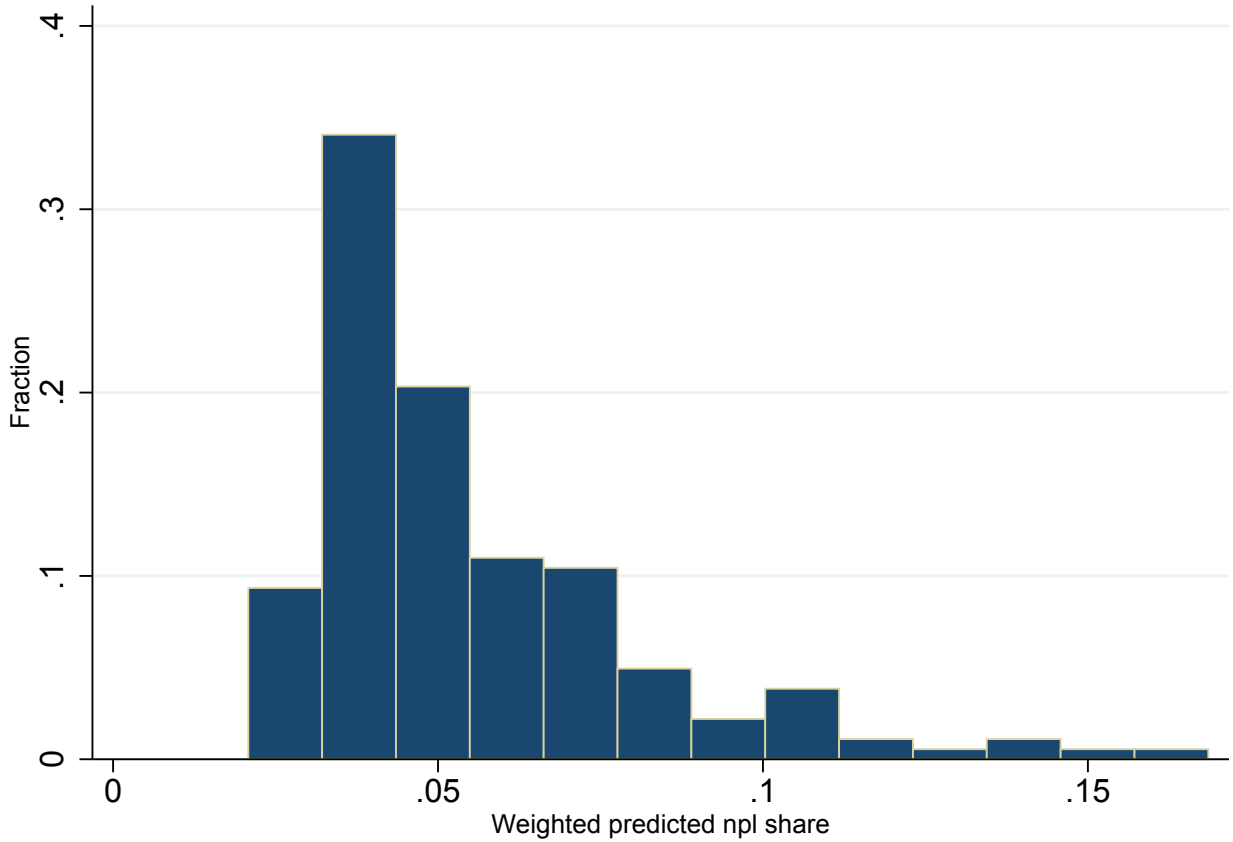
Note: Changes between 2007-2008



Note: Changes between 2008-2009

Back

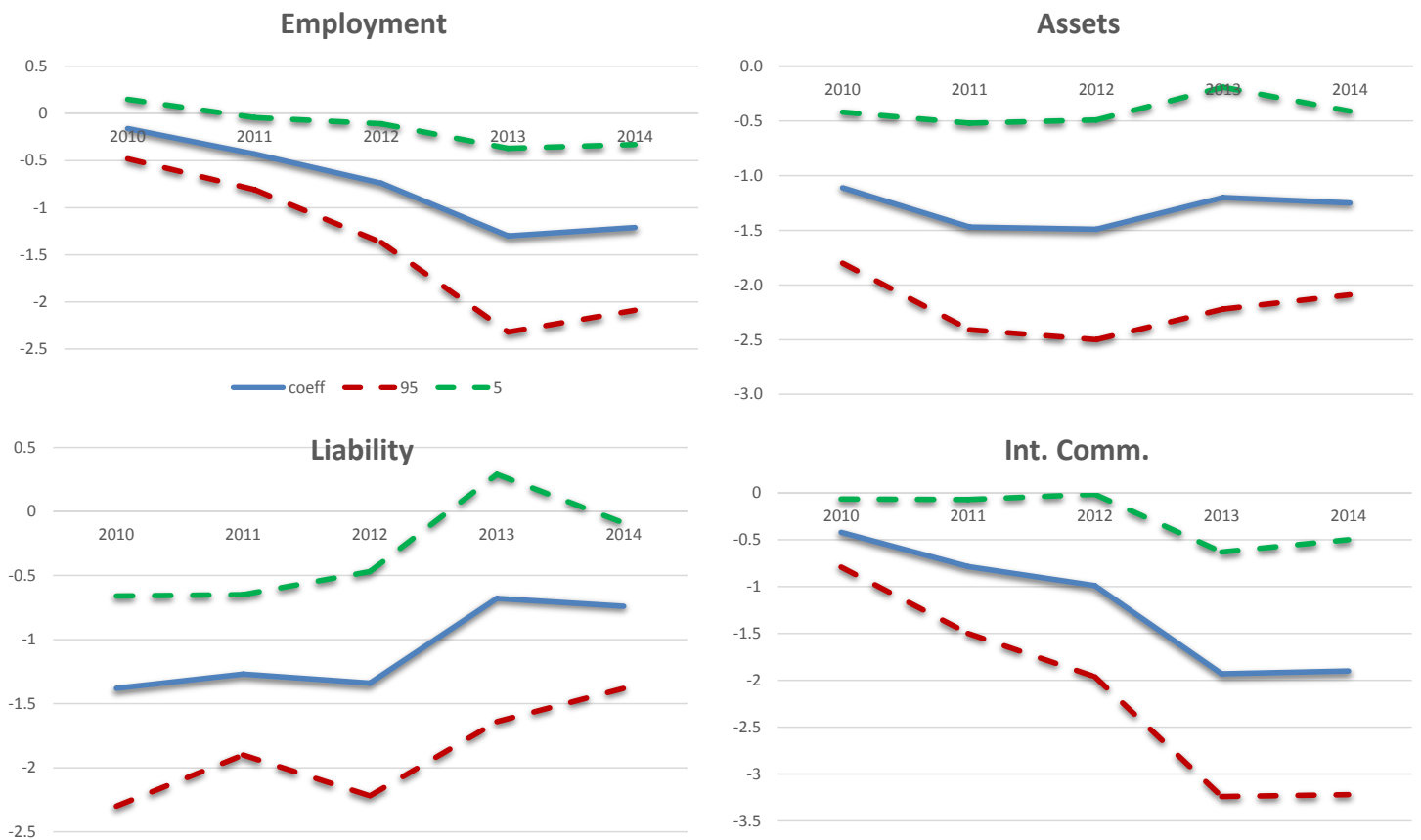
Firm's Weighted NPL Shares



Note: The 90th percentile corresponds to a npl share of 8.9% while the 10th percentile corresponds to 3.2%.

Back

Effects Over Time: Leverage $(\alpha_1 + \alpha_2)$



Effects Over Time: ST Debt $(\alpha_1 + \alpha_2)$

