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

Francisco Buera[1] Sudipto Karmakar[2]

[1]Federal Reserve Bank of Chicago and NBER

[2]Bank of Portugal and UECE

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

Background & Motivation

- In the aftermath of the financial crisis, there has been a great interest in understanding real-financial sector linkages i.e. the channels of transmission of financial shocks to the real economy.
- There has been an explosion of rich theoretical models (both on the household and the firm side) to study the propagation of financial shocks.
- Aim of our research: Use the experience of Portugal, a country with very rich micro data that arguably suffered very large financial shocks, as a laboratory to study the real effects of these shocks.

Literature: Financial Crises & the Transmission Mechanism

1. Effects on the household side:
   - Guerrieri-Lorenzoni, Eggertson-Krugman, Mian-Sufi, Justiniano-Primiceri-Tambalotti
2. Effects on the firm side (**our focus**):
   - financial accelerator mechanism (BGG, Gertler-Kiyotaki)
   - worse reallocation (Buera-Moll, Gilchrist-Sim-Zakrajsek, Gopinath et al.)
   - linkages across-sectors (Shourideh-Zetlin-Jones)
   - idiosyncratic volatility and uncertainty (Arellano-Bai-Kehoe)
3. Empirical Literature:
   - US: Chodorow-Reich, Fort et al., Eisfeldt-Rampini, Gilchrist-Zakrajsek
   - Europe (**our focus**): Bentolila et al., Bottero et al., Acharya et al., Iyer et al.

This Paper

1. Two main channels of transmission of financial distress to the real economy:
   - Sovereign channel: Real effects generated through the banks' holdings of ex ante risk-free sovereign bonds.
   - Spillover channel: Real effects generated through the accumulation of NPLs on the banks' balance sheets. Analysis conducted only for "good" firms.
2. Explore firm heterogeneity in terms of leverage and debt maturity structure.
   - Ex ante more leveraged firms & firms with a greater share of short term debt, contracted more in the aftermath of the shock.
3. Analyze multiple firm outcome variables.
   - Employment, fixed assets, total debt, and intermediate commodity usage.
4. A simple theoretical model of firm heterogeneity to gain further intuition.

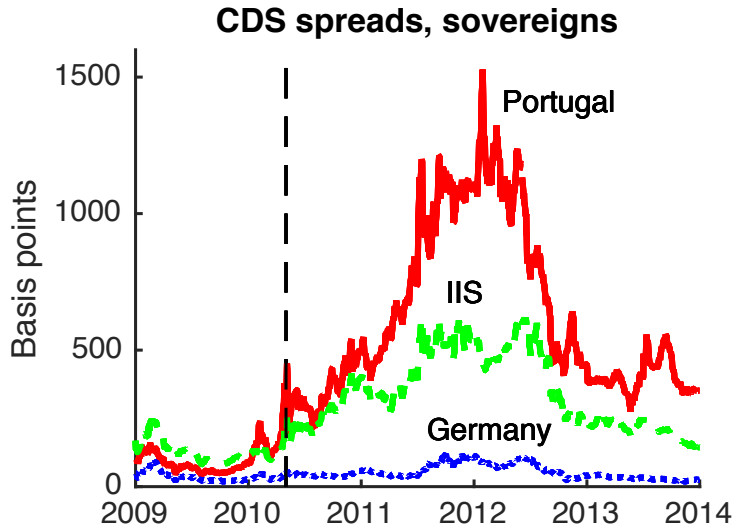
Preview of Results: Empirical

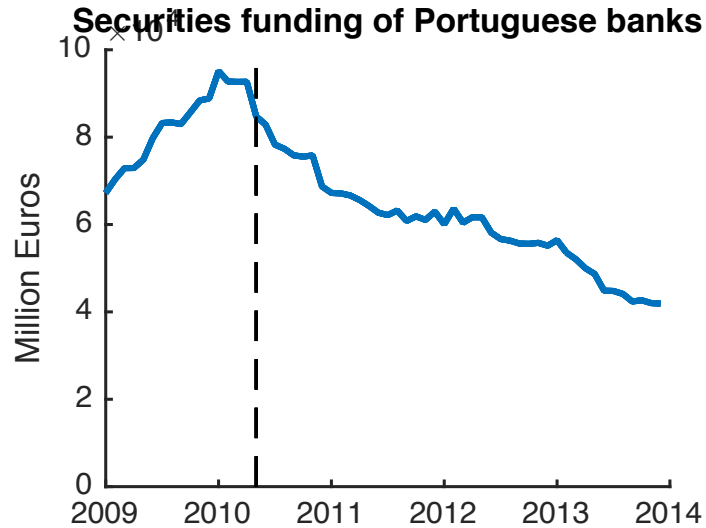
1. A bank with sovereign holdings in the 90^{th} ptile reduces lending by 3.5p.p. more, than a bank in the 10^{th} ptile, to a highly leveraged firm and 4.7p.p. more to a firm with a high share of ST debt. ($\%\Delta Lending_{nfc} = 0.70$)
2. A highly leveraged firm contracts 1.7p.p. more, than it's lower leveraged counterpart, in terms of employment, 7.2p.p. (assets), 13.8p.p. (total debt), and 3.9p.p (int. comm.), (90th-10th ptile).
3. A high ST debt firm contracts 1.2p.p. more, than it's low ST debt counterpart, in terms of employment, 2.3p.p. (assets), 2.5p.p. (total debt), and 1.9p.p. (int. comm.), (90th-10th ptile).
4. On aggregate, during the same period, employment contacted by 4.4p.p., assets by 7.2p.p., total debt by 13.8p.p., and int. comm. by 1p.p.
5. Similar results are also obtained for the *spillover channel*: high leveraged firms and firms with a large share of ST debt contracted significantly more than their counterparts.

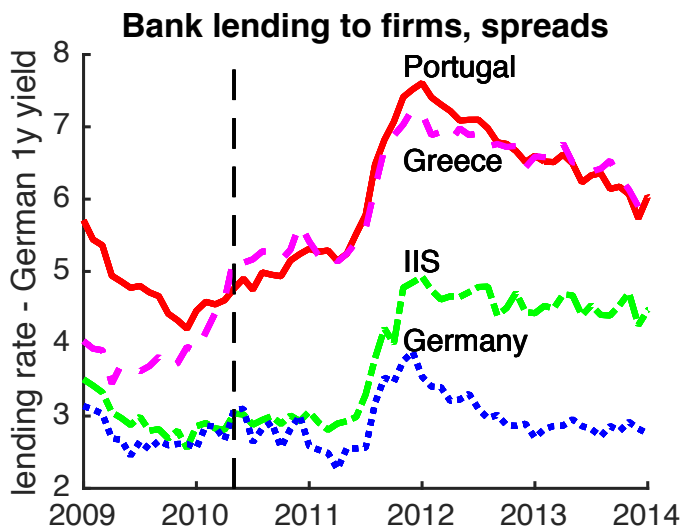
Preview of Results: Model

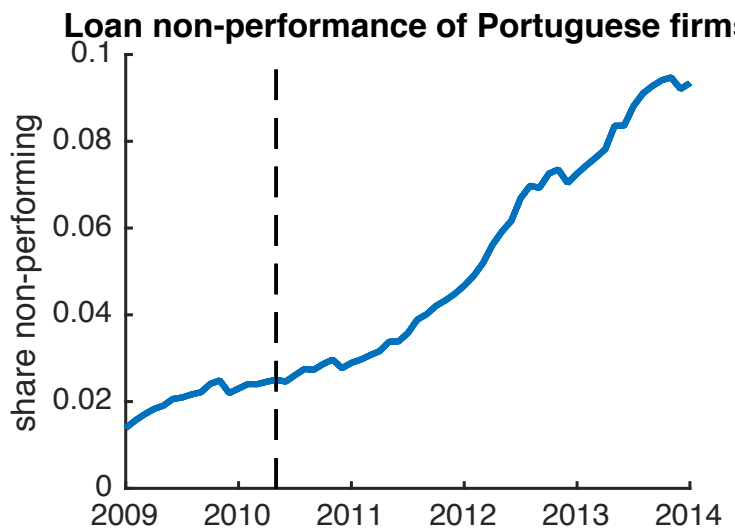
1. Model: What generates the distribution of debt maturity? $\Rightarrow$ Why do some firms issue more LT debt than others and what are the implications for aggregate investment in different states of nature?
2. Firms' may issue sub-optimal LT debt owing to:
   - Expected higher future cash flows which completely offsets the low LT debt issuance and no effect on relative investment in states of nature with high and low interest rates.
   - Firm specific borrowing costs. The firm is exposed to interest rate risk leading to adverse consequences in the high interest rate state of the world.
3. Data:
   - 1 SD $\uparrow$ in cash flows $\Rightarrow$ 4-6p.p $\downarrow$ in LT debt share.
   - 1 SD $\uparrow$ in interest rate $\Rightarrow$ 5-11p.p $\downarrow$ in LT debt share.

Sovereign CDS & Short Term Interest Rates









The Data

- 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.
- We consider growth rates between years 2009-2010 and only consider firms that have at least two banking relationships and at least ten thousand euros of outstanding credit.
- Our final sample of firms is quite representative of the Portuguese economy. It represents 71% of total loans granted, 70.51% of employment, 76.41% of turnover, and 77.07% of assets, as of 2009:Q4.

Descriptive Statistics: Non-Financial Corporations

	CBSD		CBSD & CRC		>1 Relations	
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Employment	13.66	120.345	14.81	126.864	18.89	150.535
Fixed Assets	934068.3	2.98e+07	886924.3	2.92e+07	1190380	3.52e+07
Tot. Liab	2848650	8.58e+07	2522380	8.69e+07	3404019	1.05e+08
Int. Comm. Usage	203245.3	2.05e+06	214196.5	2.15e+06	278098.5	2.58e+06
EBIT	80525.3	2684130	75880.12	2354905	103475.7	2845427
ST debt share	0.51	0.39	0.52	0.39	0.50	0.38
No. of firms	138211		106723		82561	

Figures are for 2009:Q4. IES is the firm balance sheet data, CRC is the central credit registry. Monetary figures are in Euros.

Descriptive Statistics: Financial Institutions

	All Banks		High Sov Share		Low Sov Share		P Value
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**(t-test)**
Total Assets	1.41e+10	2.83e+10	1.83e+10	3.52e+10	1.15e+10	2.14e+10	0.44
Capital Ratio	14.85	7.74	15.17	8.80	14.59	6.98	0.83
Liquidity Ratio	13.44	15.96	16.54	17.08	10.87	14.97	0.31
Overdue/total loans	2.72	2.62	2.91	2.86	2.57	2.51	0.71
Corp. Share	28.84	18.73	27.90	15.01	30.41	21.65	0.59
Hhs. Share	25.59	23.55	19.84	14.55	30.39	28.56	0.20
Funding (securities/assets)	6.32	9.74	7.05	10.62	4.91	8.70	0.45
Funding (inter-bank/assets)	24.46	19.78	25.00	21.54	24.01	18.28	0.88
Funding (central bank/assets)	7.49	13.98	9.71	16.27	6.65	11.92	0.41
Loan to deposit	2.22	2.24	1.88	1.59	2.50	2.68	0.43
No. of banking groups	33		15		18		

Descriptive Statistics: Financial Institutions contd.

	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		

- Banks' weighted borrower characteristics (2009:Q4) are presented in the table above.
- We fail to reject the null hypothesis that the means are identical.
- There does not appear to be adverse matching between firms and banks prior to the crisis.

The Empirical Exercise Growth Rates

- Following Davis & Haltiwanger (QJE, 1992), the growth rates were computed as,

$$g_t^e = \frac{e_t - e_{t-1}}{x_t}$$

- g_t^e is the growth rate of variable e at time t. And the variable x_t is defined as:

$$x_t = 0.5 * (e_t + e_{t-1})$$

- This measure of net growth is bounded in the closed interval [-2,2] with the end points representing deaths and births, respectively.
- Helps consider intensive + extensive margins and reduces the impact of outliers.
- Equal to the conventional growth rate (G_t^E) for smaller values of growth rates and they are monotonically related i.e. $G_t^E = 2g_t^E/(2 - g_t^E)$.

▸ Distributions

The Empirical Exercise

Lending Effects

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

$$\%\Delta L_{i,j,Q4:10-Q4:09} = \alpha_i + \alpha_1 SOV_{j,Q4:09} + \alpha_2 SOV_{j,Q4:09} * D + B_{j,Q4:09} + \epsilon_j$$

- $\%\Delta L_{i,j,Q4:10-Q4:09}$ is the loan growth rate in the (i-j)th firm-bank pair.
- $\alpha_i's$ are the firm fixed effects.
- $sov_{j,Q4:09}$ is the sovereign bond holdings of bank 'j' in Q4:2009, as a fraction of total assets.
- D is a dummy that is 1 for the top quartile of leverage and ST debt.
- $B_{j,Q4:09}$ are bank-specific controls (size, cap-ratio, liq-ratio).

The Empirical Exercise: 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)
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

The Empirical Exercise

Weighted sovereign shares

- Note the banks' sovereign holdings in 2009:Q4 and the firm-bank relationships.
- Construct a firm level weighted sovereign holdings measure:

$$sov_{i,Q4:2009} = \sum_{b \epsilon B_j} s_{i,b} * sovshare_b$$

- $s_{i,b}$ is the share of bank 'b' in the total borrowing of firm 'i' and $sovshare_b$ is the total Portuguese sovereign bond holdings of bank 'b' normalized by total assets.

▸ Firm Exp ▸ Relationships

The Empirical Exercise

The Baseline Regression

- The baseline regression we estimate is the following:

$$\%\Delta V_{j,Q4:10-Q4:09} = \alpha_0 + \alpha_1 sov_{j,Q4:09} + \Gamma_j^1 F_j + \Gamma_j^2 B_j + \beta_1^{ind} + \beta_2^{loc} + \epsilon_j,$$

- The variable 'V' represents employment, fixed assets, total debt, and intermediate commodities.
- F_i is a set of firm specific controls and in this vector we use measures of age, size, profitability, leverage, and maturity structure of debt.
- B_j is a vector of weighted bank controls and the variables we use here are the bank size, average loan interest rate, capital ratio, and the liquidity ratio.
- We also have additional controls for the industry of operation and location.

The Empirical Exercise

First Results: Average Effects

VARIABLES	(1) Gr_Emp	(2) Gr_Ast	(3) Gr_Liab	(4) Gr_Int
Wtd_sov_holding	-0.002	-0.427	-0.034	-0.048
	(0.091)	(0.268)	(0.245)	(0.093)
Constant	0.166***	-0.453***	0.108***	0.093***
	(0.019)	(0.043)	(0.027)	(0.017)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Location FE	Y	Y	Y	Y
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

The Empirical Exercise

Understanding Leverage and Debt Maturity Structure

- We now estimate the following specific regressions:

$$\%\Delta V_{i,Q410-Q409} = \alpha_0 + \alpha_1 sov_{i,Q409} + \alpha_3 sov_{i,Q409} * hlev + \alpha_4 hlev$$

$$+\Gamma_j^1 F_j + \Gamma_j^2 B_j + \beta_1^{ind} + \beta_2^{loc} + \epsilon_j,$$

and,

$$\%\Delta V_{i,Q410-Q409} = \alpha_0 + \alpha_1 sov_{i,Q409} + \alpha_3 sov_{i,Q409} * hstdebt + \alpha_4 hstdebt$$

$$+\Gamma_j^1 F_j + \Gamma_j^2 B_j + \beta_1^{ind} + \beta_2^{loc} + \epsilon_j,$$

- $hlev = 1$ for firms having pre-crisis leverage equal to or greater than 47% and we also include the interaction with the sovereign holdings measure.
- $hstdebt = 1$ for firms having pre-crisis share of short term equal to or higher 53% and we also include the interaction with the sovereign holdings measure.

The Sovereign Channel: Leverage

VARIABLES	(1) Gr_Emp	(2) Gr_Ast	(3) Gr_Liab	(4) Gr_Int
Wtd_sov_holding (α_1)	0.030	-0.279	0.233	0.024
	(0.083)	(0.248)	(0.206)	(0.078)
Wtd_sov_holding*Highlev (α_2)	-0.199*	-0.834***	-1.605***	-0.450***
	(0.112)	(0.207)	(0.410)	(0.142)
Highlev	0.023***	-0.009	0.001	0.050
	(0.008)	(0.161)	(0.027)	(0.085)
Constant	0.168***	-0.422***	0.131***	0.096***
	(0.019)	(0.043)	(0.027)	(0.016)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Location 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

The Sovereign Channel: Maturity Structure of Debt

VARIABLES	(1) Gr_Emp	(2) Gr_Ast	(3) Gr_Liab	(4) Gr_Int
Wtd_sov_holding (α_1)	0.017	-0.392	0.097	-0.019
	(0.090)	(0.256)	(0.349)	(0.092)
Wtd_sov_holding* High_stdebt (α_2)	-0.140**	-0.265**	-0.289**	-0.218***
	(0.069)	(0.110)	(0.125)	(0.046)
High_stdebt	-0.023	-0.144	0.097***	0.000
	(0.017)	(0.160)	(0.036)	(0.044)
Constant	0.165***	-0.454***	0.142***	0.093***
	(0.019)	(0.042)	(0.033)	(0.017)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Location 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

The Sovereign Channel: Leverage & Maturity

VARIABLES	(1) Gr_Emp	(2) Gr_Ast	(3) Gr_Liab	(4) Gr_Int
Wtd_sov_holding	0.047	-0.250	0.876	0.050
	(0.084)	(0.238)	(0.355)	(0.078)
Wtd_sov_holding * Highlev	-0.194*	-0.825***	-2.408***	-0.443***
	(0.111)	(0.206)	(0.519)	(0.142)
Wtd_sov_holding* High_stdebt	-0.131*	-0.229**	-0.163	-0.199***
	(0.067)	(0.107)	(0.110)	(0.045)
Highlev	0.024***	-0.008	-0.004	0.051
	(0.008)	(0.161)	(0.028)	(0.085)
High_stdebt	-0.025	-0.290	-0.196*	0.015
	(0.019)	(0.216)	(0.116)	(0.034)
Constant	0.168***	-0.422***	0.133***	0.096***
	(0.019)	(0.043)	(0.028)	(0.016)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Location FE	Y	Y	Y	Y
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

Discussion/Robustness

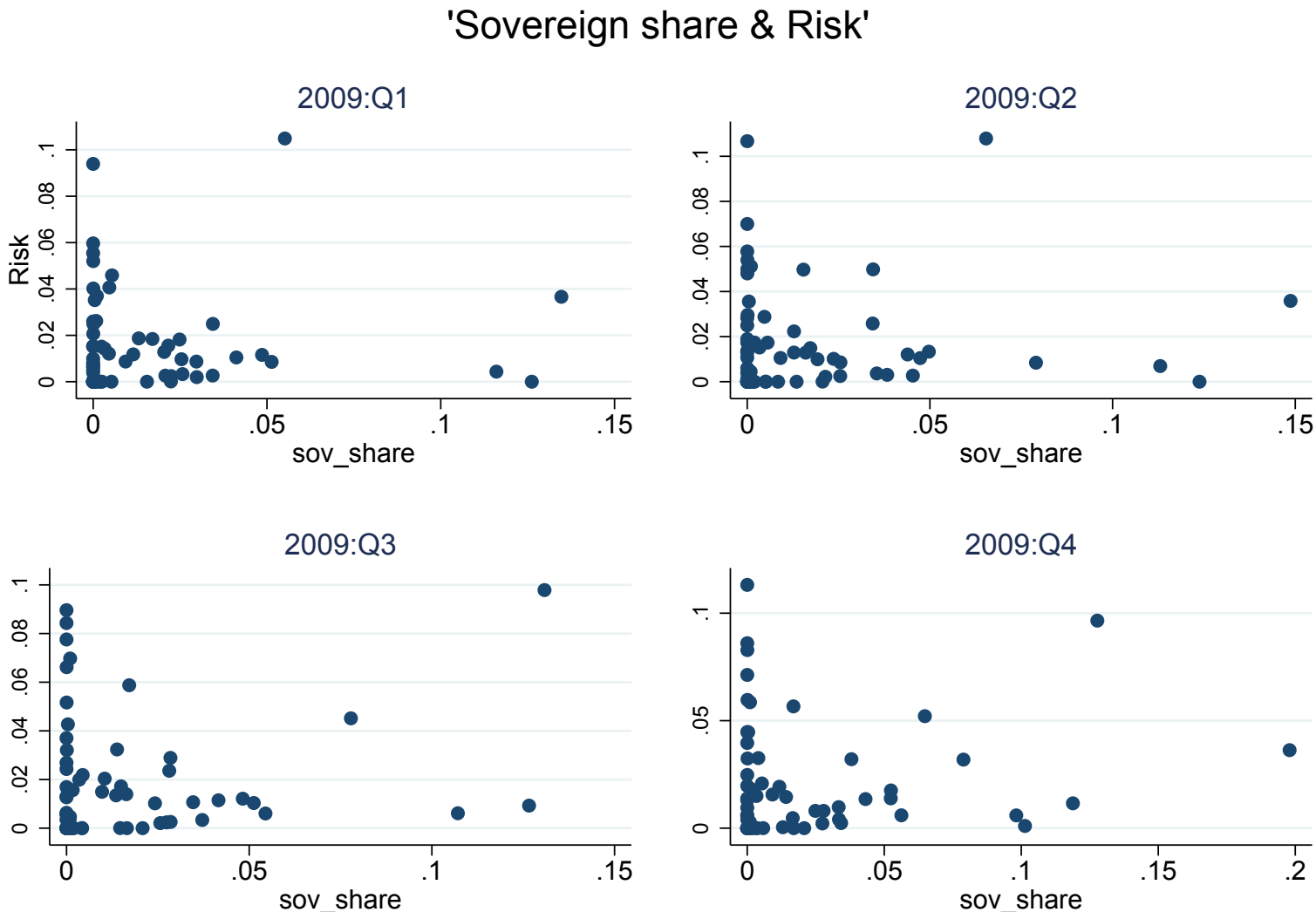
- Highly leveraged firms and firms having a higher share of ST debt contract more in the bad state of the world: credit declines more and are unable to tap into alternative sources of funding.
- Results are robust with respect to GIIPS, GP and PS bond holdings.
- Results robust to alternative time spans, pure bank leverage instead of total leverage, and a broader measure of credit (regular + potential).
- Could it be that a vulnerable sector is driving the results? (example: construction sector?) Run regressions excluding this sector to verify the same.
- Construct a "vulnerability index" for banks which is the total exposure to the sovereign and the construction sector normalized by total assets and use it as the main independent variable.

Discussion/Robustness Contd.

- Are the banks that are holding more public debt also lending more to weaker firms ex ante? Diversification motives? Ex ante scatter plot of risk vs. sovereign holdings, document firm characteristics of high and low sovereign exposure banks, document that the banks do not have different business models, and lastly saturate the regressions with sector and location fixed effects to control for such (possible) matching.
- In terms of estimation methodology, our robustness analysis included estimating weighted least square models. Weights: the importance of the firm in the credit market and the size of the firm.
- Presence of foreign banks who could be bailed out by the parent bank? All regressions were re-run for the sub-sample of only Portuguese banks.

▸ Extra Slides

The Spillover Channel



Note: The respective correlations are -0.064, -0.067, -0.033 & -0.041 and none of them are statistically significant.

The Spillover Channel: Methodology

1. Compute the share of NPLs, of the firms in 2009:Q4 and 2010:Q4, as a fraction of total loans. Define a dummy (=1) if the NPL share > 0.
2. Run the following regression and get the predicted values.

$$NPL_{j,Q4:2010} = NPL_{j,Q4:2009} + X_{j,Q4:2009} + \nu_j$$

3. Use the predicted values to construct a measure of ex ante bank risk:

$$Risk_{b,Q4:2009} = \sum_{j \epsilon F_j} s_{j,b} * \widehat{NPL}_{j,Q4:2010},$$

   where, $s_{j,b}$ is the share of bank b's loans going to firm 'j' in Q4:2009.
4. From the main CRC database drop all the firms who had any loans overdue for >=90 days.
5. Construct a weighted risk measure using the lending shares in Q4:2009 and the bank level risk measures from step 3 above.

▸ Distribution

The Spillover Channel: Leverage

VARIABLES	(1) Gr_emp	(2) Gr_ast	(3) Gr_liab	(4) Gr_int
Wtd_$\widehat{NPL}(\alpha_1)$	-0.113	0.107	-0.425**	-0.133**
	(0.088)	(0.173)	(0.097)	(0.054)
Wtd_$\widehat{NPL} * Highlev(\alpha_2)$	-0.150***	-0.261***	-0.451***	-0.146***
	(0.030)	(0.051)	(0.027)	(0.033)
Highlev	0.002	-0.156***	0.24	-0.058***
	(0.008)	(0.010)	(0.012)	(0.010)
Constant	0.031**	0.350***	0.131	0.163***
	(0.015)	(0.023)	(0.018)	(0.023)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
P($\alpha_1 + \alpha_2 < 0$)	0.99	0.99	1.00	0.99
Observations	53,780	53,528	54,425	54,444

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

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

The Spillover Channel: Maturity Structure of Debt

VARIABLES	(1) Gr_emp	(2) Gr_ast	(3) Gr_liab	(4) Gr_int
Wtd_$\widehat{NPL}(\alpha_1)$	-0.076	0.203	-0.075	-0.067
	(0.089)	(0.180)	(0.119)	(0.053)
Wtd_$\widehat{NPL} * High_stdebt(\alpha_2)$	-0.251***	-0.582***	-1.597***	-0.358***
	(0.031)	(0.087)	(0.127)	(0.040)
High_stdebt	-0.061	1.209*	-1.25	-0.063
	(0.287)	(0.615)	(0.687)	(0.366)
Constant	0.040**	0.344***	0.100	0.158***
	(0.016)	(0.023)	(0.016)	(0.021)
Firm Controls	Y	Y	Y	Y
Wtd. Bank Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
P($\alpha_1 + \alpha_2 < 0$)	1.00	0.99	1.00	1.00
Observations	53,780	53,528	54,445	54,444

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

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

The Model: Primitives

- A simple simple model that highlights the role of leverage and debt maturity in determining the sensitivity of a firm's investment decisions to interest rate shocks.
- The entrepreneur lives for three periods, owns a long term project, and has access to an additional risky investment in the interim period.
- The new investment, and the negative cash-flows associated with the long term investment, can be financed with ST and LT debt issuance.
- The cost of credit in the interim period is uncertain.
- Consumption only takes place in the last period.
- The entrepreneur starts the first period, $t = 0$, with a long term project with deterministic cash flows $\{y_t\}_{t=0}^{2}$.
- Cash-flows might include negative elements due to the initial investment or payments of previously issued debts

The Model: Primitives

- At $t = 0$, the entrepreneur chooses short (1-period) and long (2-period) debt issuance, d_0^1 and d_0^2 (bond purchases if negative), to finance a given amount of leverage d_0,

$$d_0^1 + d_0^2 = d_0$$

- We denote by r_0^1 and r_0^2 the cost of ST and LT debt, respectively.
- At $t = 1$, $r_1^1 \in [\underline{r}, \bar{r}]$ is realized.
- The entrepreneur has access to an investment opportunity k with an uncertain return, $z \in [0, \infty)$.
- She can issue new debt d_1^1 and/or finance the new investment,

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

- At $t = 2$, the last cash-flow occurs, the return of the risky investment is realized, ST and LT debts are repaid, and consumption takes place,

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

The Model: The Entrepreneurs' Problem

The problem of the entrepreneur can be simplified as that of choosing the maturity of the debt in the initial period, d_0^2, and the investment in the interim period, k, to maximize the expected utility of consumption in the final period

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

s.t.

$$c_2 = \left(z - 1 - r_1^1\right) k + y_2 + \left(1 + r_1^1\right) \left(y_1 - \left(1 + r_0^1\right) d_0\right)$$
$$+ \left(\left(1 + r_1^1\right) \left(1 + r_0^1\right) - \left(1 + r_0^2\right)\right) d_0^2.$$

We first discuss the investment choice in the interim period, given leverage d_0 and then the maturity structure, d_0^1 and d_0^2, in the initial period.

The Model: Investment Choice

The investment at $t = 1$, conditional on leverage, debt maturity, and the interest rate shock is,

$$\begin{aligned} & k\left(r_1^1\right) \\ & = \bar{k}\left(r_1^1\right) \cdot \left[y_2 + \left(1 + r_1^1\right)\left(y_1 - \left(1 + r_0^1\right) d_0\right) + \left(\left(1 + r_1^1\right)\left(1 + r_0^1\right) - \left(1 + r_0^2\right)\right) d_0^2\right] \\ & = \bar{k}\left(r_1^1\right) \cdot w\left(r_1^1\right) \end{aligned}$$

- The first term is a decreasing function of the cost of credit in the interim period, $\partial \bar{k}\left(r_1^1\right) / \partial r_1 < 0$. It captures the pure effect of an interest rate shock on the net return of investment.
- The second term is the last period's value of the net worth of the entrepreneur conditional on the realization of the interest rate shock.
- This term is independent of the interest rate shock provided $d_0^2 = d_0 - y_1 / \left(1 + r_0^1\right)$.

The Model: Simplifying Assumptions

- We assume that the present value of an entrepreneurs' cash-flows in the interim period, conditional on $d_0^2 = 0$, is positive for all realizations of r_1^1: For all $r_1^1 \in [\underline{r}, \bar{r}]$

$$\frac{y_2}{1 + r_1^1} + y_1 - \left(1 + r_0^1\right) d_0 > 0. \tag{1}$$

- In addition, we restrict long term debt positions to guarantee that investment is positive for all realizations of the interest rate in the interim period:

$$-\frac{y_2 + (1 + \bar{r})\left(y_1 - \left(1 + r_0^1\right) d_0\right)}{(1 + \bar{r})(1 + r_0^1) - (1 + r_0^2)} < d_0^2 < \frac{y_2 + (1 + \underline{r})\left(y_1 - \left(1 + r_0^1\right) d_0\right)}{(1 + r_0^2) - (1 + \underline{r})(1 + r_0^1)} \tag{2}$$

and

$$\left(1 + r_0^1\right)(1 + \underline{r}) - 1 < r_0^2 < \left(1 + r_0^1\right)(1 + \bar{r}) - 1. \tag{3}$$

The Model: Propositions

- Proposition 1: The investment in the high interest rate state relative to the low interest rate state is decreasing in leverage provided the cash flow in the last period net of long-term debt payments is positive i.e. if $y_2 - \left(1 + r_0^2\right) d_0^2 > 0$,

$$\frac{\partial \left(\frac{k(r_h)}{k(r_l)} \right)}{\partial d_0} < 0.$$

- Proposition 2: Related: When $y_2 - \left(1 + r_0^2\right) \left(d_0 - \frac{y_1}{1+r_0^1} \right) > 0$, then

$$\frac{\partial \left(\frac{k(r_h)}{k(r_l)} \right)}{\partial d_0^2} = -\frac{\partial \left(\frac{k(r_h)}{k(r_l)} \right)}{\partial d_0} + \left(1 + r_0^2\right) \frac{\bar{k}\left(r_h\right)}{\bar{k}\left(r_l\right)} \frac{w(r_h) - w(r_l)}{w(r_l)^2} > 0.$$

- Note: The condition in Proposition 2 is stronger than that in Proposition 1 when $d_0^2 < d_0 - y_1 / \left(1 + r_0^1\right)$. This will be the relevant case when the term premium is strictly positive, i.e., $1 + r_0^2 > \left(1 + r_0^1\right) \mathbb{E}\left(1 + r_1^1\right)$.

The Model: Maturity Decision

- The previous analysis takes as given the maturity structure of the debt at $t = 0$.
- Study the optimal maturity choice and, therefore, how the maturity structure depends on the primitives of the model (timing of the cash-flows of the long term investment, $\{y_t\}_{t=0}^{2}$, and the term premium, $(1 + r_t^2)$).
- When the expectation hypothesis holds, i.e, $1 + r_0^2 = \left(1 + r_0^1\right) \mathbb{E}\left(1 + r_1^1\right)$, the debt maturity is chosen to fully offset the interest rate risk.
- The investment in the high interest rate state relative to the low interest rate state is independent of leverage and the maturity structure of the debt:

$$\frac{k\left(r_h\right)}{k\left(r_l\right)} = \frac{\bar{k}\left(r_h\right)}{\bar{k}\left(r_l\right)}$$

The Model: Maturity Decision Contd..

- Our empirical results do not correspond to such a world where the expectation hypothesis holds.
- In this world, entrepreneurs who issue more ST debt conditional on leverage are those that expect to have a larger cash flow at $t = 1$. The larger cash flow exactly compensates the shorter maturity of the debt.
- Consider the case when the term premium is positive. Given Assumption (1), it is straightforward to show that

$$\frac{\partial d_0^2}{\partial \left(1 + r_0^2\right)} < 0.$$

- Entrepreneurs bear interest rate risk and the amount of LT debt issued is less than the optimal.

The Model: Maturity Decision Contd..

- As before, the quantity of LT debt is a decreasing function of the cash flow in the interim period, but now the effect is stronger:

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

- The demand for interest rate insurance is a decreasing function of the net-worth when the utility function exhibits decreasing absolute risk aversion (log utility for example).
- This simple model suggests two important sources of variation of the maturity of debt, conditional on leverage.
  - Variation in cash flows from the project, y_1 or y_2.
  - Variation across entrepreneurs in the term premium, r_0^2.

The Model: Proposition

These two sources of variation in the maturity of debt are associated with very different implications for the sensitivity of investment to interest rate shocks. Assume $1 + r_0^2 \geq \left(1 + r_0^1\right) \mathbb{E}\left(1 + r_1^1\right)$, then:

$$\frac{d\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{dy_1} = \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial y_1} + \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial d_0^2}\frac{\partial d_0^2}{\partial y_1} = 0$$

$$\frac{d\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{dy_2} = \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial y_2} + \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial d_0^2}\frac{\partial d_0^2}{\partial y_2} = 0$$

and

$$\frac{d\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{d\left(1 + r_0^2\right)} = \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial\left(1 + r_0^2\right)} + \frac{\partial\left(\frac{k\left(r_h^1\right)}{k\left(r_l^1\right)}\right)}{\partial d_0^2}\frac{\partial d_0^2}{\partial\left(1 + r_0^2\right)} < 0.$$

The Model: Intuition

- When the differences in the maturity structure of debt are driven by differences in the cash flow of the long term project, i.e., y_1 and y_2, the differential debt maturity is not associated with a differential sensitivity of investment to the interest rate shock. In this case, the longer debt maturity exactly compensates the fewer cash flows available in the interim period.
- On the contrary, when the differences in the maturity of debt are driven by differences in the term premium that the entrepreneur faces in the initial period, i.e., $1 + r_0^2$, the differential debt maturity is associated with a higher sensitivity of investment to interest rate shock.
- These results, together with our empirical analysis, suggest that it is important to model frictions to the issuance of long term debt to account for the effects of financial crisis on firm's investment.

The Model: Evidence from the Data

- Estimate the following equation:

$$(LT\_debt\_share)_{i,t} = f\left(X_{i,t}\right),$$

- The left hand side represents the long-term debt as a fraction of total debt for firm 'i' at time 't'.
- $X_{i,t}$ is a set of firm specific characteristics including variables like firm specific borrowing costs, cash flows, firm size, investment, and external finance dependence.
- We use data from 2009-2014 except for the last column, which shows the cross section.

The Model: Evidence from the Data

VARIABLES	(1) Time FE	(2) Macro controls	(3) Cross section
Interest rate	-0.236***	-0.302***	-0.141***
	(0.008)	(0.008)	(0.011)
Cash flow	-0.026***	-0.030***	-0.034***
	(0.001)	(0.001)	(0.001)
Constant	0.181***	0.569***	-0.099***
	(0.027)	(0.026)	(0.013)
Firm FE	Y	Y	N
Time FE	Y	N	N
Observations	514,663	514,663	70,016
R-squared	0.592	0.588	0.047

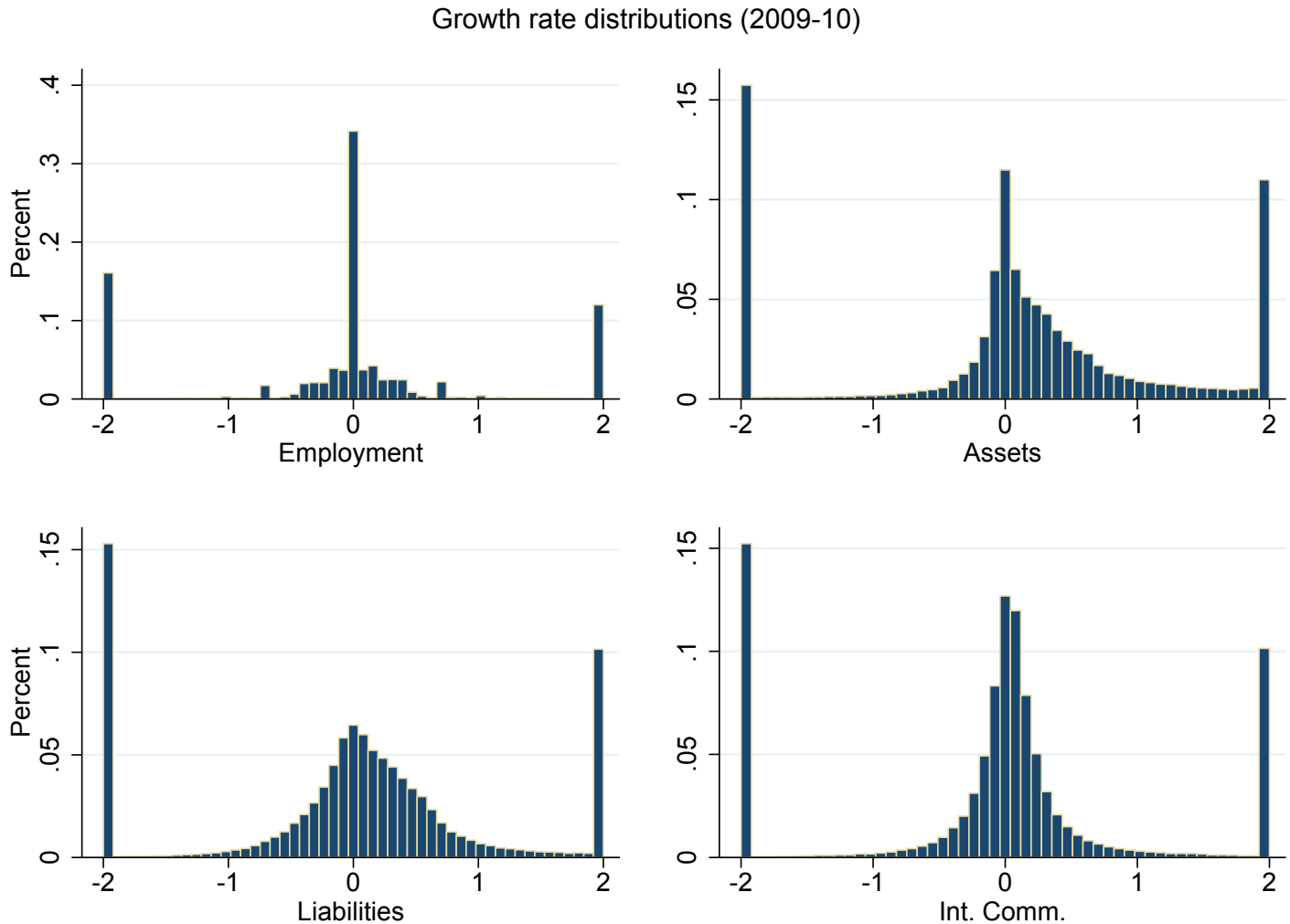
- 1 SD ↑ in cash flows ⇒ 4-6p.p ↓ in LT debt share.
- 1 SD ↑ in interest rate ⇒ 5-11p.p ↓ in LT debt share.

Conclusions and the next steps..

- Firm heterogeneity along the dimensions of leverage and maturity structure of debt were important determinants of firm performance.
- Higher leveraged firms and firms having a higher share of short term debt, ex ante, were more adversely affected.
- Spillover onto firms who were in good standing (again leverage and debt maturity matter!).
- Theoretical model: important to model frictions to the issuance of long term debt to account for the effects of financial crisis on firms' investment.
- Think about other potentially interesting dimensions of heterogeneity.
- Link to the study on reallocation (cleansing effect or evergreening?)

Thank You!

Distributions



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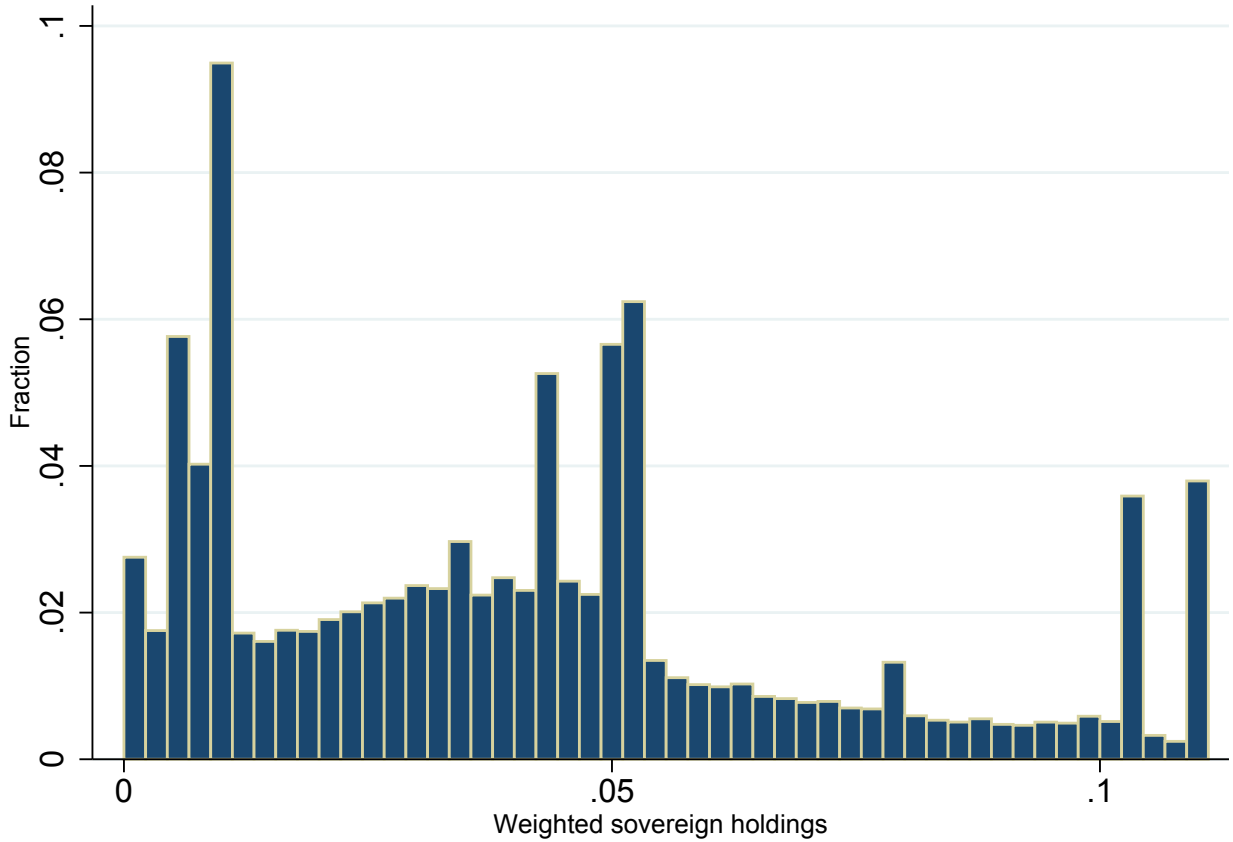
Firms' Sovereign Exposures



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

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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

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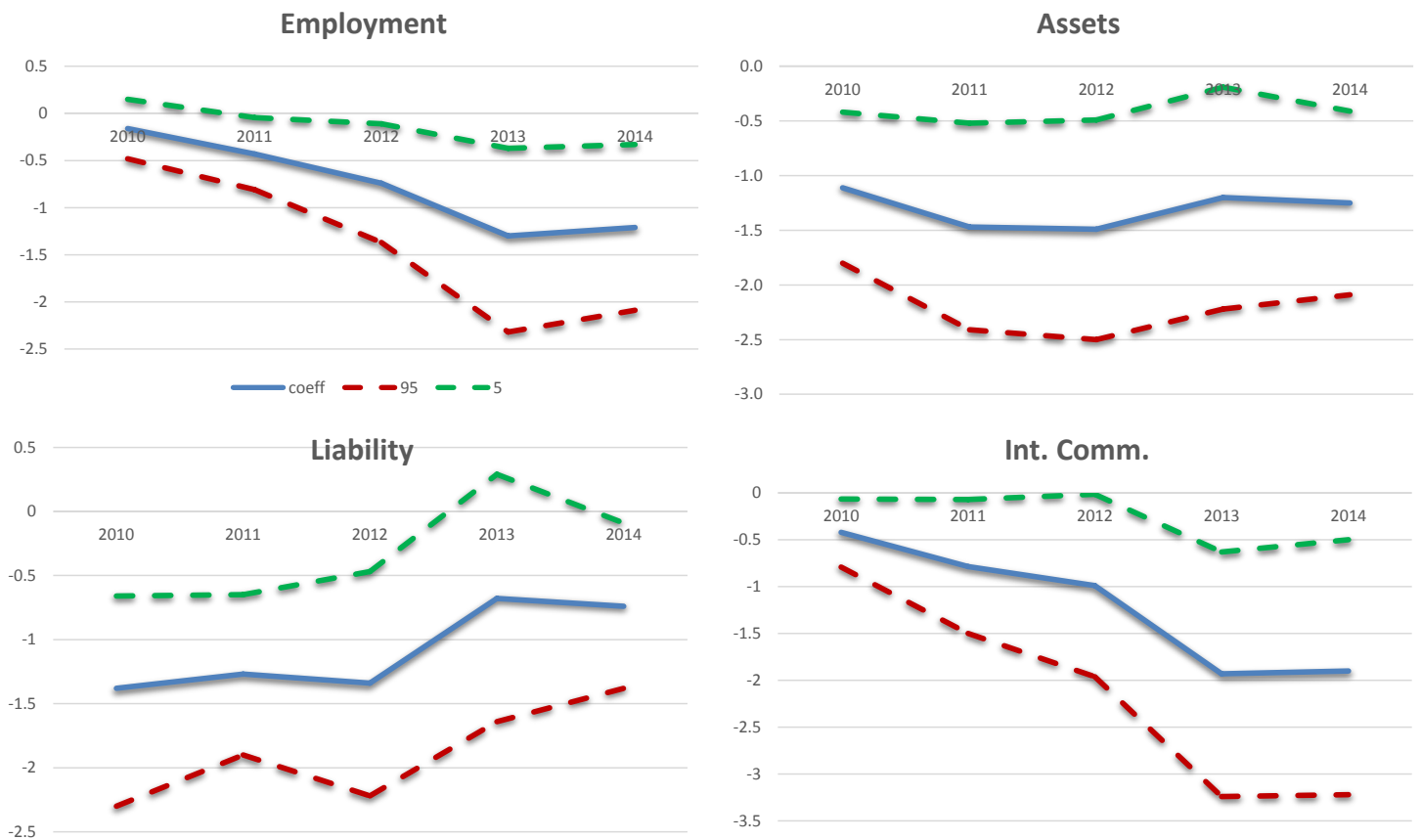
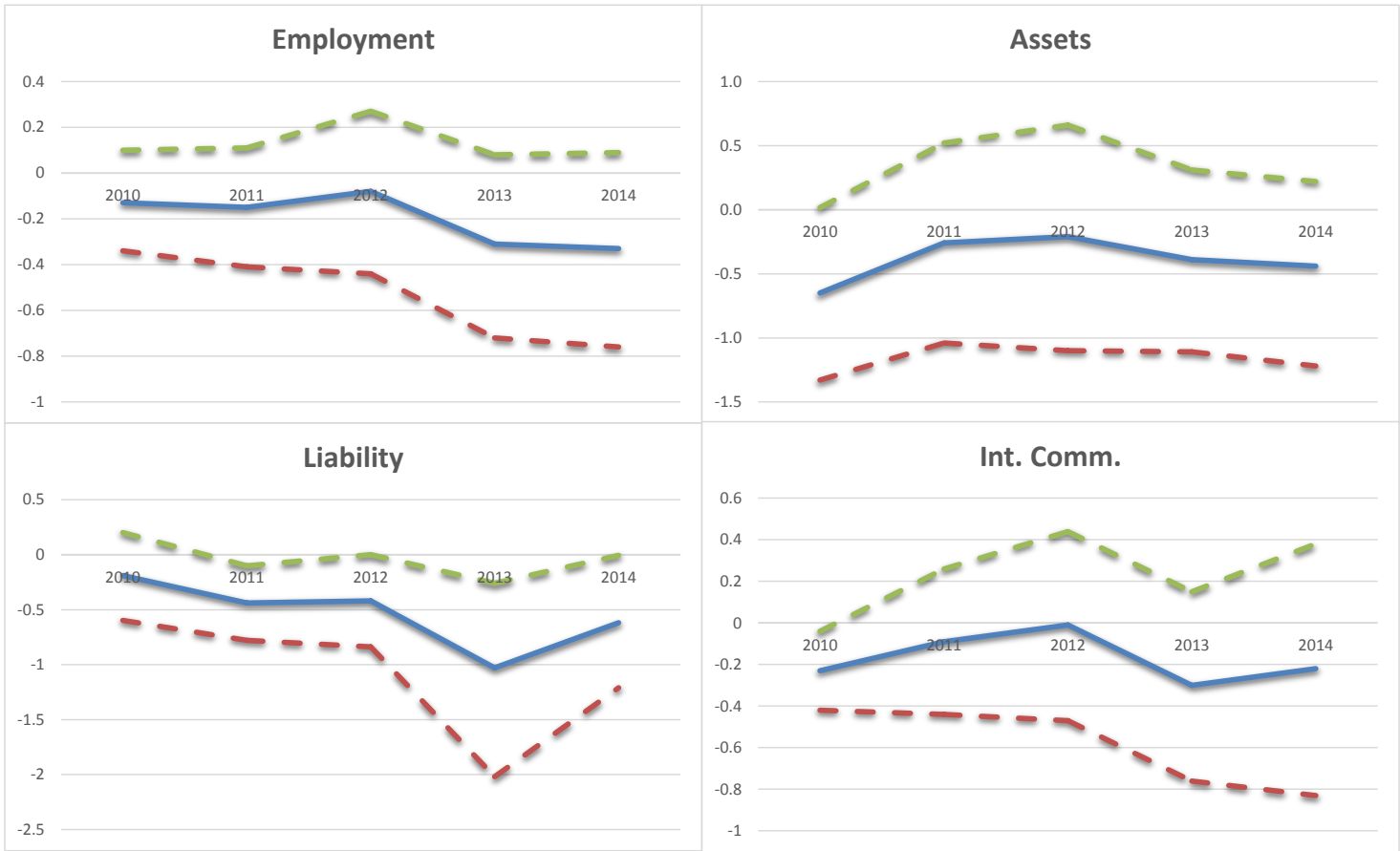
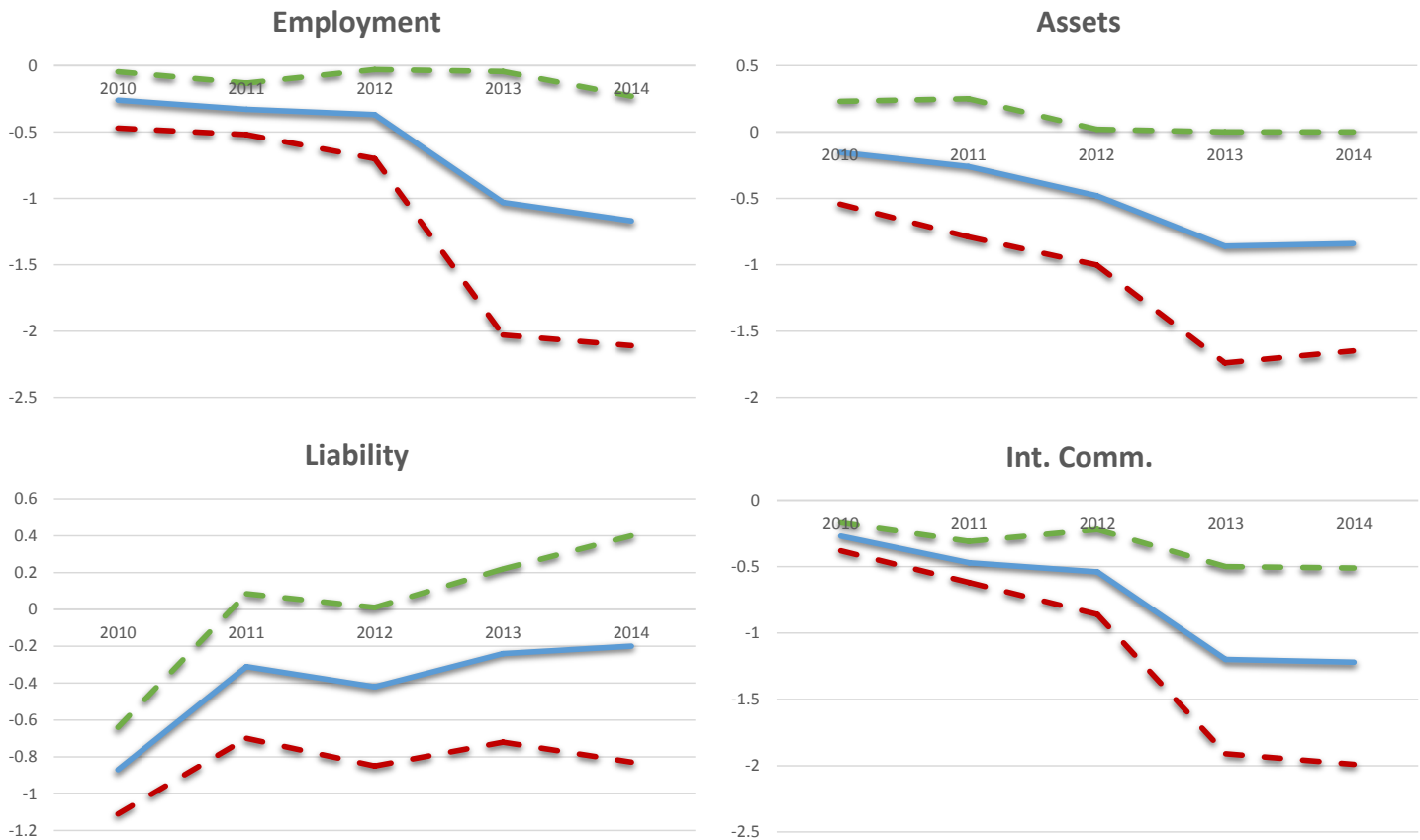
Effects Over Time: Leverage



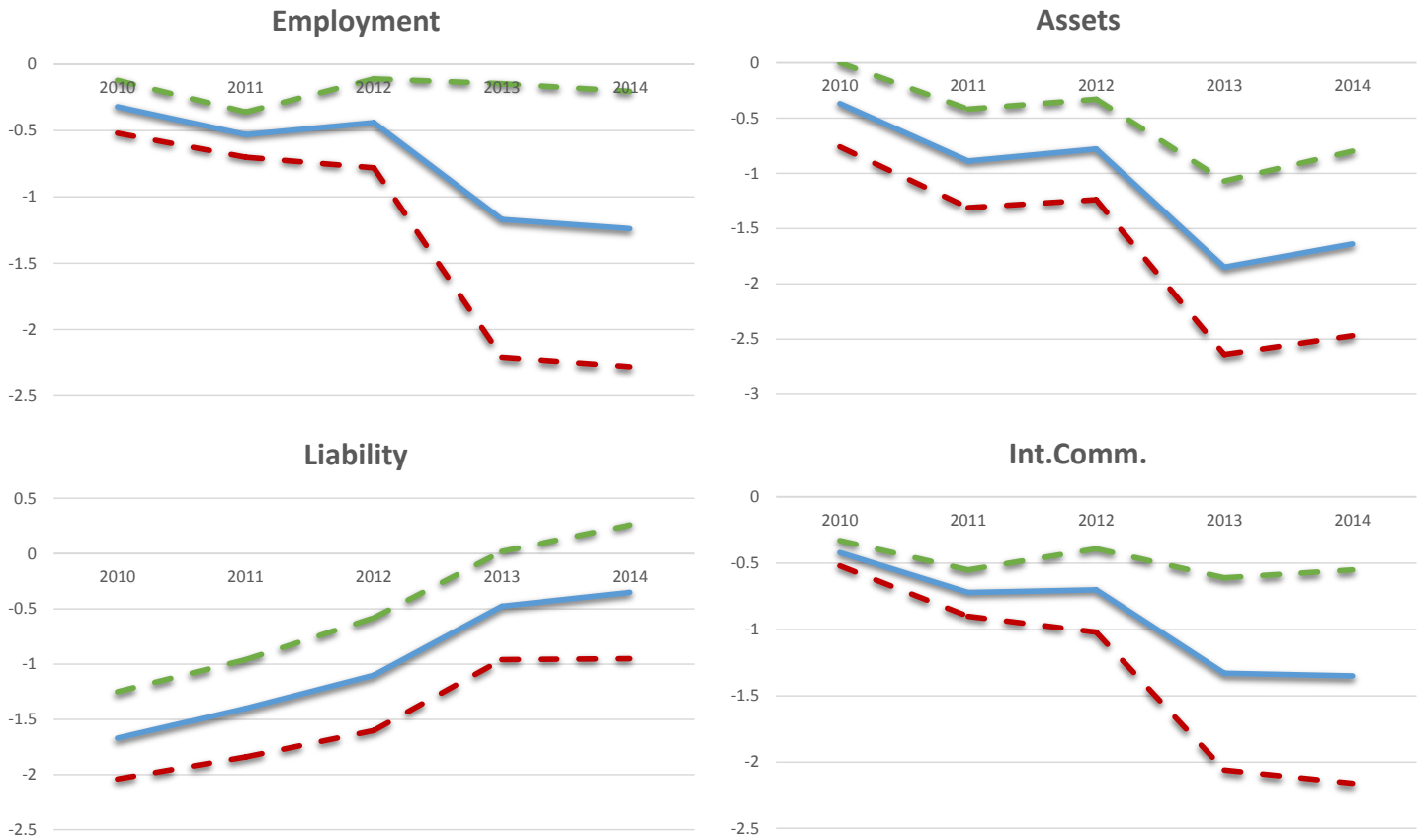
Effects Over Time: ST Debt



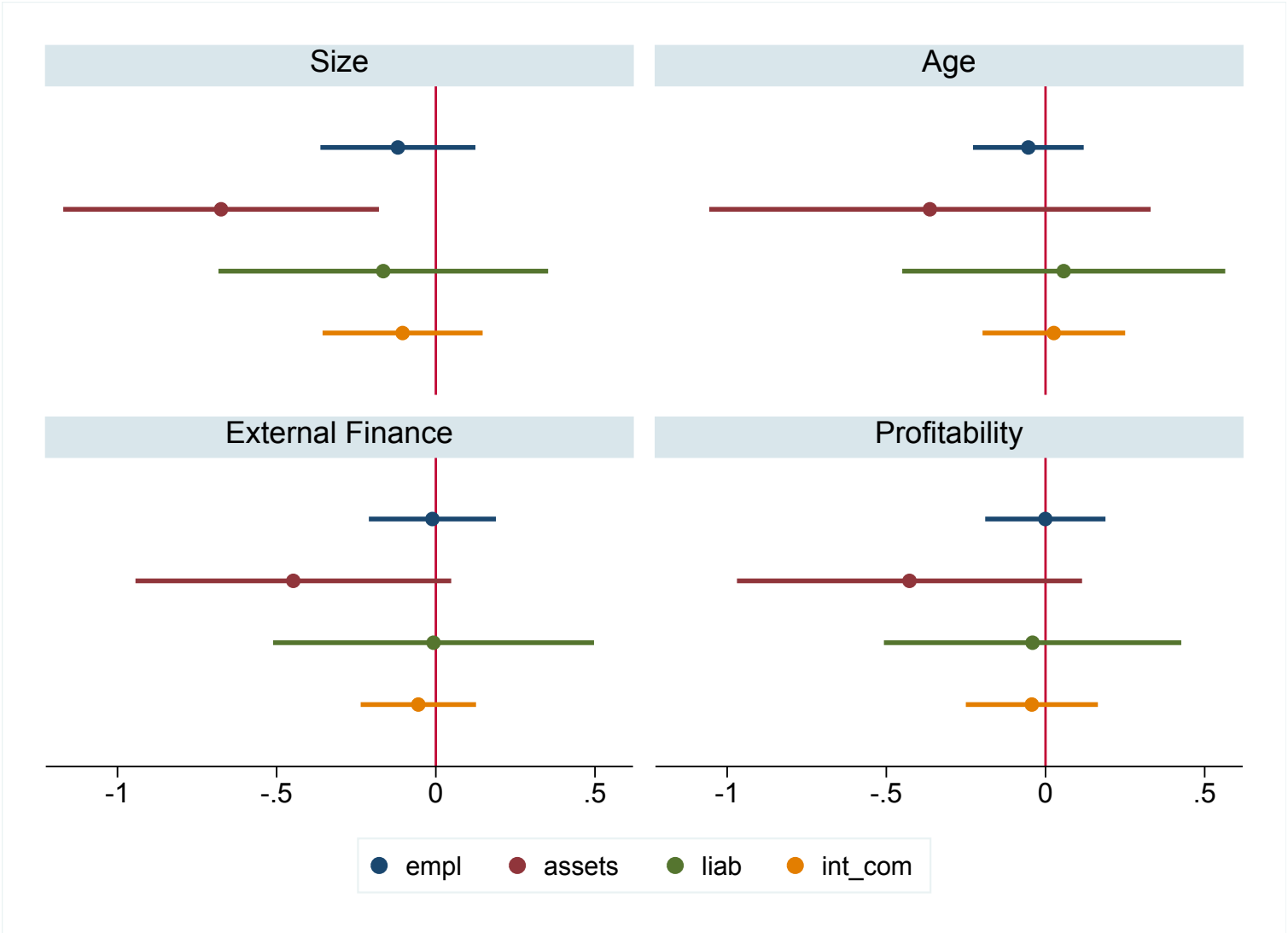
Spillover: Effects Over Time: Leverage



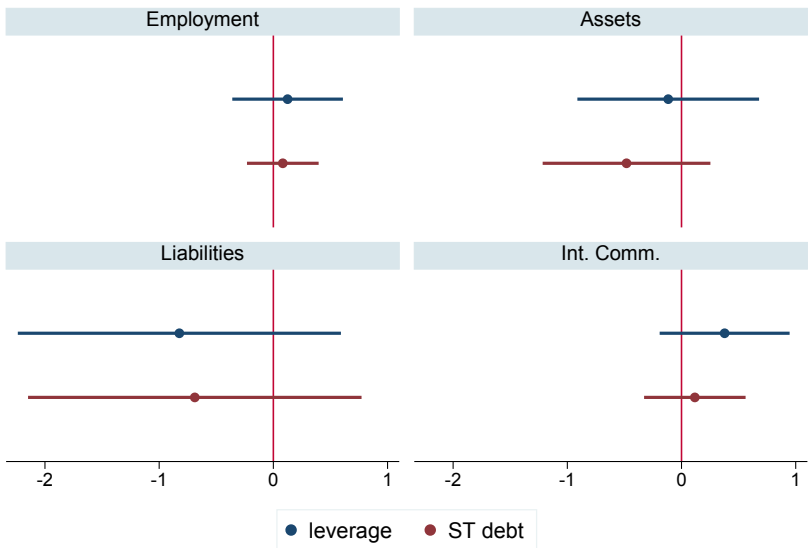
Spillover: Effects Over Time: ST Debt



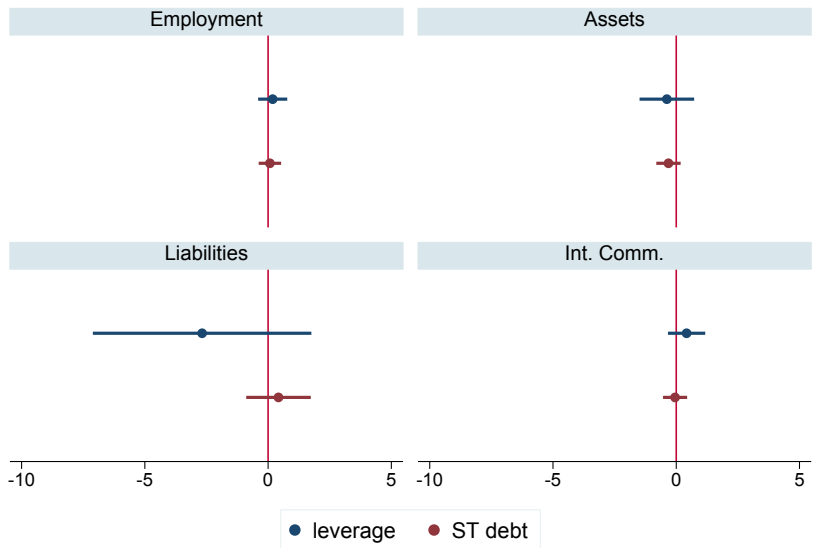
Other dimensions of heterogeneity



Placebo regresions

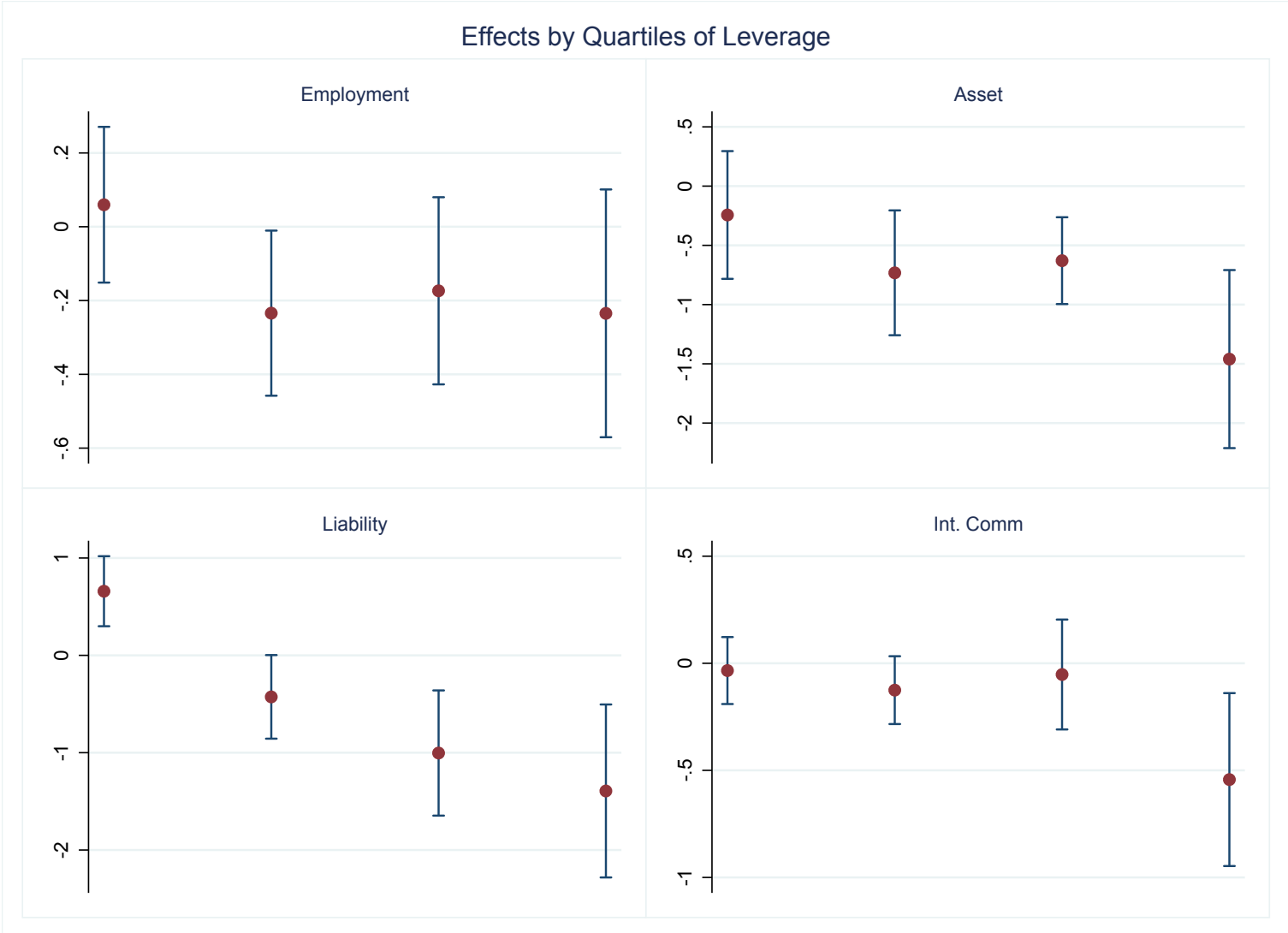


Note: Changes between 2007-2008

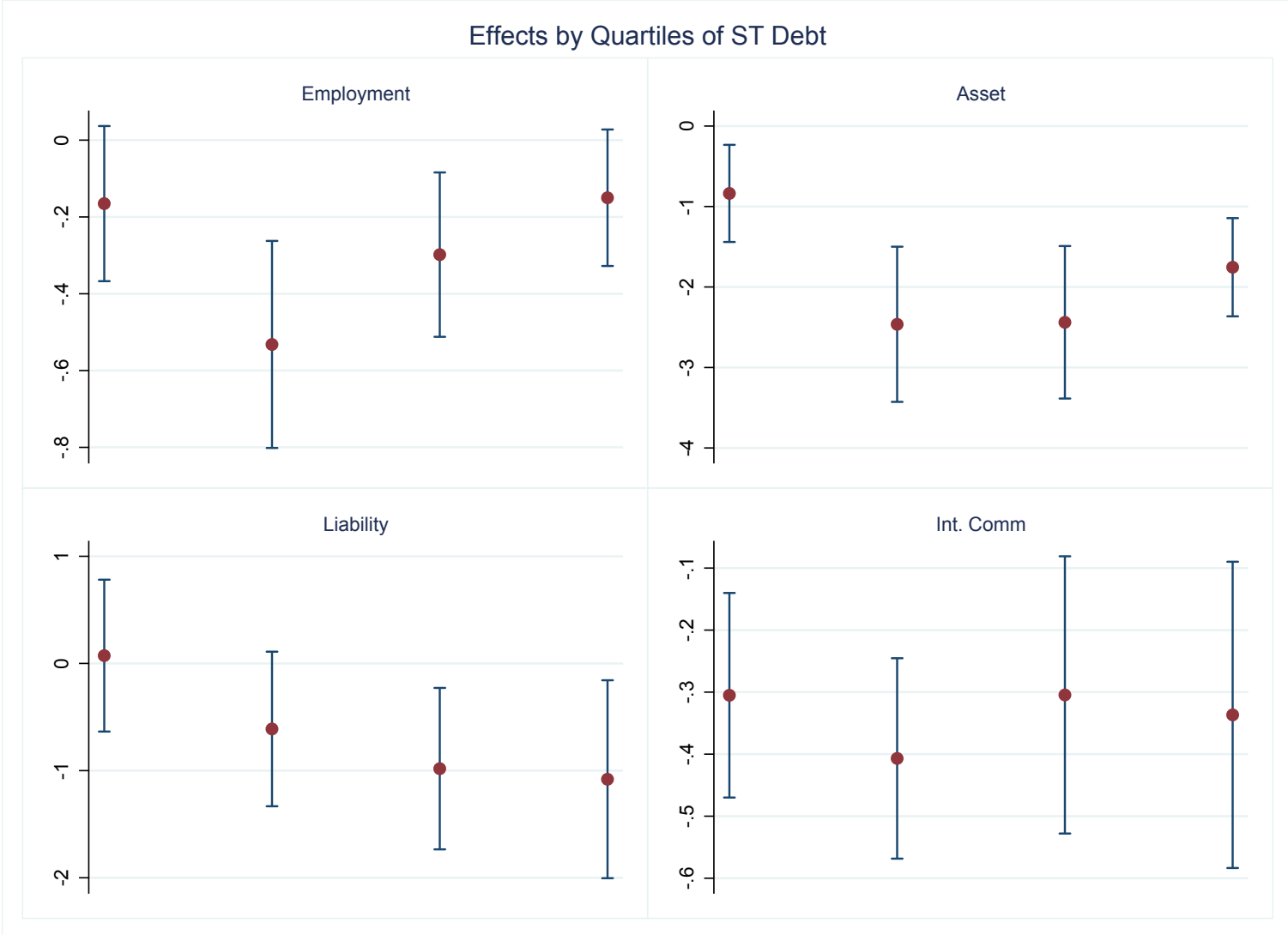


Note: Changes between 2008-2009

Effects by quartiles: Leverage



Effects by quartiles: ST Debt



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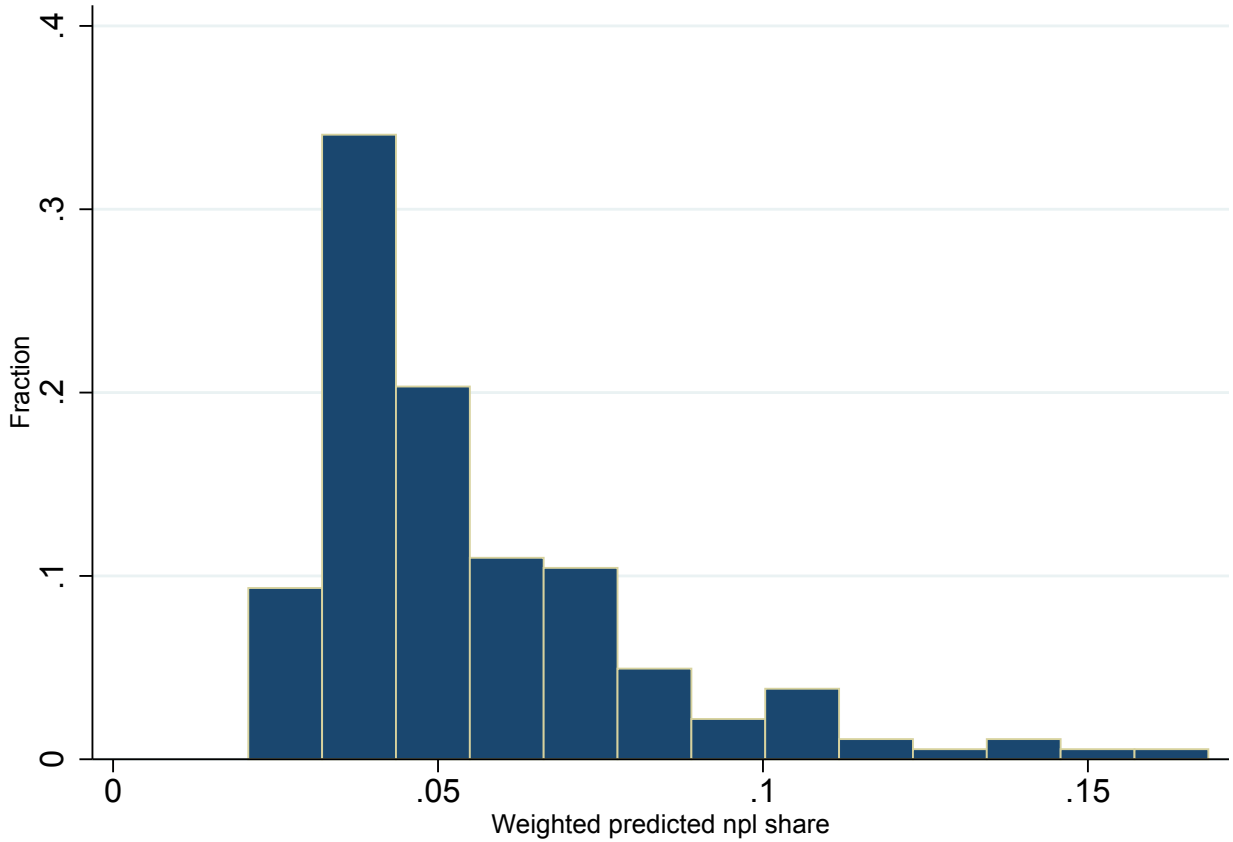
Firm's Weighted NPL Shares



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

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