Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9

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An Old Debate

- Do financial frictions operate through **demand for credit**?
  - Shocks to borrower net worth, NPV of project, collateral value of assets
  - Bernanke and Gertler (1989), Kiyotaki and Moore (1997)
- Or, do financial frictions operate through **supply of credit**?
  - Bank lending channel
  - Kashyap, Stein and Wilcox (1993)

This Paper

- Examine evidence for 2007-9 crisis, pointing to:
  - **Inelastic demand for credit** by firms
  - Sharp contraction in **supply of intermediated credit**
  - Shortfall made up by sharp increase in **demand for direct credit**

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  - Focus on behavior of banks
  - Checklist of stylized facts

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  - Focus on behavior of banks
  - Checklist of stylized facts

- Model of direct and intermediated credit from checklist

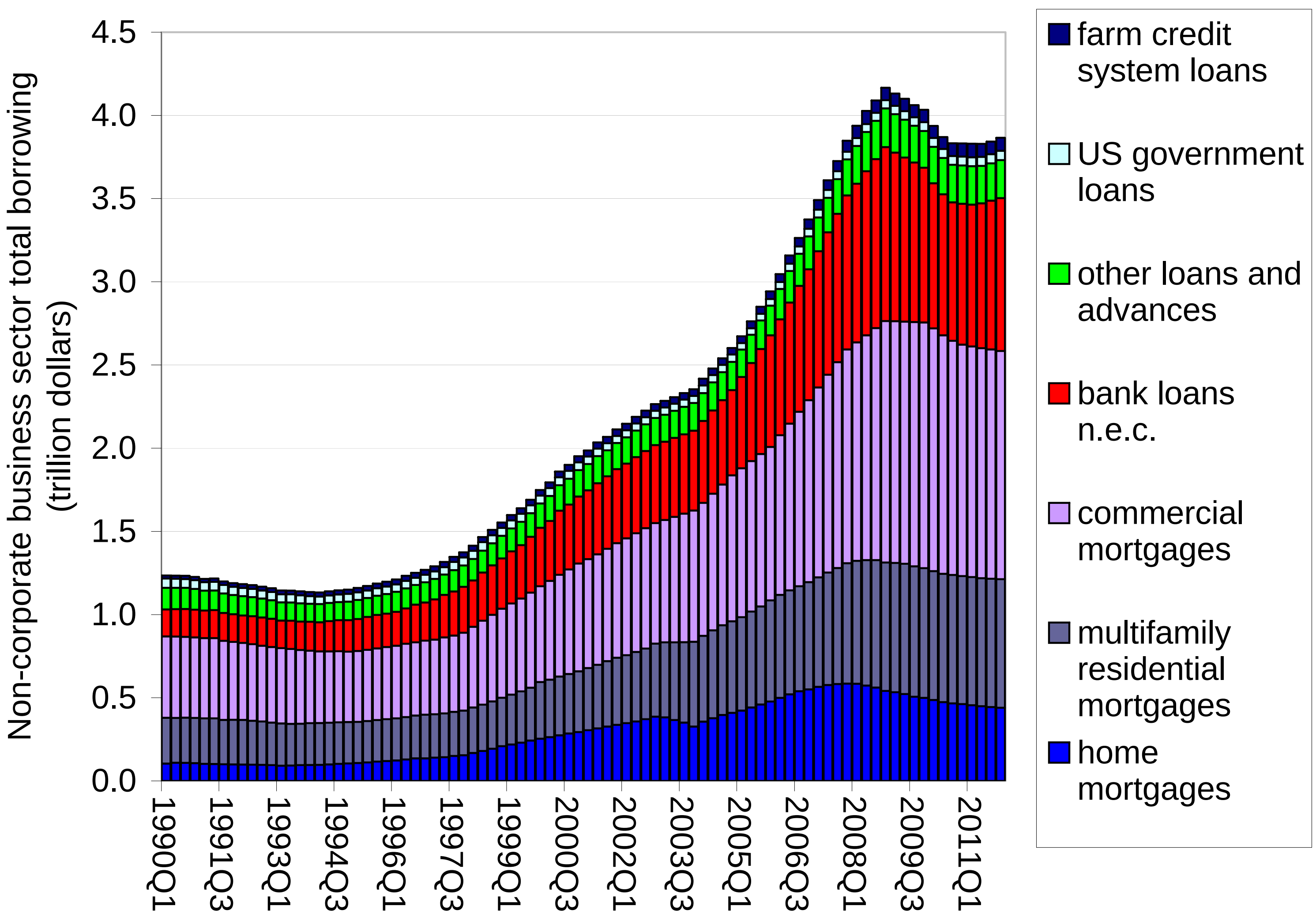


Figure 1. Credit to non-financial non-corporate businesses (Source: US Flow of Funds, tables L103, L104)

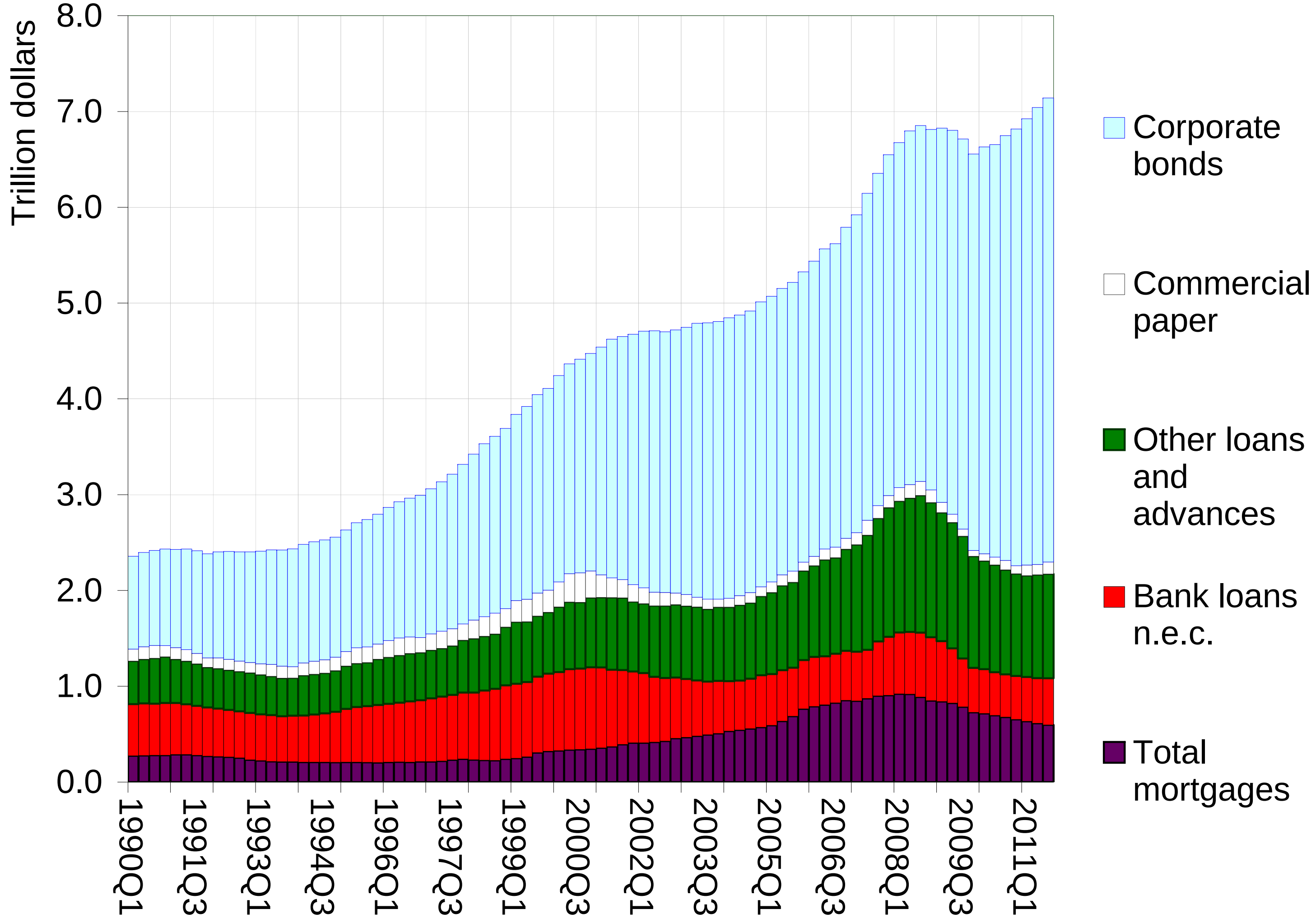


Figure 2. Credit to US non-financial corporate sector (US Flow of Funds, table L102)

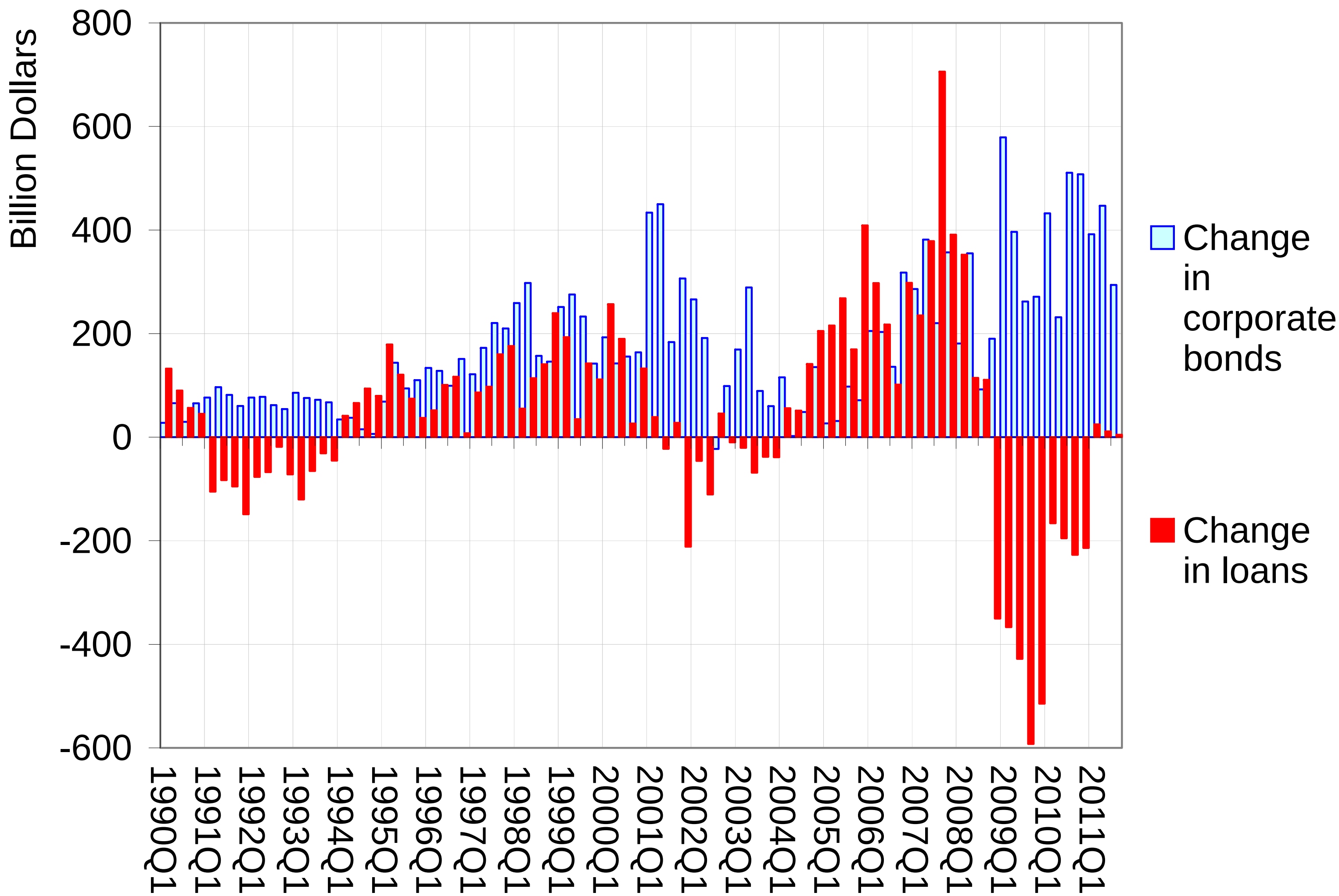
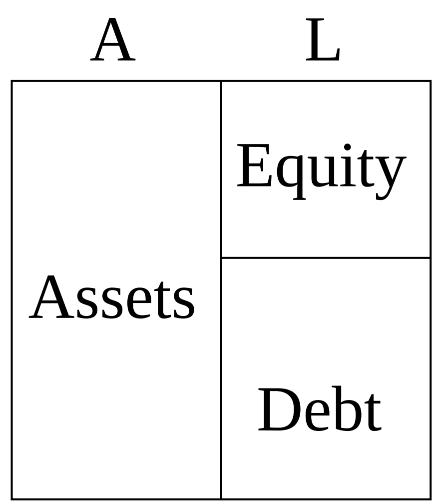
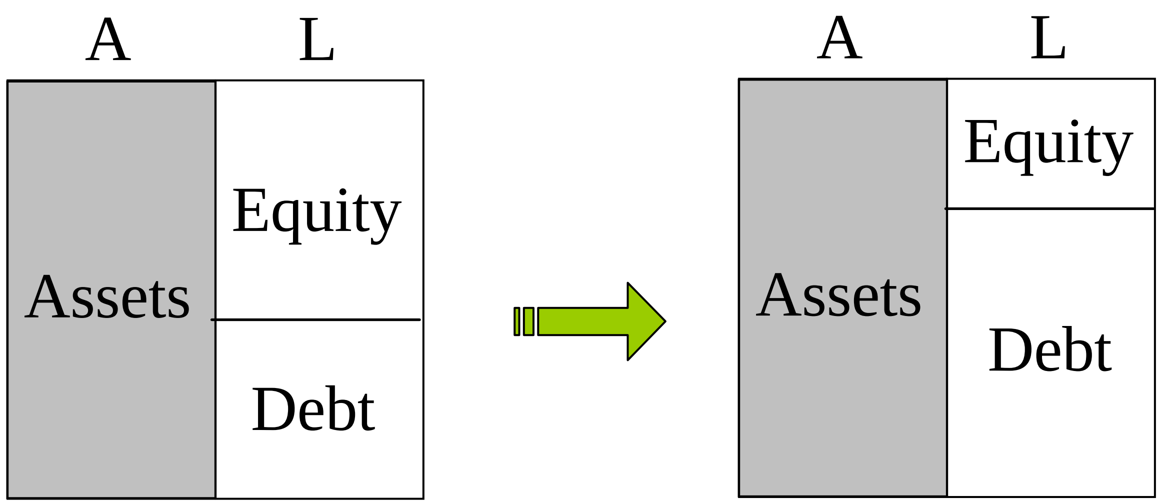


Figure 3. Changes in outstanding corporate bonds and loans to US non-financial corporate sector. Loans are defined as sum of mortgages, bank loans not elsewhere classified (n.e.c.) and other loans (US Flow of Funds, table F102)

Corporate Finance of Banking

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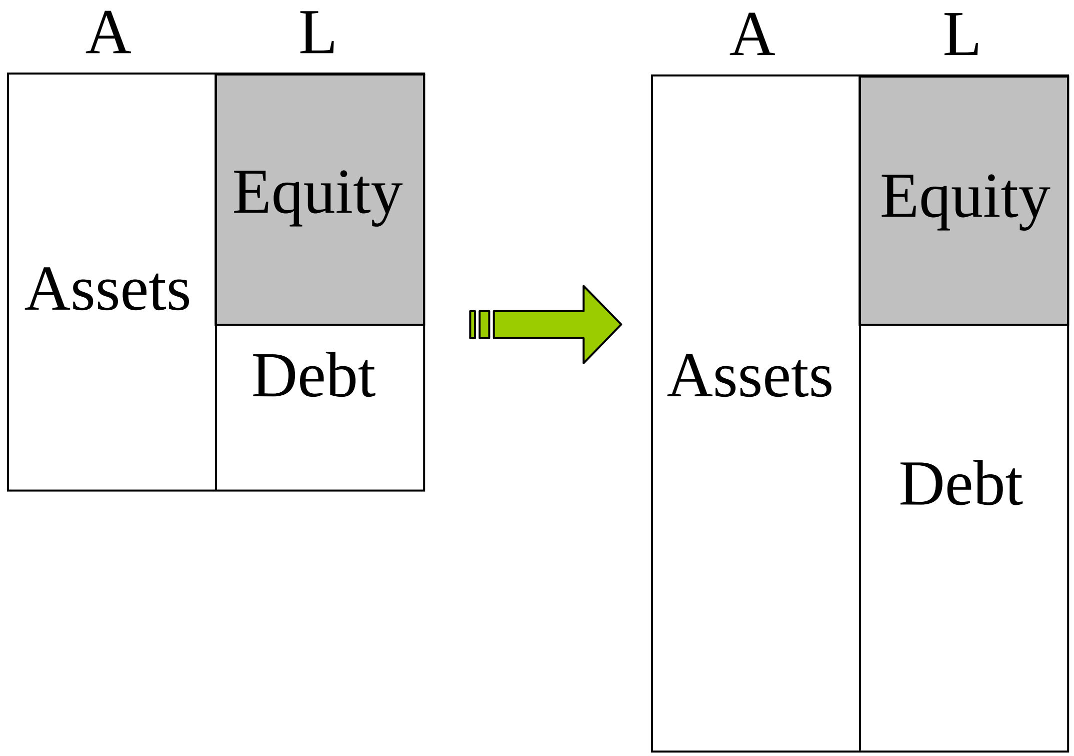
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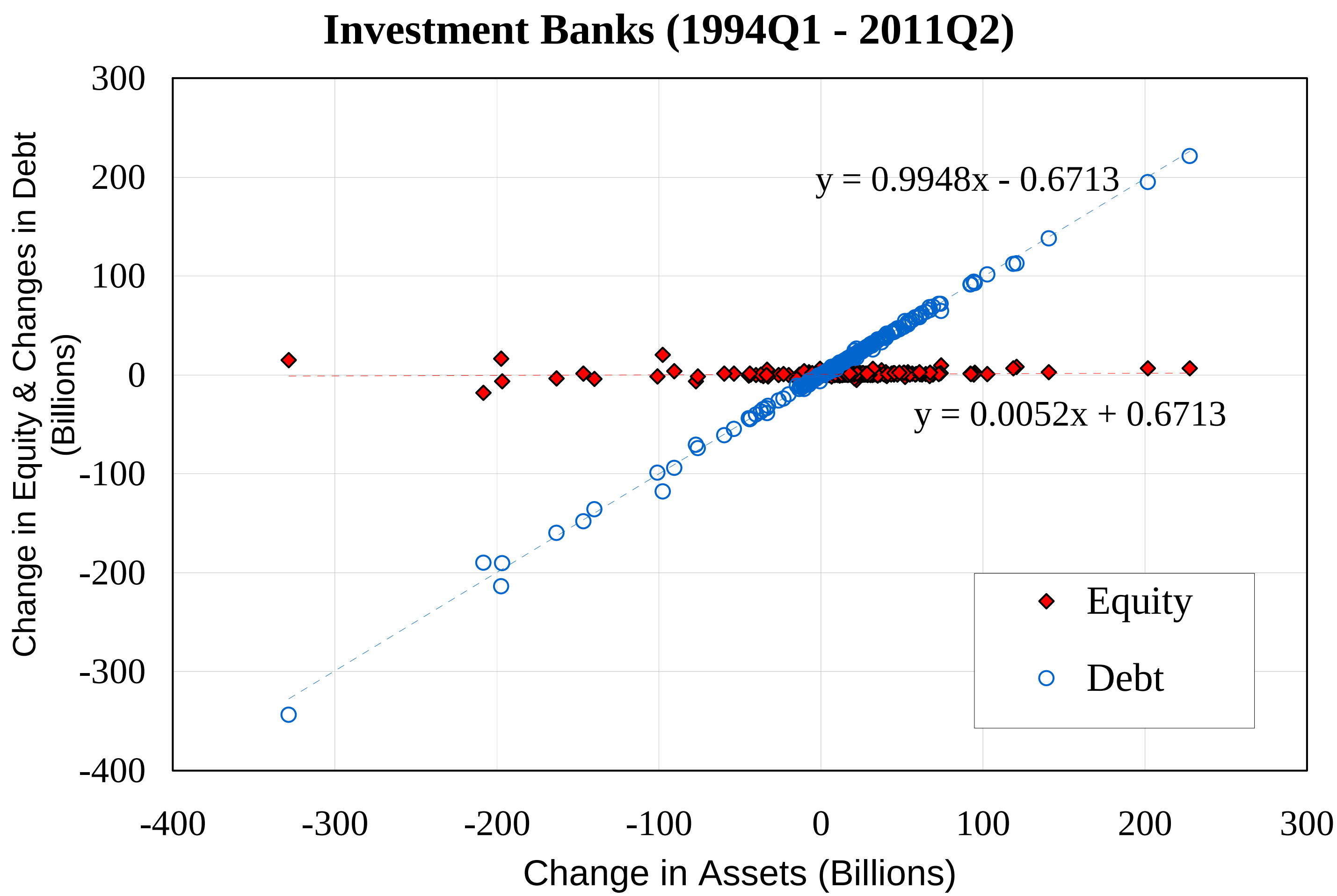


Figure 4. Scatter chart of $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ for changes in assets, equity and debt of US investment bank sector consisting of Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley between 1994Q1 and 2011Q2 (Source: SEC 10Q filings)

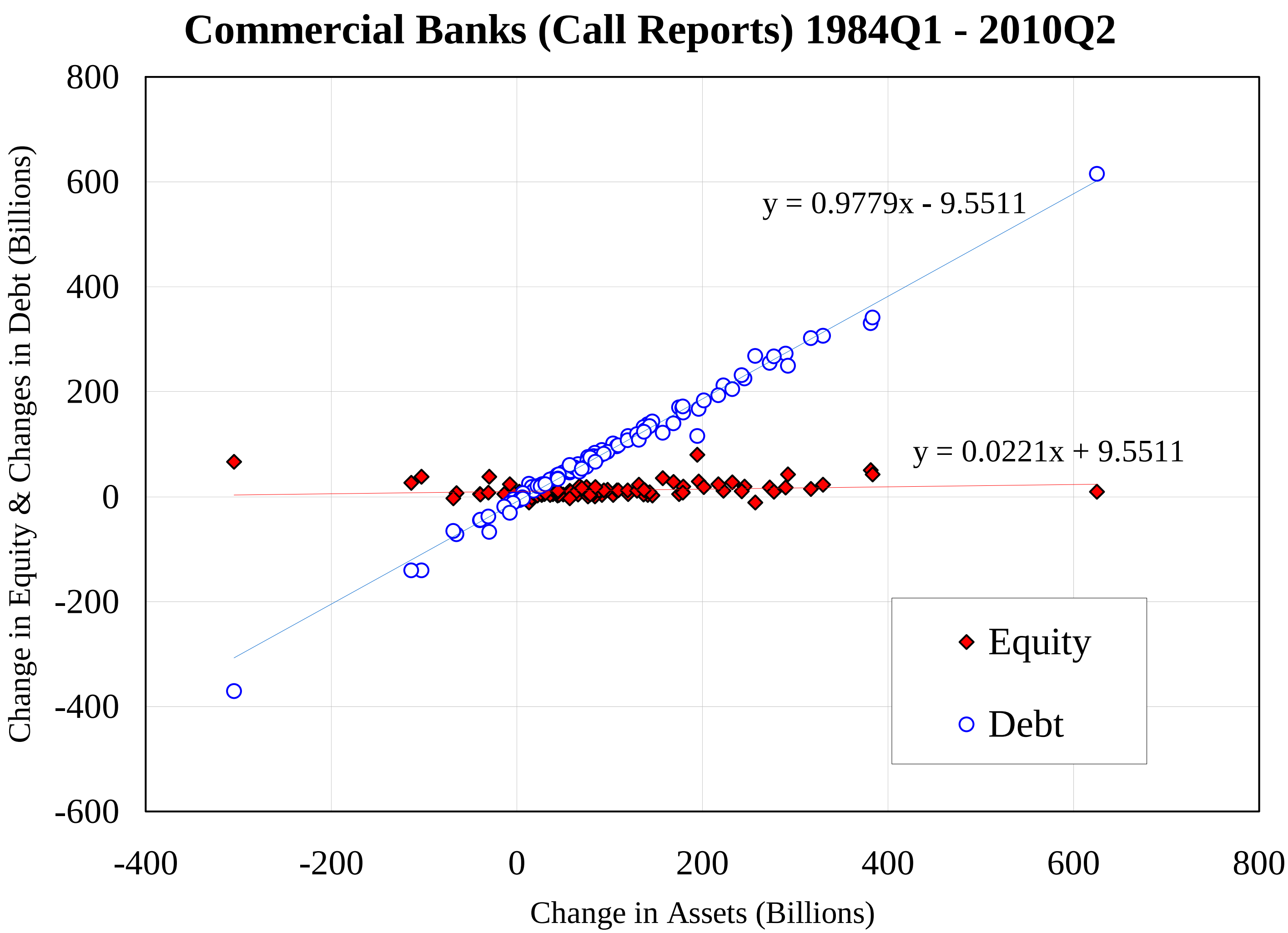


Figure 5. Scatter chart of $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ for changes in assets, equity and debt of US commercial bank sector between 1984Q1 and 2010Q2 (Source: FDIC call reports).

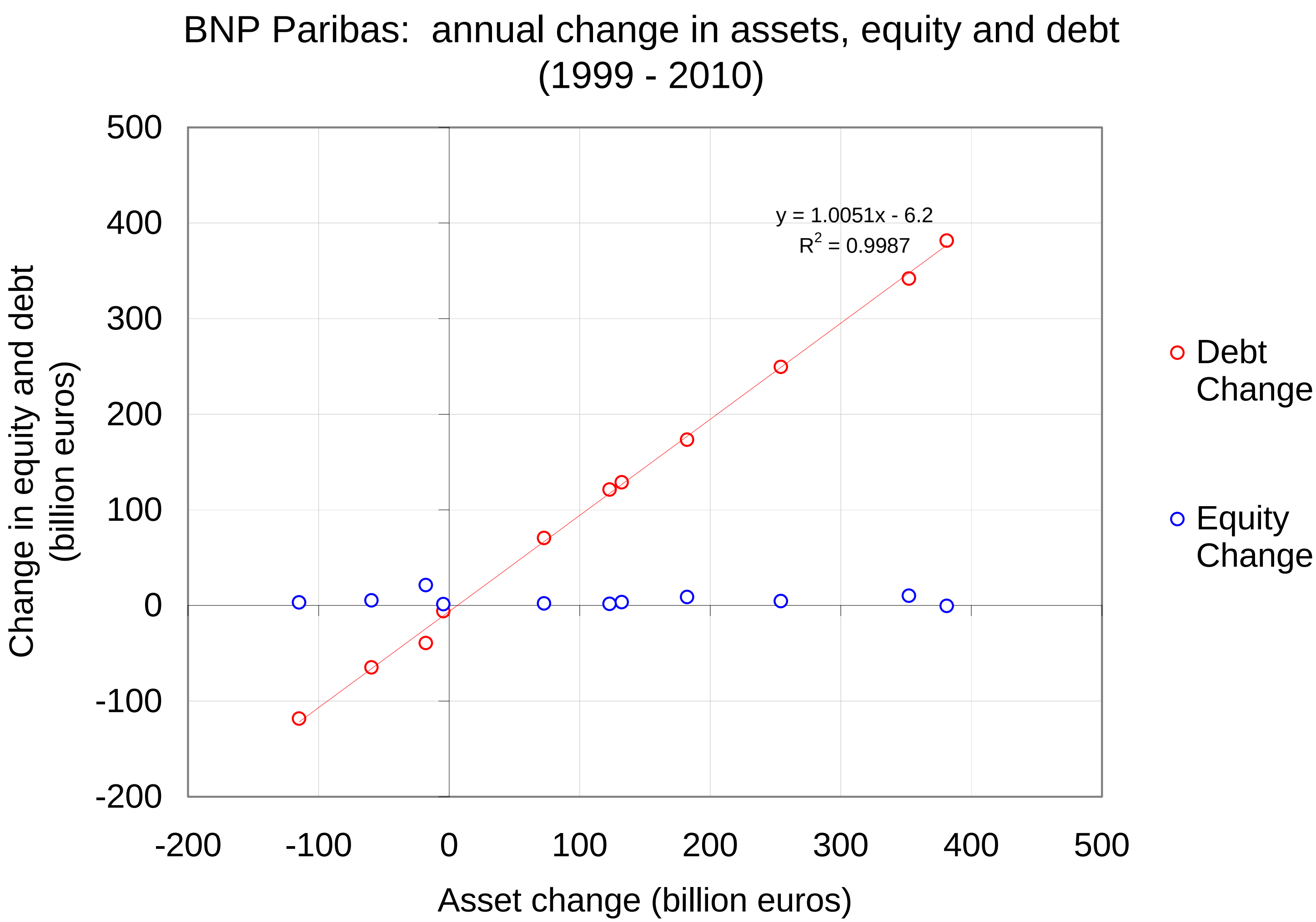


Figure 6. BNP Paribas: annual change in assets, equity and debt (1999-2010) (Source: Bankscope)

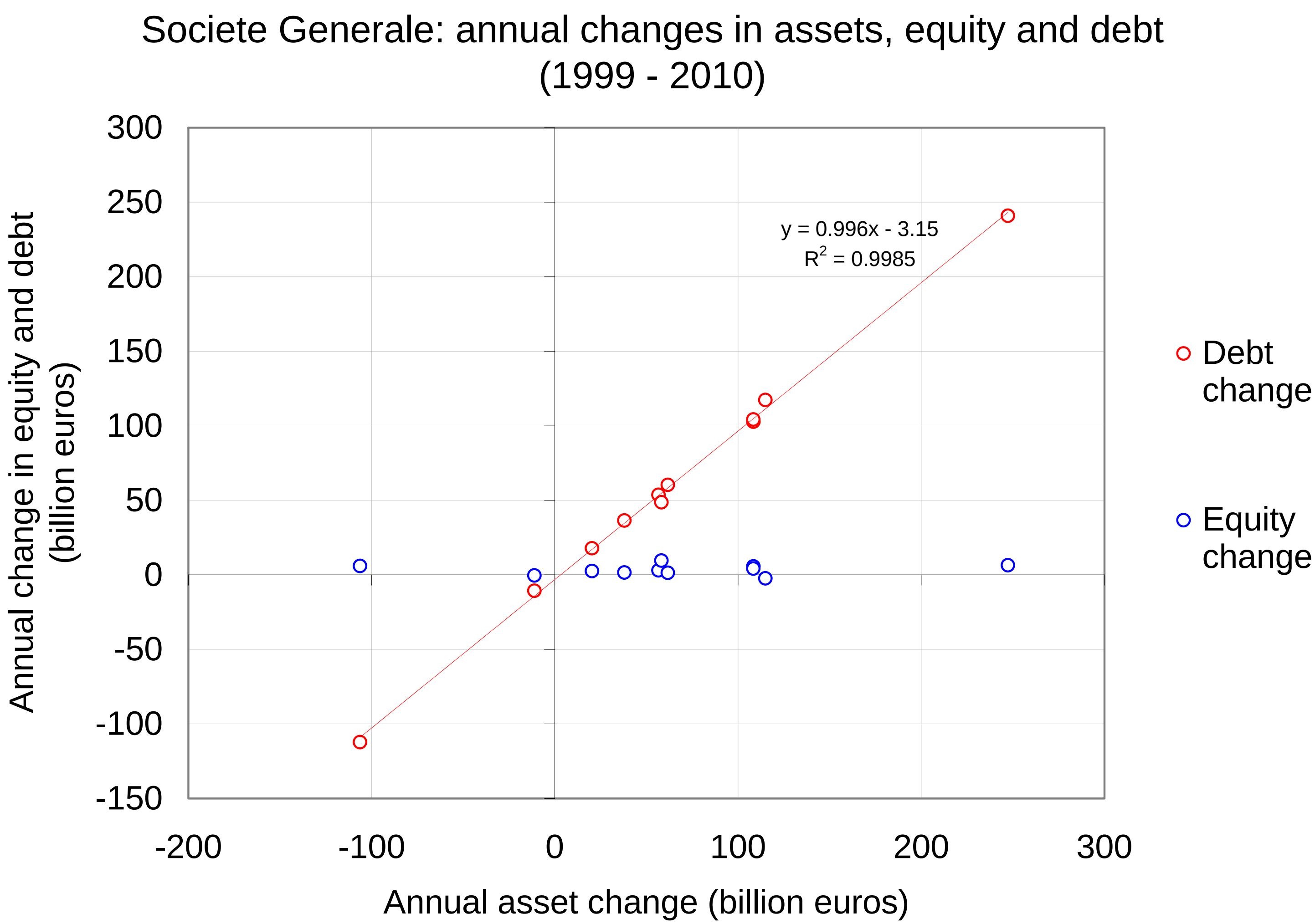


Figure 7. Société Générale: annual change in assets, equity and debt (1999-2010) (Source: Bankscope)

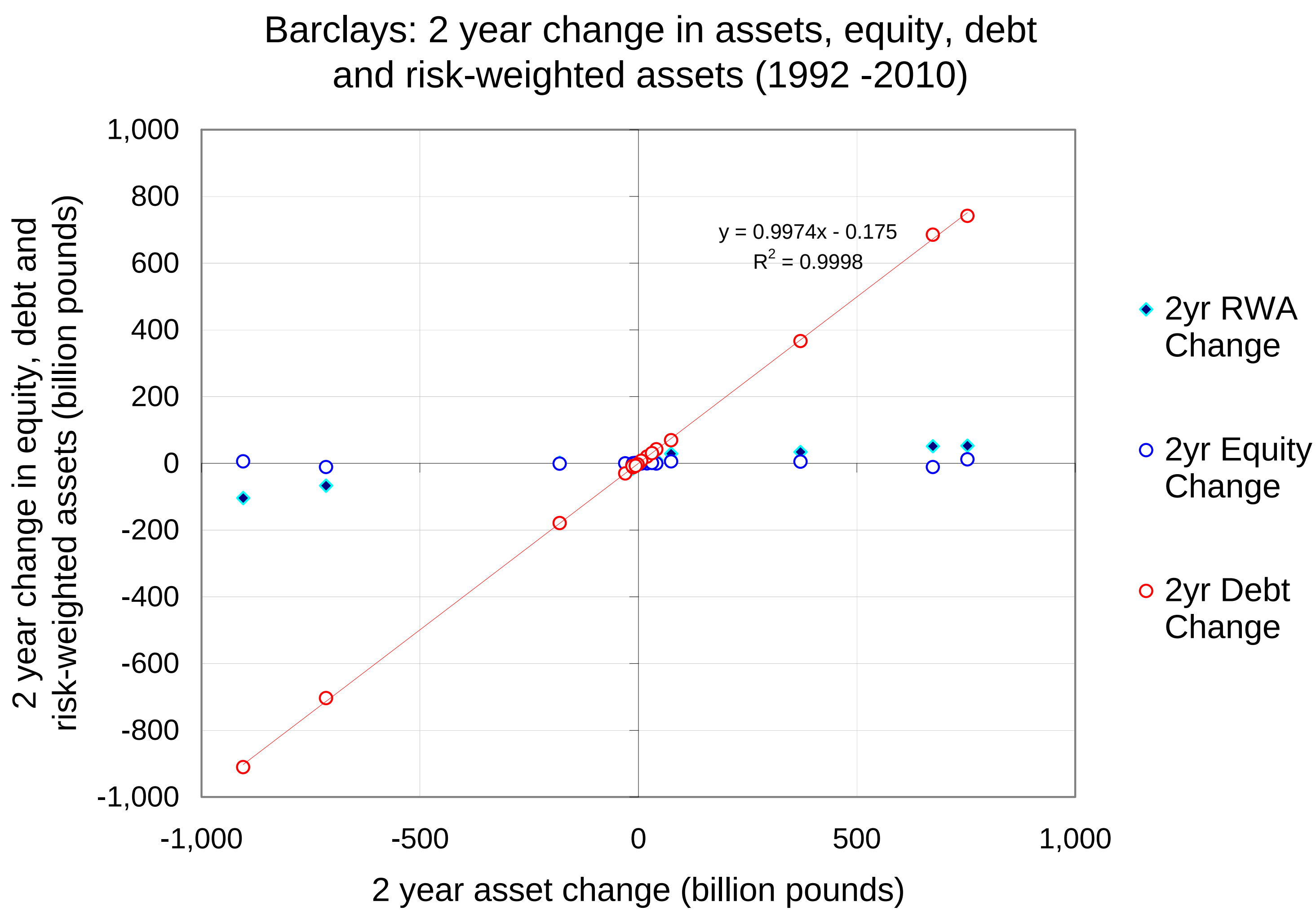


Figure 8. Barclays: 2 year change in assets, equity and debt (1992-2010) (Source: Bankscope)

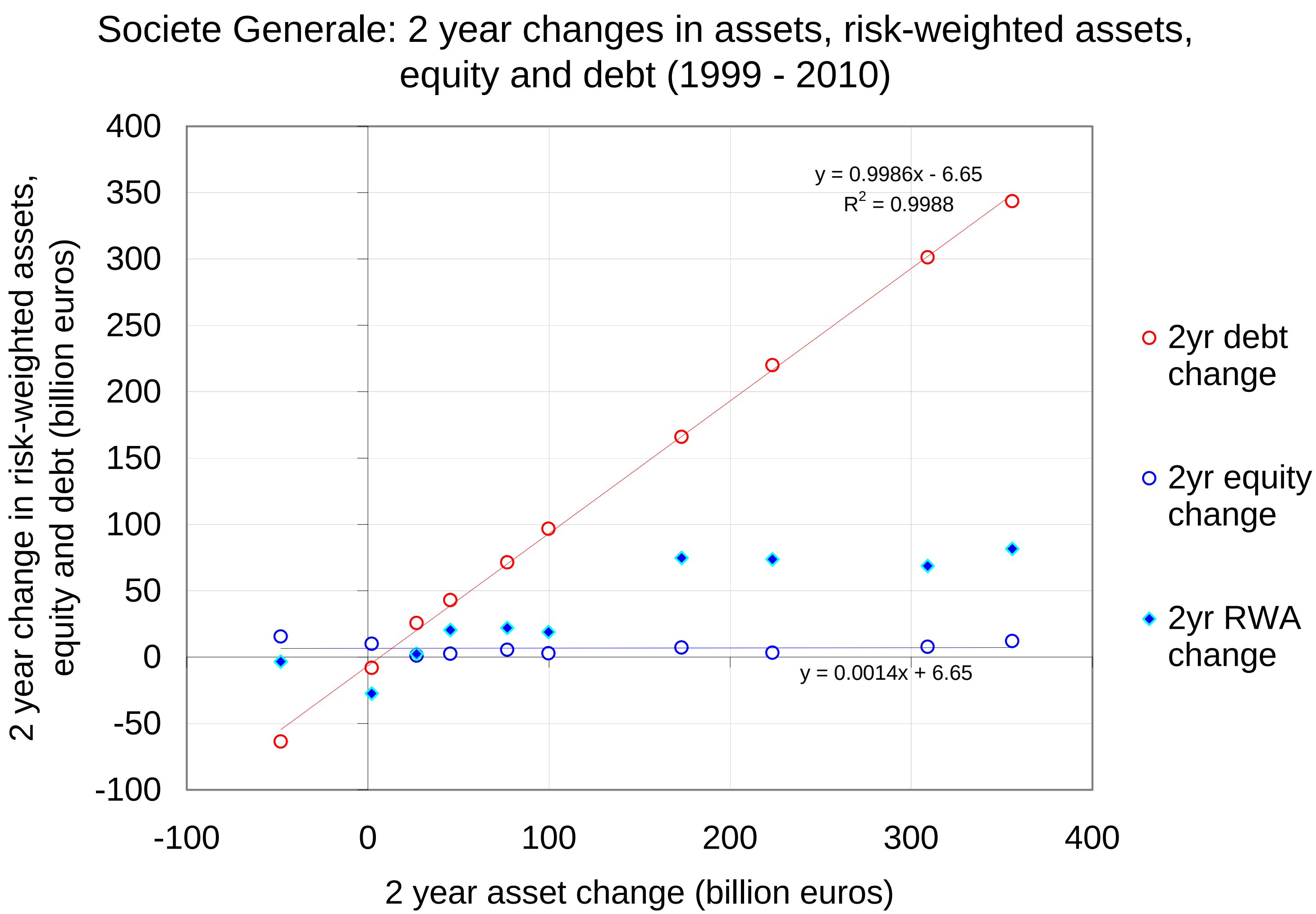


Figure 9. Société Générale: 2 year change in assets, equity and debt (1999-2010) (Source: Bankscope)

Checklist for the Banking Sector

- Bank lending changes dollar-for-dollar through change in **debt**, with equity “sticky”

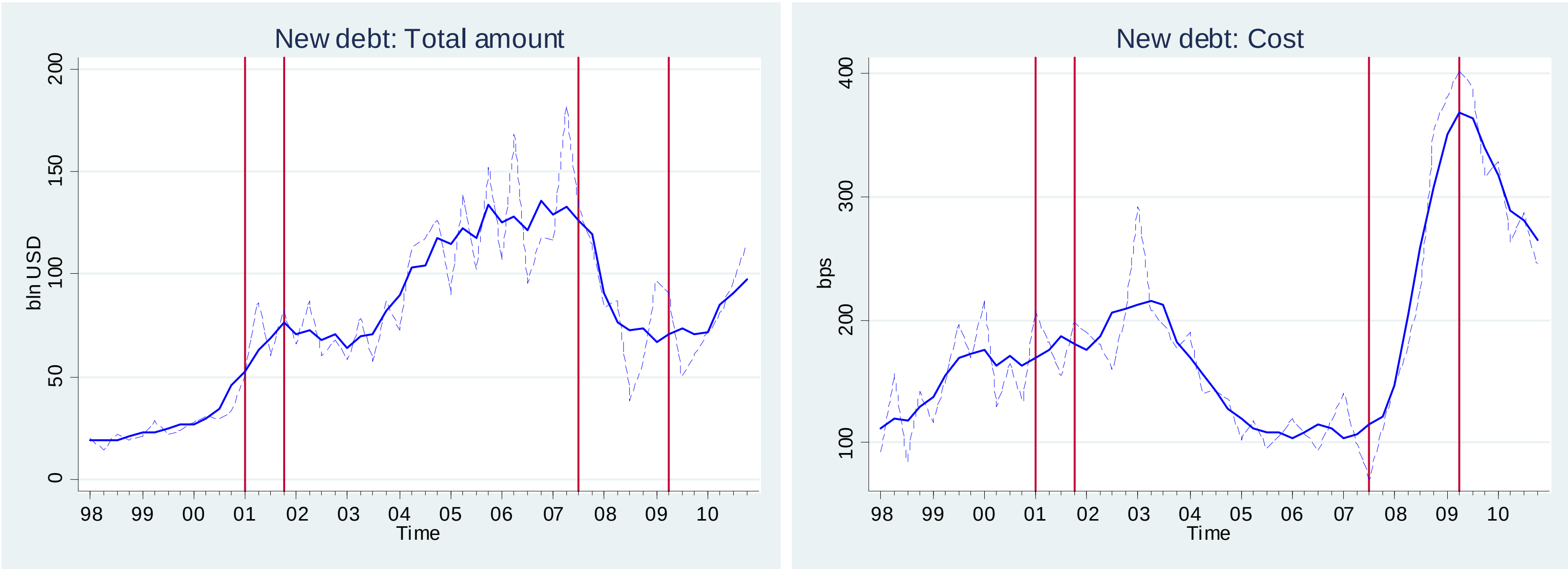
- Equivalently, bank chooses leverage given pre-determined equity

- Implication: banking sector **leverage is procyclical**

Micro Evidence

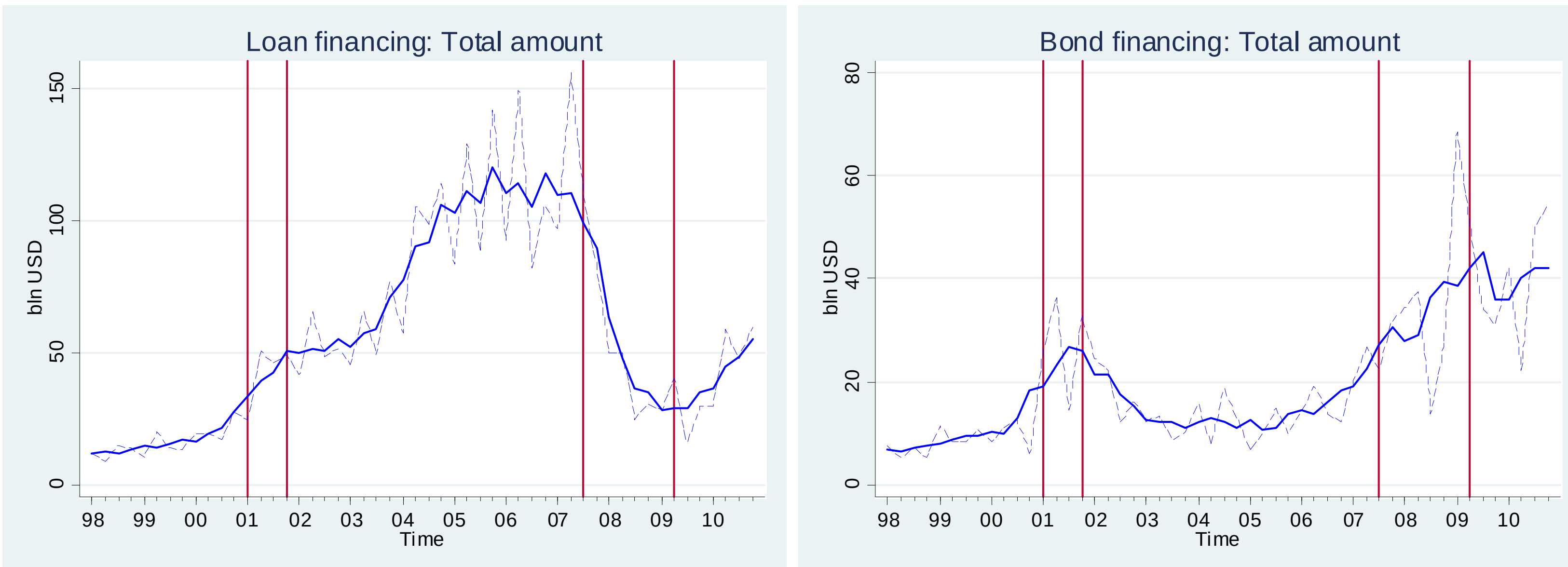
- Sample: U.S. public firms 1998-2010
- Intersection between
  - Compustat
  - Loan Pricing Corporation (LPC) Dealscan database
  - Securities Data Corporation (SDC) New Bond Issuances database
- 3,896 firms with new financing between 1998 and 2010 (out of 11,538 in Compustat sample)

Total Credit



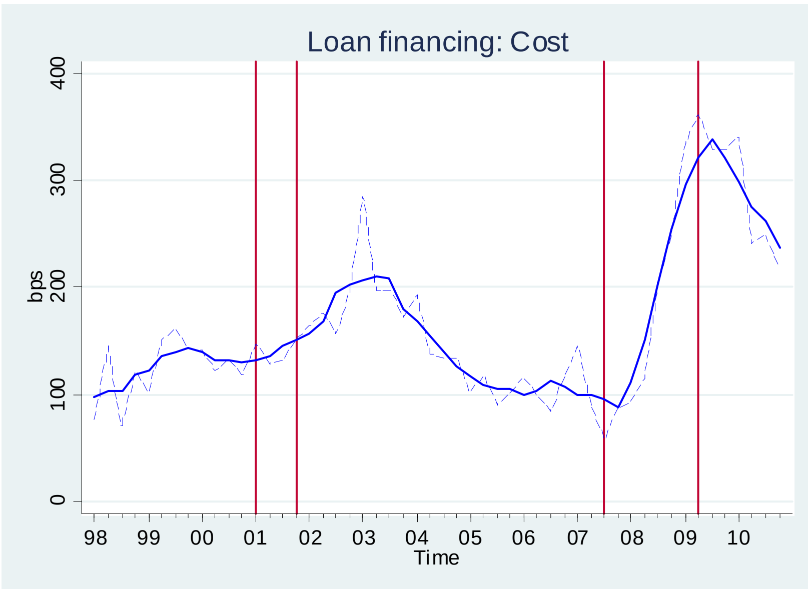
From Q2:2007 to Q2:2009: total amount 1/2, spread 4x

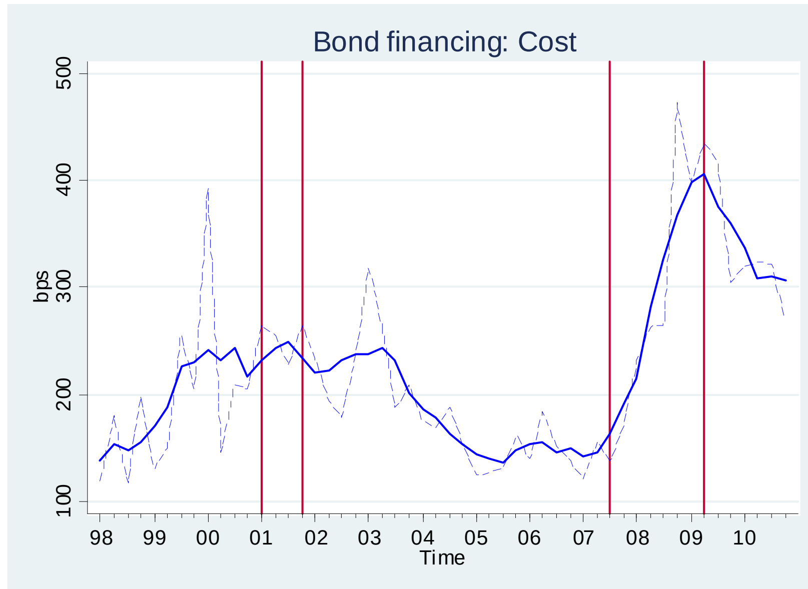
Split between Loans and Bonds



From Q2:2007 to Q2:2009: loans 1/4, bonds 2x

Pricing

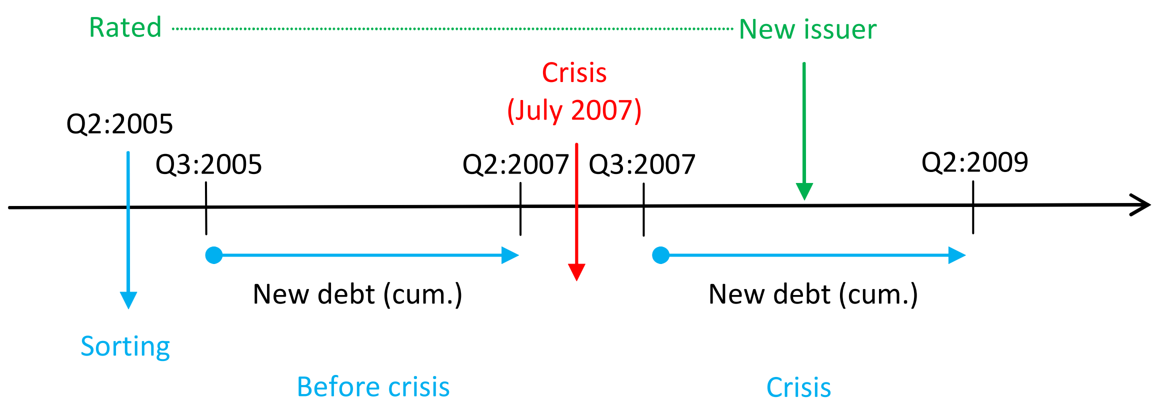




From Q2:2007 to Q2:2009: loans 4x, bonds 3x

Firms with Access to Both Loans and Bonds

Firms with access to both types of credit can be used to identify demand and supply shocks



To qualify: obtained credit during crisis, positive assets before crisis, non-missing firm characteristics

Sorting (rating and firm characteristics) based on Q2:2005

One Dimensional Sorts

Panel A: Amount									
	Total			Loan			Bond		
Relative to median	Before Crisis	Crisis	t-stat	Before Crisis	Crisis	t-stat	Before Crisis	Crisis	t-stat
Size									
Below	0.313	0.383	2.476**	0.280	0.288	0.290	0.033	0.095	5.520***
Above	1.791	1.709	-0.532	1.491	0.770	-6.122***	0.300	0.939	6.255***
Tobin's Q									
Below	1.066	0.989	-0.665	0.914	0.574	-3.475***	0.152	0.415	3.289***
Above	0.981	1.193	1.499	0.789	0.487	-3.153***	0.192	0.706	5.037***
(*more...*)									

Panel B: Cost									
	Total			Loan			Bond		
Relative to median	Before Crisis	After Crisis	t-stat	Before Crisis	After Crisis	t-stat	Before Crisis	After Crisis	t-stat
Size									
Below	129.26	262.11	8.185***	116.87	205.69	6.205***	218.40	449.84	6.222***
Above	73.55	263.02	11.855***	66.18	144.32	6.858***	112.98	376.87	9.394***
Tobin's Q									
Below	106.80	269.23	9.027***	94.88	193.67	7.290***	178.81	479.21	7.847***
Above	84.87	244.24	10.670***	77.10	151.18	5.526***	126.13	347.37	8.203***
Tangibility									
Below	89.87	250.18	10.536***	81.33	170.47	7.265***	122.06	360.01	7.901***
Above	103.32	277.55	10.125***	92.00	190.32	7.086***	166.60	444.00	8.111***
Rating									
Below	132.94	302.43	10.949***	120.87	216.40	7.999***	208.02	528.24	10.055***
Above	42.54	190.99	10.868***	34.40	92.80	6.261***	81.00	280.24	8.784***
(*more...*)									

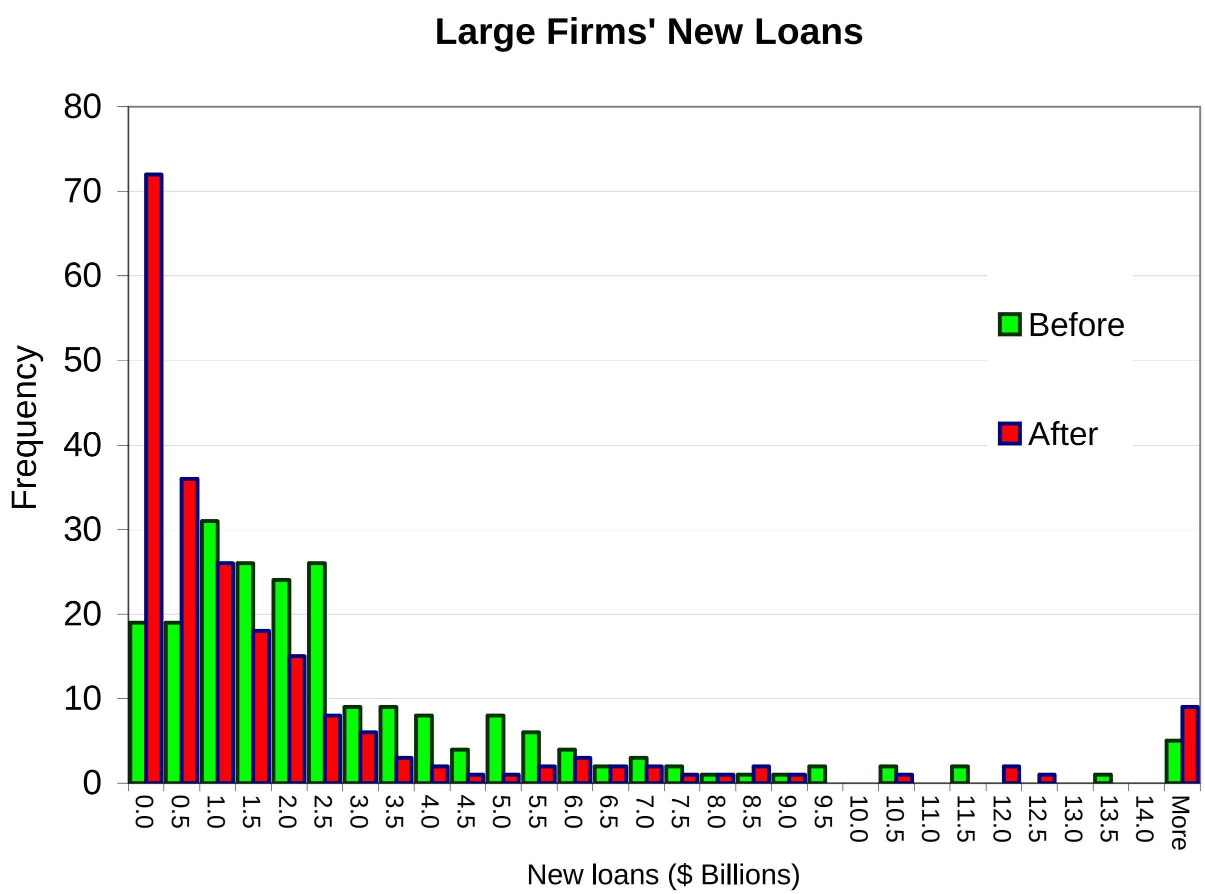


Figure 10. New loans to large firms (upper tercile) before and after the crisis

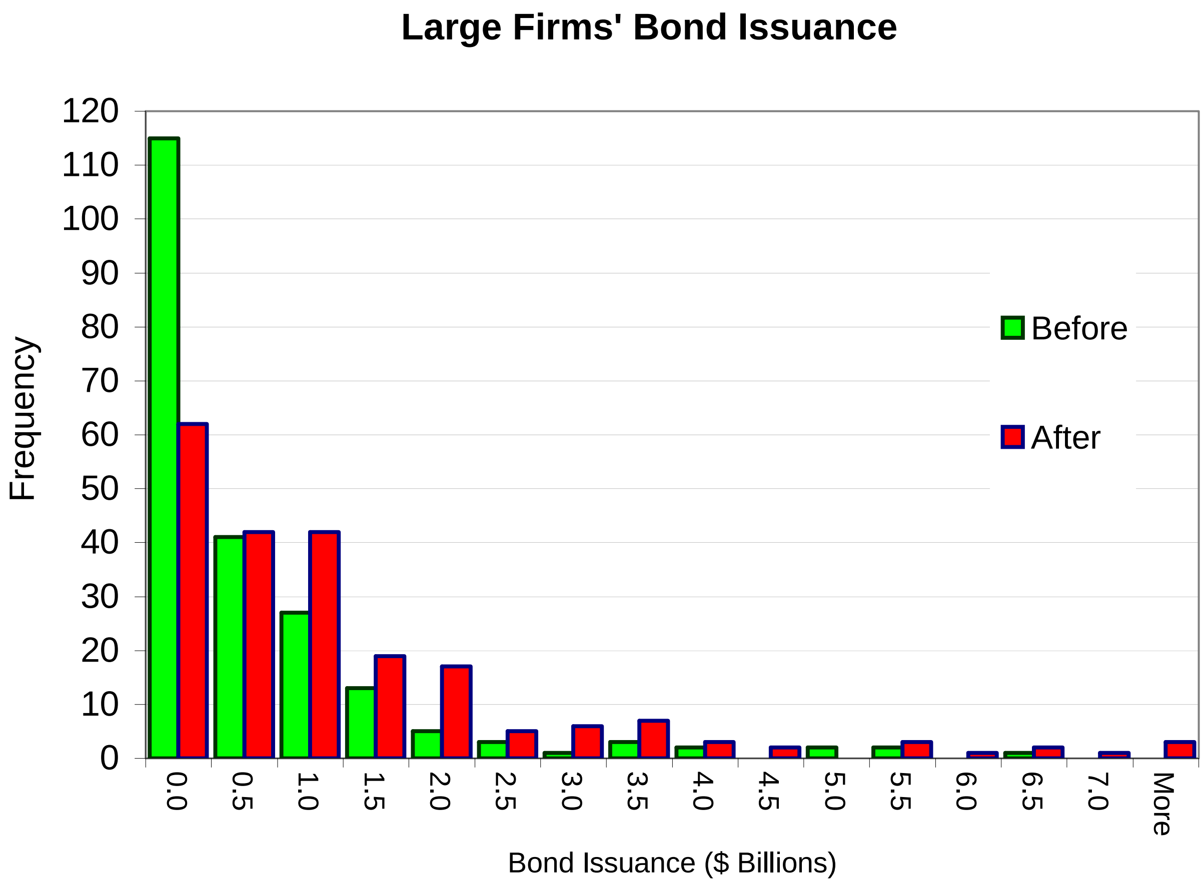


Figure 11. Bond issuance by large firms (upper tercile) before and after the crisis in billions of dollars

One Dimensional Sorts: Main findings

- Flow of new credit: **no change overall** (!)
  - New loans: sharp reduction;
  - New bonds: sharp increase.
- Spreads: sharp increase.

Logit Analysis for Bond Issuance

- Determinants of new loans and bonds in regression framework (Denis and Mihov 2003, and Becker and Ivashina 2011).

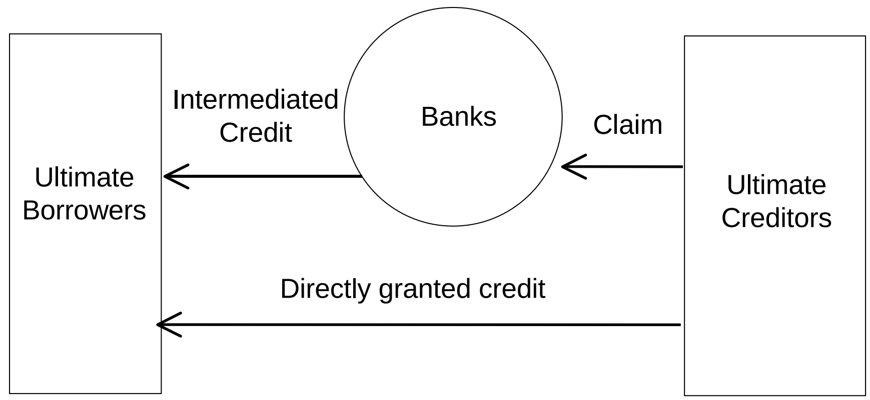
- Details:
  - Sample: new issuers, rated the quarter prior to issuance
  - Dependent variable: $Bond\ Issuance_{i,q} = 1$ if bond issued during quarter q, and $= 0$ if loan (robust to exclusion of simultaneous issuers, 191 obs.)
  - Independent variables: firm characteristics (as before)
  - Specification: logit model

Loan supply proxy	Crisis	Monetary policy	BD leverage	Lending practice	Non-perf. loans	EBP
Panel A: logit regressions (dependent variable: bond issuance)						
Size	0.337***	0.337***	0.366***	0.327***	0.313***	0.354***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.043)	(0.042)
Tobin's Q	0.061	0.033	0.119	0.070	0.174**	0.087
	(0.075)	(0.074)	(0.076)	(0.076)	(0.078)	(0.075)
Tangibility	-0.285	-0.270	-0.236	-0.308	-0.211	-0.244
	(0.203)	(0.207)	(0.206)	(0.205)	(0.213)	(0.211)
Rating	0.052***	0.061***	0.045**	0.059***	0.087***	0.039*
	(0.019)	(0.019)	(0.019)	(0.020)	(0.021)	(0.020)
Profitability	11.286***	11.208***	11.733***	11.192***	10.065***	12.622***
	(2.506)	(2.543)	(2.503)	(2.537)	(2.649)	(2.538)
Leverage	1.007***	1.039***	0.798***	1.027***	0.974***	0.796***
	(0.255)	(0.257)	(0.263)	(0.257)	(0.270)	(0.259)
Loan supply proxy	0.621***	0.232***	-0.009***	0.015***	0.404***	0.591***
	(0.087)	(0.031)	(0.001)	(0.001)	(0.023)	(0.046)
Observations	4,276	4,276	4,276	4,276	4,276	4,153
Pseudo R-squared	0.075	0.077	0.079	0.085	0.128	0.095
Panel B: changes in implied probabilities						
Loan supply proxy	0.140	0.158	-0.179	0.257	0.422	0.238

Model Checklist

1. Direct and intermediated credit
2. In downturn, new loans contract but bond issuance increases
3. Spreads increase on both loans and bonds
4. Bank lending increases or decreases dollar for dollar with an increase or decrease in debt, with equity being sticky
5. Bank leverage is procyclical

Model of Direct and Intermediated Finance

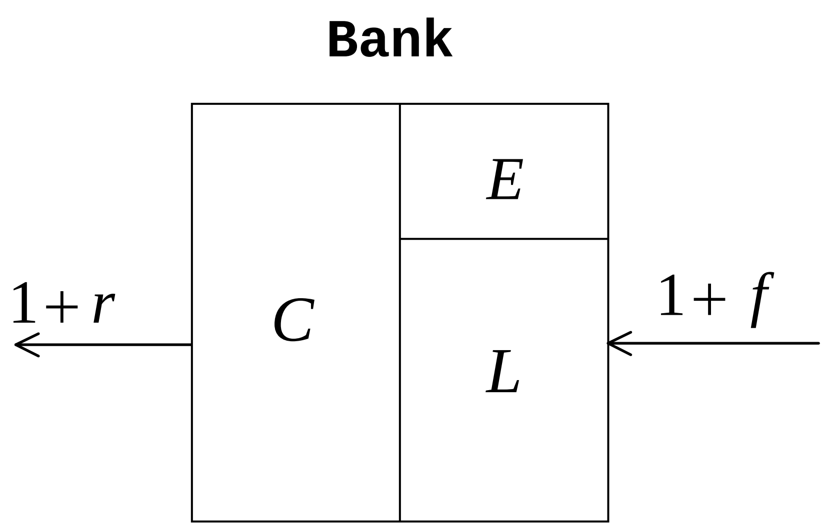


- Banking sector

- Mean-variance investors who hold portfolio of (i) cash (ii) bank liabilities (iii) risky loans

Bank Credit Supply

Notation for balance sheet of bank



Credit Risk

Vasicek (2002) model, backbone of Basel capital requirements.

Project j succeeds when $Z_j > 0$, where

$$Z_j = -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y + \sqrt{1-\rho}X_j$$

$\Phi(.)$ c.d.f. of standard normal, Y and $\{X_j\}$ independent standard normals

$$\begin{aligned} \Pr(Z_j < 0) &= \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j < \Phi^{-1}(\varepsilon)\right) \\ &= \Phi\left(\Phi^{-1}(\varepsilon)\right) = \varepsilon \end{aligned}$$

Bank diversifies away idiosyncractic risk

Conditional on Y, defaults are independent.

Keep C fixed but diversify: increase number of borrowers, reduce face value of individual loans

In the limit, realized value of assets is function of Y only

$$\begin{aligned} w(Y) &\equiv (1+r)\,C \cdot \Pr\left(Z_j \geq 0 | Y\right) \\ &= (1+r)\,C \cdot \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)\,|Y\right) \\ &= (1+r)\,C \cdot \Phi\left(\frac{Y\sqrt{\rho}-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \qquad (*) \end{aligned}$$

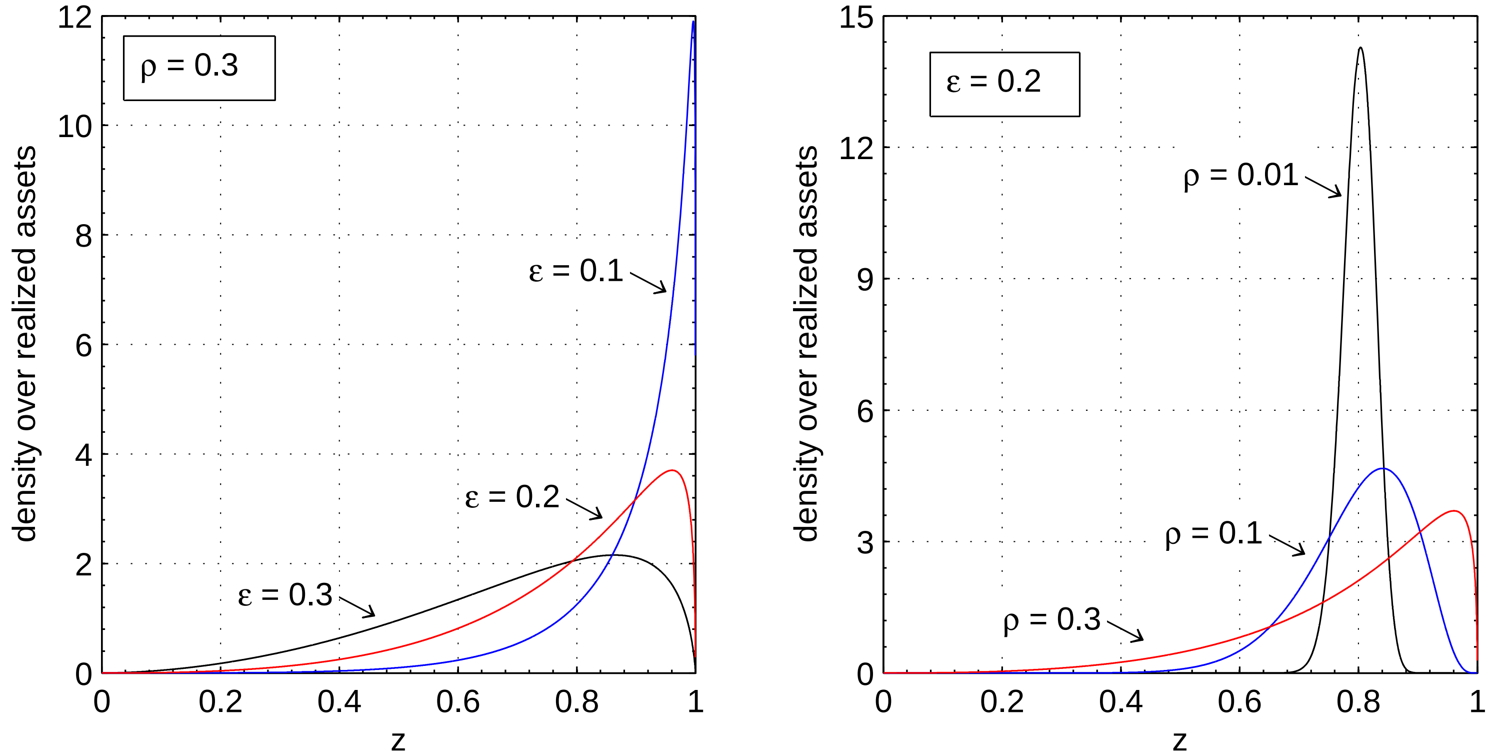


Figure 12. The two charts plot the densities over realized assets when $C(1+r) = 1$. The left hand charts plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies from 0.01 to 0.3.

Turning Credit Risk Model on Its Head

- Turn credit risk model on its head and think of it as credit supply model
  - Fix E. Determine credit supply C_S

$$C_S = \frac{E}{1 - \frac{1+r}{1+f}\varphi\left(\rho, \alpha, \varepsilon\right)}, \qquad \varphi \in (0,1)$$

φ is ratio of **notional liabilities** to **notional assets** to be derived below.

From (*), the c.d.f. of w is

$$\begin{aligned} F(z) &= \Pr(w \leq z) \\ &= \Pr\left(Y \leq w^{-1}(z)\right) \\ &= \Phi\left(w^{-1}(z)\right) \\ &= \Phi\left(\frac{1}{\sqrt{\rho}}\left(\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\,\Phi^{-1}\left(\frac{z}{(1+r)\,C}\right)\right)\right) \end{aligned}$$

Common risk factor ρ determines shape of the density, with larger ρ implying fatter tail.

Value-at-Risk (VaR) rule: keep enough equity to limit insolvency probability to $\alpha > 0$

Bank credit supply C determined from

$$\Pr\left(w<\left(1+f\right)L\right)=\Phi\left(\frac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\,\Phi^{-1}\left(\frac{(1+f)L}{(1+r)C}\right)}{\sqrt{\rho}}\right)=\alpha$$

$$\frac{\text{Notional liabilities}}{\text{Notional assets}}=\frac{\left(1+f\right)L}{\left(1+r\right)C}=\Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}\left(\alpha\right)-\Phi^{-1}\left(\varepsilon\right)}{\sqrt{1-\rho}}\right) \qquad (1)$$

where

$$\varphi\left(\alpha,\varepsilon,\rho\right)\equiv\Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}(\alpha)-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right)$$

Supply of Credit by Bank

Credit supply C and demand for funding L is obtained from (1) and balance sheet identity $C = E + L$

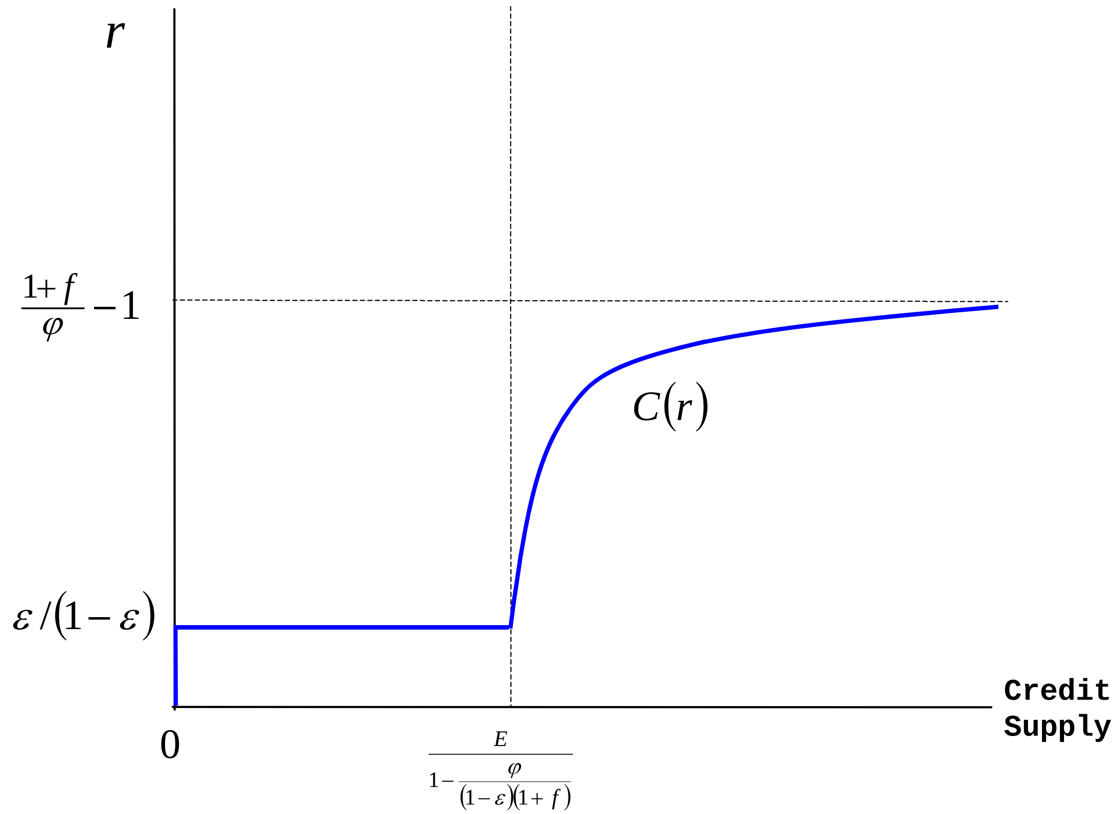
$$C = \frac{E}{1 - \frac{1+r}{1+f} \cdot \varphi}, \qquad L = \frac{E}{\frac{1+f}{1+r} \cdot \frac{1}{\varphi} - 1}$$

Aggregation holds due to proportionality

$$\text{Leverage } = \frac{1}{1 - \frac{1+r}{1+f} \cdot \varphi}$$

Risk premium is well-defined

$$\text{Risk premium } = (1 - \varepsilon)(1 + r) - 1$$



Supply of credit

Mean-Variance Investors

Loans are packaged into bonds that diversify away idiosyncratic risk.

Demand for bonds (supply of credit) by mean-variance investor with risk tolerance τ

$$\frac{\tau\left[\left(1-\varepsilon\right)\left(1+r\right)-1\right]}{\sigma^2\left(1+r\right)^2}$$

where σ^2 is variance of $w\left(Y\right)$. There are N mean-variance investors, and $T=\tau N$. Aggregate supply of credit from mean-variance sector is

$$C_H=\frac{T\left[\left(1-\varepsilon\right)\left(1+r\right)-1\right]}{\sigma^2\left(1+r\right)^2}$$

We need to work out σ^2.

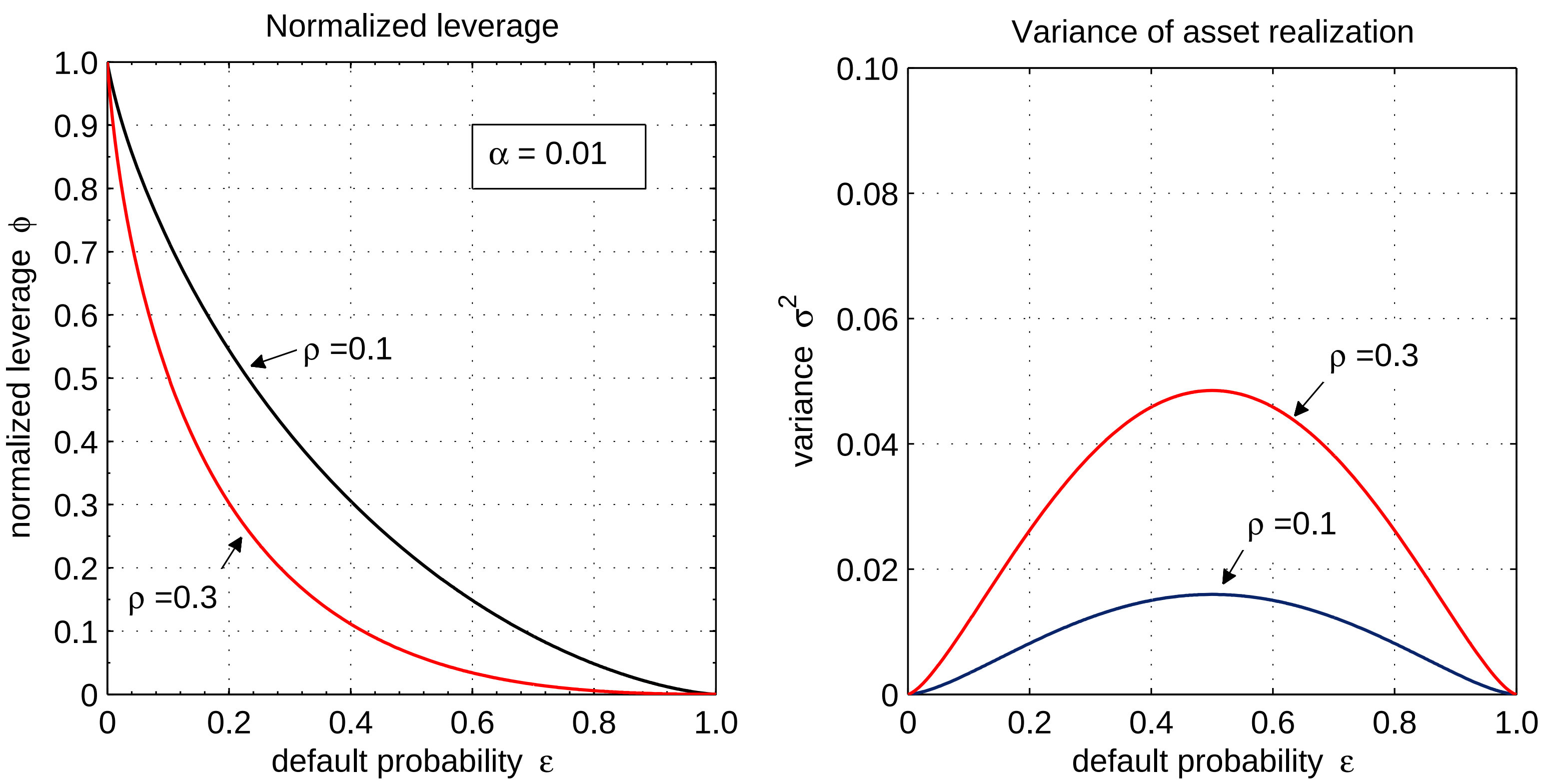


Figure 13. Left hand panel plots the normalized leverage ratio φ as a function of ε. The right hand panel plots the variance σ^2 as a function of epsilon for two values of ρ.

Market Clearing

π is risk premium, given by $(1-\varepsilon)(1+r)-1$

Credit market clears when **total demand** for credit is met by **direct** and **intermediated** credit.

$$\underbrace{\frac{E}{1-\frac{1+\pi}{1-\varepsilon}\varphi}}_{C_B}+\underbrace{T\frac{(1-\varepsilon)^2\pi}{\sigma^2(1+\pi)^2}}_{C_H}=K(\pi)$$

Bank Iso-Lending Curves

Points in (ε, π)-space with C_B constant

$$\pi(\varepsilon) = \left(1 - \frac{E}{C_B}\right) \frac{1-\varepsilon}{\varphi(\varepsilon)} - 1 \quad (2)$$

Slope of the iso-lending curve tends to $+\infty$ as $\varepsilon \to 0$

$$\pi'(\varepsilon) = -\left(1 - \frac{E}{C_B}\right) \left[\frac{1-\varepsilon}{\varphi^2} \varphi'(\varepsilon) + \frac{1}{\varphi}\right] \quad (3)$$

since $\varphi'(\varepsilon) \to -\infty$ as $\varepsilon \to 0$

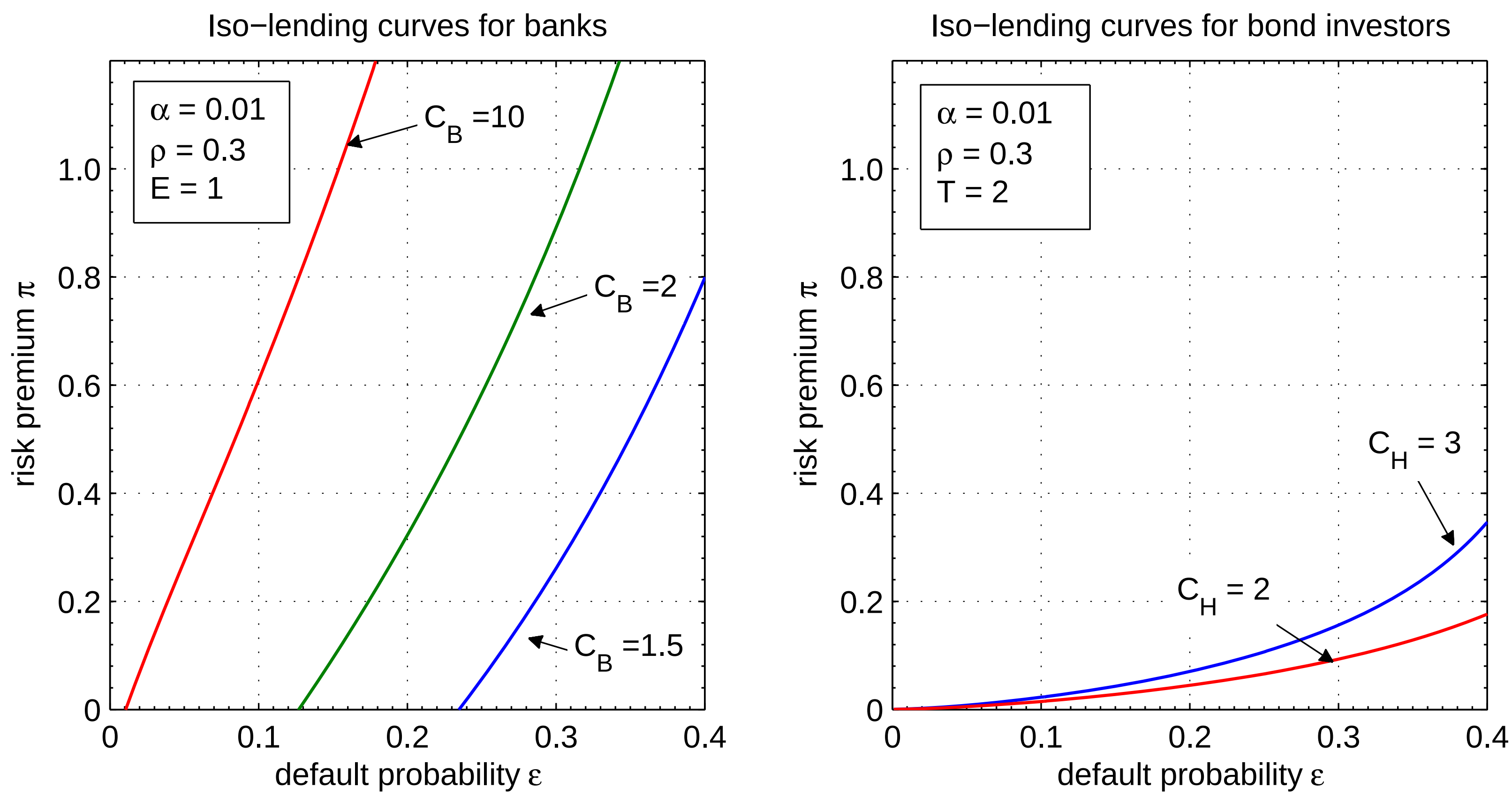


Figure 14. Iso-lending curves in (ε, π)-space for banks (left panel) and bond investors (right panel). Parameter values are as indicated in the boxes.

Two Main Results

Proposition. Under mild regularity conditions, risk premium π is increasing in ε.

Excess bond premium goes up in recessions

Proposition. For demand for credit not too elastic, an increase in ε is associated with a contraction of banking sector assets, both in absolute terms and as a proportion of the total credit received by borrowers.

In recessions, bank lending contracts but bond lending expands.

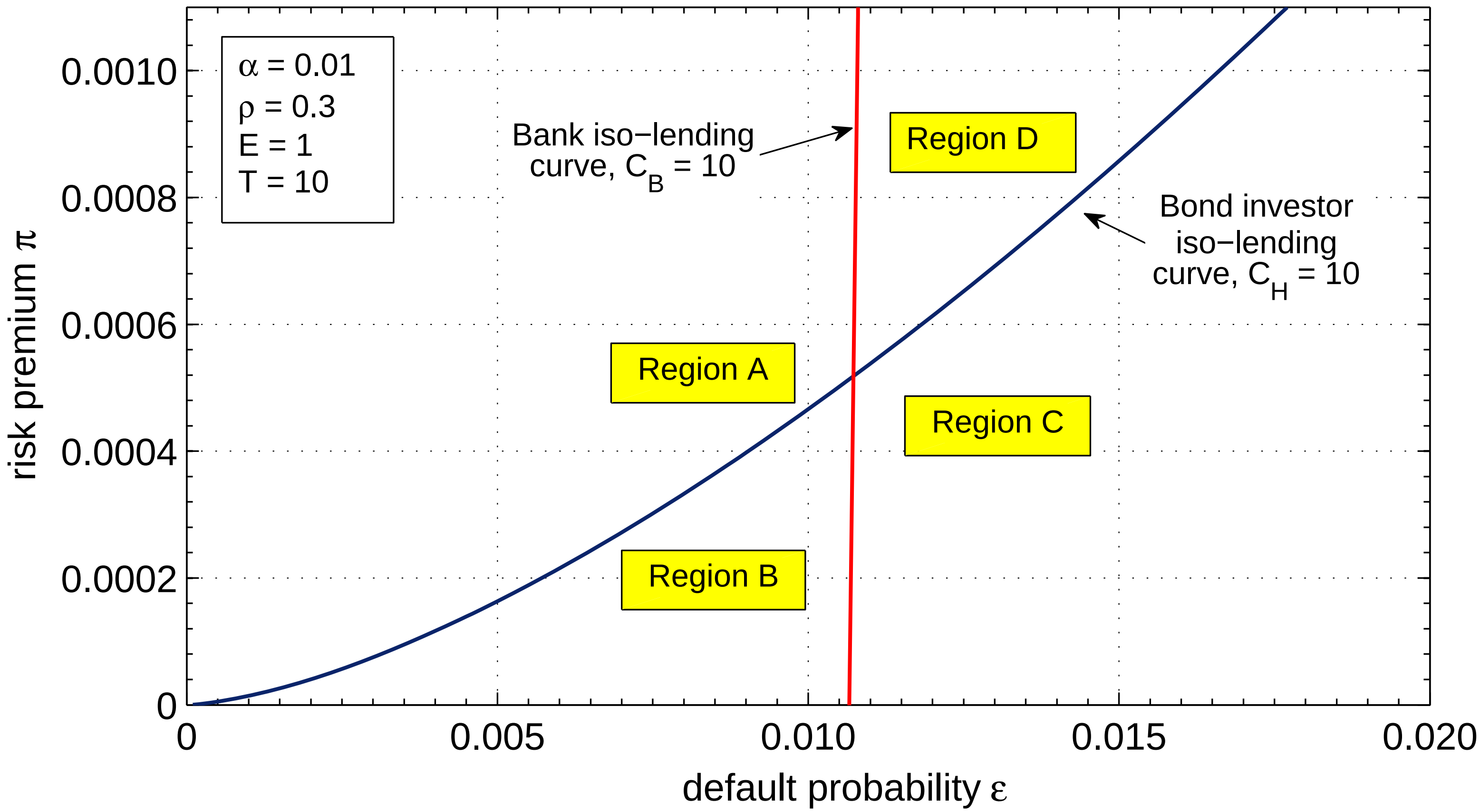


Figure 15. Crossing point for the iso-lending curves of banks and households.

Back to Our Main Question

Why is one dollar of credit through the banking system so different from one dollar of credit that flows directly?

Answer: *Size of banking sector proxies for banking sector risk-taking. Procyclical behavior of banking sector drives the risk premium over the cycle.*

- Economic activity (esp. investment) sensitive to risk premium.

- Spike in excess spreads is followed by decline in economic activity (Gilchrist, Yankov and Zakrajsek (2009), Gilchrist and Zakrajsek (2011))

Checklist for Macro Models

- Reconcile procyclical leverage with standard dynamic portfolio choice
- Incorporate explanatory power of balance sheet variables for asset pricing (Adrian, Moench and Shin (2012))
- Explore quantitative impact of shifting composition of credit
- ...