

14.09: Financial Crises

Lecture 2: Borrowing Constraints, the Net Worth Channel, and the Credit Crunch

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What is the role of financial institutions?

Financial institutions (or “banks”) seem central to financial crises. They intermediate credit between ultimate savers and borrowers. Broadly, can think of them as investment specialists/experts. They can identify firms with good borrowers, ensure repayment etc. They can also collect information and “correct” asset prices, thereby indirectly influencing investment (e.g., trading type activities). Next: A model of banks and their borrowing constraints, based on Holmstrom and Tirole (QJE, 1997).

- 1 Borrowing constraints and the net worth channel
- 2 Empirical evidence on the net worth channel
- 3 The credit crunch
- 4 The net worth channel more broadly

A stylized model of banks

Consider a model with two periods $t \in \{0, 1\}$.

Two types of agents: banks (B) and financiers (F).

The H-T model has three agents: Firms, banks (which they call monitors), and financiers. I am presenting a simpler version.

Both types have linear preferences, $C_0 + C_1$.

Financiers are money rich but idea poor:

Large endowments at both periods. Happy to make loans as long as they break even. The interest rate is, $1 + r = 1$.

They don't have ideas for profitable investment.

Banks (our focus) are the opposite: idea-rich but money poor...

Banks have investment opportunities

Each bank starts with some initial cash, denoted by N .

It chooses how much to invest at date 0, denoted by I .

Suppose each unit of investment generates payoff R at date 1.

Suppose $R > 1$ so bank wants to invest as much as possible...

It invests her own cash. But she might also borrow from Fs.

Banks face borrowing constraints

Suppose the bank borrows on “per asset” basis.

For each unit of investment I , it can borrow ρ .

Imagine the bank as using its assets as collateral to borrow.

E.g., a mortgage with 20% downpayment features $\rho = 0.8$.

For a given ρ , the bank's budget constraint can be written as,

$$I = N + \rho I.$$

The bank's investment can then be written as,

$$I = \frac{1}{1 - \rho} N .$$

We can also illustrate this on a balance sheet.

Assets	Liabilities
I	debt, ρI
	net worth, N (capital)

Balance Sheet of All Commercial Banks in the U.S. in August 2007
(entries are percentage of total assets)

Assets		Liabilities	
Reserves and cash substitutes	8%	Transaction (checkable) deposits	6%
Securities		Nontransaction deposits (e.g., time deposits, savings deposits)	56%
U.S. government and agency	11%	Borrowings	21%
Other securities	11%	Other liabilities	6%
Loans		Bank capital	11%
Commercial and industrial	13%	Total	100%
Real estate	34%		
Consumer	7%		
Other loans	7%		
Other assets (e.g., physical capital)	9%		
Total	100%		

The instructor's calculations based on the Federal Reserve Statistical Releases.

Need: A theory of the leverage ratio

Recall our investment equation

$$I = \frac{1}{1 - \rho} N .$$

The ratio of total investment (or assets) to net worth, $1/(1 - \rho)$ is known as **the leverage ratio**.

What is the leverage ratio of commercial banks in 2008?

Might ask: What determines ρ , and thus, $1/(1 - \rho)$?

Why is $\rho < 1$? What would happen if we had, $\rho \simeq 1$?

Need: A theory of borrowing constraints

These are deep questions. The field of **corporate finance**.

If we had $\rho \simeq 1$, the bank would not be borrowing constrained.

Can do as much investment as she likes with little or no capital.

In practice, banks as well as firms (sometimes) seem constrained.

Literature emphasizes constraints driven by information frictions.

We next illustrate this using a version of Holmstrom-Tirole's (1997) model based on moral hazard—a particular information friction...

Moral hazard: The bank can misbehave

Suppose the project either succeeds and yields R , as before, or fails and yields 0. Suppose also two versions of the project:

Project	Normal	Shirk
Private benefit to the bank	0	$cl > 0$
Prob. of success	1	$q < 1$

The normal version succeeds for sure as before.

The shirk version requires less effort (skip due diligence etc).

Might fail, but it generates private benefit for bank insiders..

Moral hazard: Insiders (managers/workers/owners) might misbehave.

(Information friction: Fs do not observe whether bank insiders shirk).

Skin-in-the-game, to provide incentives

A borrowing contract divides the output from each unit of the project (in case of success), $R = R^F + R^B$, to meet two objectives:

Financiers need to break even,

$$R^F = \rho.$$

The bank insiders need to behave (incentives):

$$R^B \geq qR^B + c.$$

The second condition can also be rewritten as,

$$R^B \geq \frac{c}{1 - q}.$$

For good management, B must have “skin in the game.”

Key implication: Limited borrowing

Combining the two conditions with $R = R^F + R^B$, we obtain

$$\begin{aligned}\rho = R^F &= R - R^B \\ &\leq R - \frac{c}{1 - q}.\end{aligned}$$

So ρ cannot exceed an upper bound,

$$\bar{\rho} = R - \frac{c}{1 - q}.$$

Suppose c is large (incentive problems severe) so $\bar{\rho} < 1$.

We have thus obtained a theory of limited borrowing, $\bar{\rho}$.

Broader interpretation: Limited pledgeability

This is a highly specific and stylized model.

But some features of the model are more general.

The bank is constrained since cannot promise (or pledge) all of the value from investment, R , to potential lenders.

Can only pledge up to a level, $\bar{\rho} < R - \frac{c}{1-q}$.

This feature, **limited pledgeability**, is more general...

Broader interpretation: Limited pledgeability

An alternative and broader interpretation of limited pledgeability:

$$R = \underbrace{\bar{\rho}}_{\text{more tangible or less "risky" assets (collateral)}} + \underbrace{R - \bar{\rho}}_{\text{less tangible or more "risky"}} .$$

Less risky \implies More pledgeable since it varies less with info (including unobserved action), and thus, is subject to fewer frictions.

Limited pledgeability on collateralized loans

In collateralized lending, each loan is backed by specific asset.

In this case, you might imagine ρ as applying asset by asset.

In this context, ρ is known as the **loan-to-value ratio**.

Residual, $1 - \rho$, is known as **the margin/haircut/downpayment**

The amount B would have to pay out of its pocket to buy the asset.

The inequality, $\rho \leq \bar{\rho}$, becomes a LTV or haircut constraint.

We do observe margins on collateralized loans in practice....

Table 4
Repo Haircuts
(percent)

	<i>Repo haircuts (%)</i>			
	<i>Spring 2007</i>	<i>Spring 2008</i>	<i>Fall 2008</i>	<i>Spring 2009</i>
U.S. Treasuries (short-term)	2	2	2	2
U.S. Treasuries (long-term)	5	5	6	6
Agency mortgage-backed securities	2.5	6	8.5	6.5
Corporate bonds, A-/A3 or above	5	10	20	20
Collateralized mortgage obligations, AAA	10	30	40	40
Asset-backed securities, AA/Aa2 and above	10	25	30	35

Source: The data in the first three columns is from the Depository Trust and Clearing Corporation (provided by Tobias Adrian of the New York Fed), with the column for fall of 2008 filled out from reports of investment banks.

Courtesy of the American Economics Association. Used with permission.

Limited pledgeability on collateralized loans

Repo is a particular type of collateralized loan. Will come back.

The table shows that riskier assets have greater haircuts/margins.

It also shows haircuts are (typically) low on many financial assets.

One reason why banks can have so high leverage—will come back.

Back to model: Investment with limited pledgeability

With limited pledgeability, the bank's budget constraint becomes:

$$I = \frac{1}{1 - \rho} N \text{ with } \rho \leq \bar{\rho}.$$

The bank chooses how much to borrow and invest subject to $\rho \leq \bar{\rho}$.

The bank's return from choosing particular ρ can be written as,

$$\underbrace{RI - \rho I}_{\text{net return after paying back financiers}} = \frac{R - \rho}{1 - \rho} N = \left(1 + \frac{R - 1}{1 - \rho} \right) N.$$

Since $R > 1$, the bank borrows and invests to the max (intuition?):

$$\rho = \bar{\rho} \text{ and } I = \frac{1}{1 - \bar{\rho}} N.$$

Implication: Net worth channel of investment

$$I = \frac{1}{1 - \bar{\rho}} N.$$

Key implication: Greater bank net worth, N , raises investment, I .

This is known as **the net worth channel** of investment.

The logic of the result is in fact more general. As long as:

The borrower has profitable projects (captured by $R > 1$),

The projects have limited pledgeability (captured by $\bar{\rho} < 1$).

Then, it is reasonable to think that the borrower's net worth, N (more broadly, internal funds) would affect its investment. Why?

A caveat: What if banks' net worth could grow?

The more general interpretation also raises a warning flag.

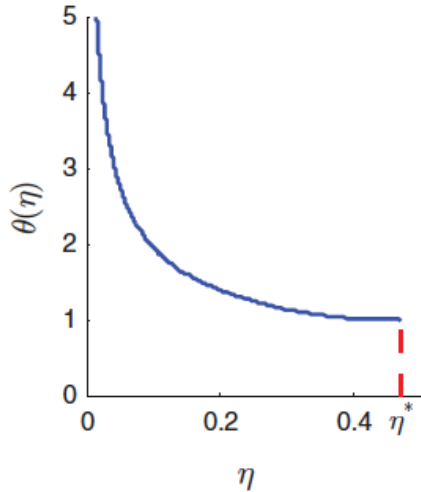
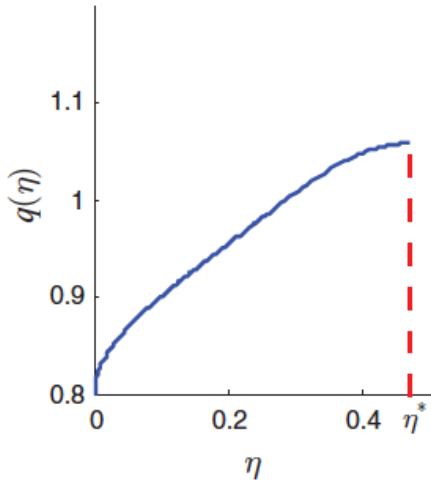
In a dynamic setting, banks would accumulate net worth (e.g., by realizing returns from past investment).

Eventually, their net worth and investment could be so high that they could run out of projects, $R \simeq 1$ (already invested in all).

If this happened, additional N wouldn't affect investment. Why?

These considerations are built into more sophisticated models.

Let's look at some results (pictures) from Brunnermeier-Sannikov (AER, 2014), "A Macro Model with a Financial Sector."



Courtesy of Markus K. Brunnermeier and Yuliy Sannikov. Used with permission.

Net worth channel in a dynamic setting

η in the Bru-San model is the analogue of N in the static model.

q is the analogue of investment, I .

θ captures the marginal value of additional net worth ($\sim 1 + \frac{R-1}{1-\rho}$).

The second plot illustrates diminishing returns: As $\eta \uparrow \eta^*$, the banks run into diminishing returns ($\theta \downarrow 1$ similar to $R \downarrow 1$).

Banks' assets are subject to shocks, so η moves around...

Net worth channel in a dynamic setting

When η hits η^* banks pay out dividends to their owners (who value receiving them). Don't need funds, so might as well pay out.

This keeps $\eta \leq \eta^*$. Within this range, there are two regimes:

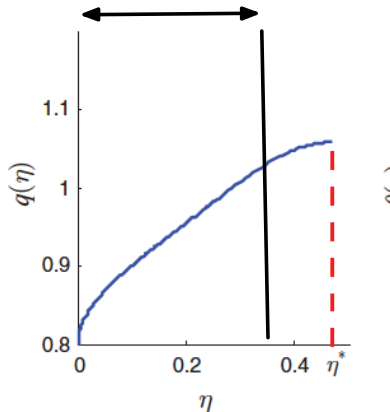
Most of the time (normal times) η remains around η^* .

Is the sensitivity of investment to η higher or lower in this range?

But negative shocks can lower η substantially below η^* :

Is the sensitivity of investment to η higher or lower in this range?

Imagine the static model capturing a situation in which the bank's net worth is in this range (e.g., due to negative shocks or other reasons)



Courtesy of Markus K. Brunnermeier and Yuliy Sannikov. Used with permission.

(In practice, η^* might also be even lower for reasons outside Bru-San).

Back to the static net worth channel

$$I = \frac{1}{1 - \bar{\rho}} N.$$

More broadly, imagine this equation as saying: Net worth affects investment, **especially if the bank net worth is sufficiently low.**

What are some policy implications of the net worth channel?

Financial shocks that lower B's net worth lower investment.

Shocks to Bs assets, e.g., subprime shock, can trigger a crisis.

Heterogeneity and **distribution of wealth** matters.

Transfer of wealth from Fs to Bs raise investment—especially during a severe crisis that depletes B's net worth. Why?

A bailout can be thought of as a transfer from Fs to Bs.

So the NW channel provides one justification for bailouts.

But is the channel true? Let's look at some empirical evidence.

Roadmap

- 1 Borrowing constraints and the net worth channel
- 2 Empirical evidence on the net worth channel
- 3 The credit crunch
- 4 The net worth channel more broadly



FIGURE I

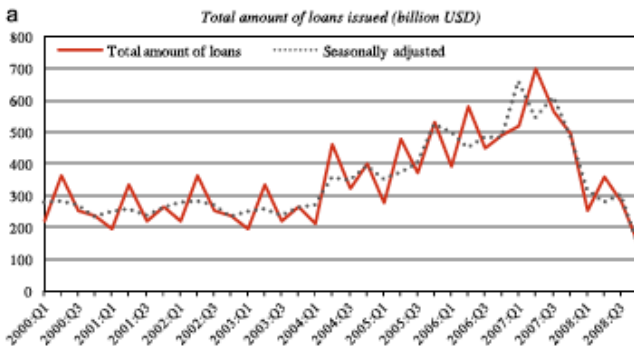
Stress in the Interbank Lending Market

Courtesy of Gabriel Chodorow-Reich. Used with permission.

The graph plots the rate at which banks lend to one another. Imagine this as a (very rough) empirical counterpart of R or θ . When do we expect the net worth channel to be more relevant? Recall also that banks indeed realized losses in 2007 and 2008. What would the net worth channel imply for banks' investment—i.e., their loans to firms or consumers—over this period?

Ivashina-Scharfstein (2010): Bank lending declines

V. Ivashina, D. Scharfstein / *Journal of Financial Economics* 97 (2010) 319–338



Courtesy of Elsevier, Inc., <http://www.sciencedirect.com>. Used with permission.

Syndicated loans: Large loans originated by one bank and held by multiple banks. Main source of bank loans for large corporations.

Syndicated loans provides as an empirical counterpart to I .

Total syndicated loans fell by 79% from 2007Q2 until end of 2008.

They fell by 47% at the peak of crisis, 2008Q4 (Lehman shock).

The timing is quite consistent with the net worth channel.

Chodorow-Reich (QJE, 2014): Further analysis with more data:

Variation in the lending of individual banks: Did banks that were more exposed to the (negative) subprime shock reduce lending more?

What happens to the economic activity of firms whose credit is cut?

CR: Aggregate lending declines (replicating IS)

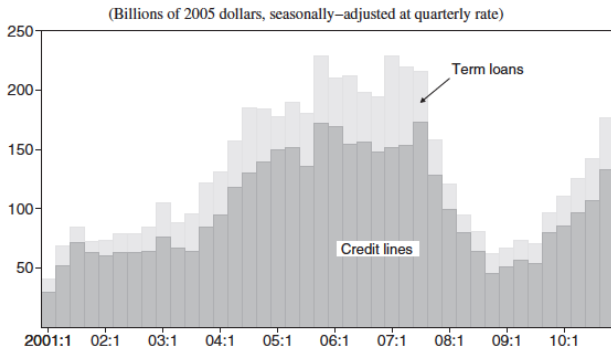


FIGURE II

Aggregate New Lending from Top 43 Lenders

The figure shows the face value of new loans to non-FIRE borrowers for working capital or general corporate purposes in which one of the 43 most active lenders had a lead role. Values seasonally adjusted by author using Census-X12.

Courtesy of Gabriel Chodorow-Reich. Used with permission.

CR: Individual lending is consistent with the NW channel

TABLE III
DETERMINANTS OF BANK LENDING

	(1)	(2)	(3)
	Change in lending during the crisis		
Explanatory variables			
Lehman cosyndication exposure	-0.14** (0.049)		
ABX exposure		-0.11* (0.041)	
2007-8 trading revenue/assets			0.046 (0.040)
Real estate charge-offs flag			0.012 (0.050)
2007-8 real estate net charge-offs/assets			-0.092+ (0.051)
2007 Bank Deposits/Assets			0.19** (0.059)
Joint test p -value	0.008	0.013	0.002
R^2	0.16	0.15	0.35
Observations	42	40	42

Courtesy of Gabriel Chodorow-Reich. Used with permission.

CR: Individual lending is consistent with the NW channel

2nd column: More exposed to subprime CDOs \implies Lower lending.

3rd column: Lower trading revenues or greater charge-offs (realized losses) on real estate assets \implies Lower lending.

(Ignore the 1st column and the deposits entry of the 3rd column for now. These will make a come back next week.)

Consistent with the net worth channel (though not conclusive).

The more important part of Chodorow-Reich concerns firms' activity.

To address this, we have to expand our "model" to think of firms...

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Incorporating firms into the analysis

We haven't explicitly modeled firms—only Bs and financiers.
Recall banks intermediate credit between financiers and firms.
Consider a firm who has a relationship with a particular bank.
Assume:

- A1. The firm doesn't have sufficient net worth or internal funds of its own.
- A2. The firm cannot directly borrow from financiers (see the more general model in H-T for a relaxation of this assumption).
- A3. The firm cannot easily switch banks and start a new relationship.

Credit crunch: Firms lose bank financing and cut activity

This type of firm must borrow from its bank to spend.

What would happen to the firm's borrowing as its bank loses NW?

What about the firm's economic activity (investment, employment...)?

These effects are known as **the credit crunch** (firms' perspective).

THE EFFECT OF BANK HEALTH ON THE LIKELIHOOD OF OBTAINING A LOAN

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm obtains a new loan or positive modification					
	Probit	$\Delta \tilde{L}_{i,s}$ instrumented using				
			Lehman exposure	ABX exposure	Bank statement items	All
Explanatory variables						
% Δ loans to other firms ($\Delta \tilde{L}_{i,s}$)	2.19** (0.79)	2.00** (0.53)	3.65** (1.28)	2.33* (1.12)	2.28** (0.64)	2.32** (0.63)
2-digit SIC, state, loan year FE	No	Yes	Yes	Yes	Yes	Yes
Bond access/public/private FE	No	Yes	Yes	Yes	Yes	Yes
Additional Dealscan controls	No	Yes	Yes	Yes	Yes	Yes
First stage F -statistic			14.0	8.2	18.2	19.8
J -statistic p -value			.	.	.	0.206
$E[\text{borrow}]$	0.134	0.134	0.134	0.134	0.134	0.134
$E[\widehat{\text{borrow}}: \Delta \tilde{L}_{p_{90}} - \Delta \tilde{L}_{p_{10}}]$	0.052	0.048	0.087	0.055	0.054	0.055

Courtesy of Gabriel Chodorow-Reich. Used with permission.

Credit crunch “reduces” firms’ borrowing

$\Delta L_{i,s}$ is the total amount of loans made (to all firms) by the bank s from which firm i received syndicated loan prior to Lehman.

$-\Delta L_{i,s}$ can be thought of as a measure of credit crunch faced by i .

Results show: Credit crunch reduces the firm’s probability of borrowing. Supports A3 above: Firms can’t easily switch to another bank.

The effects are economically large (see the last two lines).

TABLE IX
THE EFFECT OF LENDER CREDIT SUPPLY ON EMPLOYMENT

	(1)	(2)	(3)	(4)	(5)	(6)
	Employment growth rate 2008:3–2009:3					
	OLS	$\Delta\tilde{L}_{i,s}$ instrumented using				
			Lehman exposure	ABX exposure	Bank statement items	All
Explanatory variables						
% Δ loans to other firms ($\Delta\tilde{L}_{i,s}$)	1.17*	1.67**	2.49*	3.17*	2.13*	2.38**
	(0.58)	(0.61)	(1.00)	(1.35)	(0.88)	(0.77)
Lagged employment growth		0.0033	0.0039	0.0045	0.0036	0.0039
		(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Emp. change in firm's county		0.89*	0.85+	0.86+	0.87+	0.89+
		(0.43)	(0.46)	(0.48)	(0.45)	(0.46)
2-digit SIC, state, loan year FE	No	Yes	Yes	Yes	Yes	Yes
Firm size bin FE	No	Yes	Yes	Yes	Yes	Yes
Firm age bin FE	No	Yes	Yes	Yes	Yes	Yes
Bond access/public/private FE	No	Yes	Yes	Yes	Yes	Yes
Additional Dealscan controls	No	Yes	Yes	Yes	Yes	Yes
First-stage F -statistic			15.5	8.5	18.5	23.1
J -statistic p -value			.	.	.	0.190
$E[g_j^y]$	-0.092	-0.092	-0.092	-0.093	-0.092	-0.093
$E[g_j^y : \Delta\tilde{L}_{p90} - \Delta\tilde{L}_{p10}]$	0.027	0.039	0.058	0.074	0.050	0.055

Courtesy of Gabriel Chodorow-Reich. Used with permission.

Credit crunch “reduces” firms’ employment

Firms whose pre-Lehman banks cut back lending more (e.g., due to a greater drop in net worth) reduced employment more.

The effects are economically very large (last two lines).

CR finds (rough estimate) credit crunch can account for 1/3-1/2 of the decline in employment in small-medium firms between 2008:3 and 2009:3.

There are concerns with causality (as usual) but still very interesting.

Differential effects on small and large firms

CR also finds the effects of a credit crunch differ by firm size. Significant for small and medium firms, but not for the largest firms. This finding can also be reconciled with the general model in H-T. Large firms have a plausible alternative to bank financing: They might be able to borrow directly from financiers.

E.g., IBM can issue and sell bonds to raise funds.

This might not be feasible for small firms—they need bank financing. So small and medium size firms would arguably be affected more. H-T formalize this by allowing for direct financing (relaxing A1-A2).

Differential effects on small and large firms

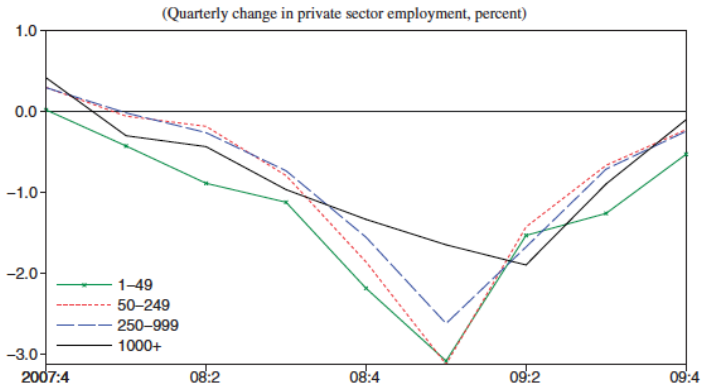


FIGURE III

Courtesy of Gabriel Chodorow-Reich. Used with permission.

In the raw data, employment of small firms fell much more.
CR: Much of this drop can be “explained” by the credit crunch.

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How about firms' borrowing constraints?

So far, we emphasized banks' borrowing problems as being central. But firms might invest to some extent with **their** own funds, N^{firm} . Large firms, such as IBM, might also be obtain direct financing. H-T model considers both firms' and banks' borrowing constraints. Firms face borrowing constraints, $\rho^{firm} < 1$, just like banks do. Their net worth, N^{firm} , can also affect investment, similar to above.

The net worth channel more broadly

The more general insight is: The net worth of **the borrowing sector** of the economy matters for economic activity.

Banks' net worth, N^{bank} , declines: Credit crunch.

Firms' net worth, N^{firm} , declines: Collateral squeeze.

The shocks to N^{bank} are typically amplified more (next lecture).

But shocks to N^{firm} could also matter and trigger a financial crisis.

Next: A different source of evidence that is consistent with some version of the net worth channel—without pinning its exact location.

An alternative source of evidence: CFO surveys

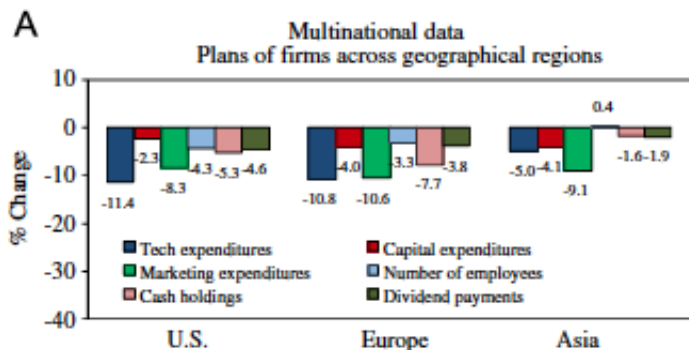
Campello, Graham, and Harvey (2010): Survey of 1050 CFOs in 39 countries conducted in Fall 2008: US (574), Europe (192), and Asia (284).

Questions about financial constraints and future plans.

Results:

All firms planned cuts in investment over this episode (no surprise). Firms that report to be financially constrained planned much deeper cuts in investment—consistent with borrowing constraints (a drop in N^{firm} or N^{bank} or both).

In Fall 2008, firms across the globe planned to reduce various forms of investment (and employment)



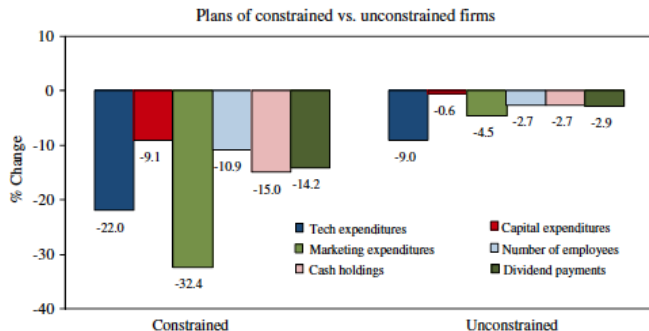
Courtesy of Murillo Campello, John Graham, and Campbell R. Harvey. Used with permission.

Figure displays all firms' (not just constrained) change in the policy variable (% per year) as of Fall of 2008.

Borrowing constraints: Are you affected by difficulties in accessing credit markets?

In the US sample: 244 indicate **unaffected**, 210 indicate **somewhat affected**, 115 indicate **very affected**.

Main result: Constrained firms in the US planned much larger cuts than unconstrained firms



Courtesy of Murillo Campello, John Graham, and Campbell R. Harvey. Used with permission.

They control for many aspects of the firm except for CFOs report of financial constraints and find similar results.

Taking stock: Transmission mechanisms

So why care about banks' problems (or financial shocks in general)?

Because they affect economic activity via **the net worth channel**:
Borrowing is constrained (due to frictions) so borrowers' internal funds/net worth matters.

Decline in banks' net worth \implies **Credit crunch** for firms.

Firms' net worth also matters (albeit to a lesser extent).

Channels supported by empirical evidence from the recent crisis.

Tomorrow: Amplification mechanisms. Read the LTCM case study.

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January IAP 2016

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