

The Bank Lending Channel and Corporate Innovation

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Motivation

- Corporate innovation:
 - is an important driver of economic growth and a source of competitive advantage for firms,
 - though susceptible to failures in financial markets.
- The recent financial crisis resulted in the contraction of the bank lending channel, inducing corporate funding shortfalls that potentially reinforce adjustments in innovation activity of firms.
- However, the use of relationship based credit to finance innovation remains a matter of debate.

Motivation

- Anecdotal Evidence:

- Everything that appears to be unnecessary for survival in the short-run is cut (Cisco CEO): "It is difficult and unpopular to explain to people why there is a need to maintain investment in something that only brings benefits in the long term when survival makes short-term action imminent" - to rephrase, as Keynes once said, "in the long run we are all dead".
- Campello et al. (2010) survey 1,050 CFOs to assess the impact of financial constraints induced by the recent crisis on the activity of firms and find that the innovation activities are hit disproportionately being cut by 22%.

Research Questions

The paper:

- Takes advantage of the recent financial crisis to examine the impact of bank credit supply frictions on corporate innovation.
- The unexpected nature of the Lehman Brothers' collapse provides a causal interpretation for the relation.

Do frictions in the supply of bank credit propagate in corporate innovation?

Do financial constraints amplify innovative efficiency?

Findings

- Disruptions in the bank credit market have a significant impact on both the innovation output and the quality of innovation.
- In particular, firms maintaining relationship with financial institutions less exposed to the liquidity shock increased innovative output by 7.2% followed by a 9.1% increase in non-self citations.
- However, financial constraints improve firm-level innovative efficiency by potentially alleviating agency problems that induce unproductive R&D investment.

In the presence of frictions in relationship lending, corporate innovation is adversely affected holding back firm-level growth.

Policy Implications

- The policy response to provide substantial government support for financial institutions during the recent financial crisis has received considerable attention by the public and been subject to criticism.
- Policymakers' arguments focus on the need to prevent potential unfavorable spillovers in the real economy that hinder economic growth.
- Maintaining the innovative activity of firms has been potentially part of the reasoning behind the policymakers' stance towards supporting failing institutions.

Contribution

I Financing sources for innovation activity and the cyclicity of R&D investment.

- Financing and innovation (Brown et al (2013)), impact of banking deregulation (Amore et al. (2013); Cornaggia et al. (2013)), the cyclicity of R&D (Barlevy (2007)), financial constraints and innovative efficiency (Almeida et al. (2014)).
- Document the causal firm-level effect of the contraction in the bank lending channel on the basis of borrower-lender relationships.

II Impact of constraints in credit availability induced by crises on corporate policies.

- Japanese Real Estate Bubble (Peek and Rosengren (1997, 2000); Gan (2007)), the 1998 Russian Crisis (Chava and Purnanandam (2011); and Schnabl (2012)), the 2007-09 Financial Crisis (Ivashina and Scharfstein (2010); Almeida et al. (2012); Chodorow-Reich (2013)).
- The literature has remained silent in exploring non-financial outcomes.

Outline

I Empirical Methodology

- Document cross-sectional variation in credit availability among lenders.

II Introduction and Validity of Bank Health Measure

- Unobserved borrower demand not varying in the cross-section of lenders.

III Frictions in the Bank Lending Channel and Corporate Innovation

- Relate firm-level innovation with the availability of bank credit in the crisis.

Methodological Approach

- I focus on the syndicated loan market and exploit the cross-sectional variation in lender health induced by the collapse of Lehman Brothers as a source of exogenous variation in the availability of bank credit to borrowers.
- Identifying assumptions:
 - **Relationship lending exists.** Firms dependent on financial institutions highly exposed to the Lehman Brothers' collapse had difficulty in securing bank financing by switching between lenders.
 - The recent financial crisis originated **in the supply side of lending markets** implying that the cross-sectional variation in banks' willingness to extend financing was independent of the characteristics of the pre-crisis borrowers.

Example

Consider an example:

- Credit Suisse experienced large losses from exposure to MBS reducing crisis lending by 79%, while U.S. Bankcorp with limited MBS exposure only by 14%.
- Availability of bank credit in a firm with a credit facility before the crisis with CS and Lehman compared to a firm maintaining a relationship with U.S. Bankcorp and Wells Fargo.

Measure of Lender Health

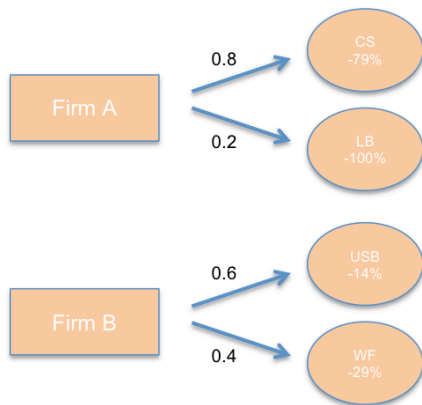
- Change in aggregate lending quantities to other borrowers before and after the Lehman shock.

$$\Delta L_{-i,b} = \frac{\sum_{j \neq i} a_{b,j,crisis} L_{b,j,crisis}}{0.5 \sum_{j \neq i} a_{b,j,pre-crisis} L_{b,j,pre-crisis}} \quad (1)$$

- Measure the relative health of a firms lenders based on the the firms last pre-crisis syndicate (Chodorow-Reich (2014)).

$$\Delta \tilde{L}_{i,s} = \sum_{b \in s} a_{b,i,last} \Delta L_{-i,b} \quad (2)$$

Measure of Lender Health



- Firm A's: $\Delta L_{-A,CS} = 1 - 0.79 = 21\%$ and $\Delta L_{-A,LB} = 0\%$ thus $\Delta \tilde{L}_{A,s} = 0.8 \times 21\% + 0.2 \times 0\% = 16.8\%$
- Firm B's: $\Delta L_{-B,USB} = 1 - 0.14 = 86\%$ and $\Delta L_{-B,WF} = 1 - 0.29 = 71\%$ thus $\Delta \tilde{L}_{B,s} = 0.6 \times 86\% + 0.4 \times 71\% = 80.0\%$

Alternative Measure

- I also consider exposure to Lehman through co-syndication (Ivashina and Scharfstein (2010)).

$$LehmanExposure_{i,s} = \sum_{b \in s} a_{b,i,last} LehmanExposure_b \quad (3)$$

Aggregate Lending and Bank Characteristics

Variables	(1)	(2)
	Change in Lending Activity	
Lehman Exposure	-4.54*** (1.20)	-4.21** (1.71)
Deposits/Assets		0.51*** (0.170)
Profitability		1.72 (3.039)
Capital		-0.35 (1.289)
Real Estate Net Charge-Offs		-13.44 (27.789)
Loan Net Charge-Offs		7.58 (11.403)
Trading Revenue/Assets		3.56 (7.300)

Empirical Specification

- Difference-in-differences with continuous treatment around Lehman's collapse:

$$\text{InnovationMeasure}_{i,b,t} = \alpha + \beta_0 \text{Post} + \beta_1 \Delta \tilde{L}_{i,s} + \beta_2 \text{Post} \Delta \tilde{L}_{i,s} + \text{Controls} + FE + u_{i,b,t} \quad (4)$$

- The period under consideration is two years before and after Lehman's collapse reflecting the typical innovation cycle duration.
- Use time and industry fixed effects to control for any variation driven by e.g. industry-specific shocks.

Data

- **LPC Dealscan:** Syndicated Loan Data.
- **Call Reports:** Federal Reserve FR Y-9C Consolidated Financial Statements for Bank Holding Companies.
- **SNL Financial Institutions Database:** Foreign Holding Companies and Investment Banks Financial Data.
- **Compustat:** Financial Data on Public Firms.
- **CapitalIQ:** Financial Data on Private Firms.
- **Harvard Business School Patent Database and KPSS Patent Data:** Data on number of patents filed by firms with the USPTO and subsequently granted and the number of non-self citations.

Sample Construction

- Focus on non-financial U.S. borrowers that have either obtained a syndicated loan between 2004 and August 2008 or obtained a loan prior to 2004 that matured after October 2007 with the purpose reported being either "working capital" or "corporate purposes".
- I hand-match with the patent data based on information on the names of the borrowers and the assignees along with state and zip code identifiers leading to a final merged sample of around 1,700 firms corresponding to about one third of the original Dealscan dataset.

Summary Statistics

	N	Mean	Std Dev.	p10	p50	p90
Panel A: Firm Variables						
Loan Amount						
Dealscan Sample	5,068	18.28	1.53	16.12	18.42	20.12
Merged Sample	1,715	18.49	1.65	16.12	18.48	20.62
Credit Spread						
Dealscan Sample	4,257	208.94	166.59	45	175	400
Merged Sample	1,465	180.81	149.64	35	150	350
Maturity						
Dealscan Sample	4,874	52.06	24.69	18	60	72
Merged Sample	1,657	51.86	24.51	15	60	72
Sales						
Dealscan Sample	3,574	20.17	1.86	17.91	20.11	22.58
Merged Sample	1,357	20.55	1.98	18.10	20.49	23.10
Panel B: Innovation Variables						
Patents						
Pre-Crisis	1,716	54.94	86.27	0	2	66
In Crisis	1,716	38.67	45.50	0	1	47
Citations						
Pre-Crisis	1,716	57.94	382.99	0	1	75
In Crisis	1,716	30.27	173.64	0	0	63

Innovation Outcomes - $\Delta \tilde{L}_{i,s}$ Measure

Impact On Innovative Activity

Panel A		
Variables	Extensive Margin Results	
	(1) Patents	(2) Citations
Post	-0.26*** (0.029)	-0.95*** (0.053)
$\Delta \tilde{L}_{i,s}$	-0.53*** (0.120)	-0.15 (0.127)
$Post \times \Delta \tilde{L}_{i,s}$	0.22*** (0.052)	0.29*** (0.094)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	26,832	26,832
R ²	0.11	0.26

Panel B		
Variables	Intensive Margin Results	
	(1) Patents	(2) Citations
Post	-0.42*** (0.055)	-1.48*** (0.084)
$\Delta \tilde{L}_{i,s}$	-0.09 (0.223)	-0.26 (0.252)
$Post \times \Delta \tilde{L}_{i,s}$	0.32*** (0.105)	0.43*** (0.170)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	16,080	16,080
R ²	0.27	0.28

Innovation Outcomes - Lehman Exposure Measure

Impact On Innovative Activity

Panel A		
Variables	Extensive Margin Results	
	(1) Patents	(2) Citations
Post	-0.18*** (0.020)	-0.05*** (0.008)
<i>LehmanExposure</i>	0.56 (0.64)	0.24 (0.18)
<i>Post × LehmanExposure</i>	-0.75*** (0.28)	-0.59** (0.22)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	26,832	26,832
R ²	0.11	0.12

Panel B		
Variables	Intensive Margin Results	
	(1) Patents	(2) Citations
Post	-0.28*** (0.03)	-0.09*** (0.01)
<i>LehmanExposure</i>	0.66 (0.83)	0.28 (0.24)
<i>Post × LehmanExposure</i>	-0.81*** (0.31)	-0.62** (0.26)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	16,080	16,080
R ²	0.10	0.18

Relationship Lending

Variables	(1) Participation as Lead Arranger	(2) Participation as Lead Arranger	(3) Participation as Participant	(4) Participation as Participant
Previous Lead Arranger	0.65*** (0.009)	0.59*** (0.009)	0.12*** (0.008)	-0.02*** (0.010)
Previous Participant	0.012*** (0.001)	0.005*** (0.001)	0.54*** (0.007)	0.51*** (0.007)
Lender Fixed Effects	Yes	Yes	Yes	Yes
Industry-Lender Fixed Effects	No	Yes	No	Yes
Year Fixed Effects	No	Yes	No	Yes
Borrower Controls	No	Yes	No	Yes
Observations	573,169	573,169	573,169	573,169
R ²	0.40	0.46	0.37	0.39

Credit Demand Channel

- Borrowers of financial institutions that were more exposed to the collapse of Lehman Brothers share unobservable characteristics that influence both loan demand and corporate innovation.
 - Control for a battery of observed borrower characteristics (including size, access to bond market, creditworthiness) and unobserved year and industry characteristics in the form of fixed effects.
 - Employ the Khwaja and Mian (2008) within-firm estimator that uses borrower fixed effects to absorb variation in unobserved borrower characteristics to mitigate concerns of a credit demand explanation.
 - Focus on the subsample of firms that acquired access to loan commitments during the crisis period from the same lender and examine within-relationship contractual variables.
 - Placebo regressions for parallel trends assumption.

Pre-Trends

- The observables are not significantly heterogeneous among the quantiles mitigating concerns that financial institutions that experience a larger shock are matched to ex-ante riskier borrowers.

Pre-Trends of Borrower Characteristics

Variables	Exposure Quantiles	
	(1)	(2)
$\Delta L_{i,s}$	0.22	0.51
Median Sales	20.52	20.06
Median Cash	0.054	0.057
Median Cash Flow	0.035	0.034
Median Leverage	0.26	0.24
Public/Private Status	0.57	0.62
Mean Bond Access	0.40	0.30
Mean Credit Spread	209	175
Mean Due Crisis	0.11	0.10
Mean Year Open	2005.89	2006.10

Borrower Characteristics

$$\Delta Lending_{i,b} = \alpha + \beta \Delta \tilde{L}_{-i,b} + FE_i + u_{i,b} \quad (5)$$

- If unobserved characteristics are correlated with the credit supply measure, the point estimates of the specification with the borrower fixed effects and the one without but including the observable borrower characteristics are expected to differ.

Unobserved Borrower Characteristics

Variables	(1) Bank-Firm Change in Lending	(2) Bank-Firm Change in Lending
$\Delta L_{-i,b}$	1.77*** (0.25)	1.80*** (0.28)
Borrower Fixed Effects	Yes	No
Industry Fixed Effects	No	Yes
Loan Year Fixed Effects	No	Yes
Borrower Controls	No	Yes
Observations	1,857	1,857
R ²	0.64	0.45

Loan Terms

- Consider only the subsample of firms that initiated a credit facility during the crisis of the same type from the same lender so that the estimate of loan supply changes is identified only by bank-firm variation.

Impact on Loan Contract Terms

	(1)	(2)	(3)
Variables	Credit Spread	Maturity	Loan Amount
$\Delta \tilde{L}_{i,s}$	-215.38*** (73.01)	11.34* (6.46)	0.10 (0.37)
Industry Fixed Effects	Yes	Yes	Yes
Loan Year Fixed Effects	Yes	Yes	Yes
Borrower Controls	Yes	Yes	Yes
Observations	320	316	320
R ²	0.09	0.20	0.08

Extensive Margin

- Borrowers that maintain lending relationships with financial institutions less exposed to the liquidity shock have 10% higher probability of accessing the syndicated market during the crisis.

Impact On The Likelihood Of Accessing Bank Credit

Variables	(1)	(2)
	Access to Bank Credit	Access to Bank Credit
$\Delta \tilde{L}_{i,s}$	0.59*** (0.15)	0.60*** (0.23)
Industry Fixed Effects	No	Yes
Loan Year Fixed Effects	No	Yes
Borrower Controls	No	Yes
Observations	4,578	3,016

Innovative Efficiency

- Innovative efficiency is estimated as either the number of patents or the number of citations scaled by R&D.

Impact On Innovative Efficiency

Variables	(1) Patents/R&D	(2) Citations/R&D
Post	-0.14*** (0.038)	-0.40*** (0.139)
$\Delta \tilde{L}_{i,s}$	0.09 (0.072)	1.06** (0.419)
$Post \times \Delta \tilde{L}_{i,s}$	-0.16*** (0.070)	-0.82*** (0.395)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	5,683	5,683
R ²	0.09	0.06

Placebo Regressions

- Conduct placebo regressions corresponding both to the 2001 recession and to a period that there is no explicit expected relation between corporate innovations and conditions in the lending market so as to invalidate the experimental design.

Placebo Regressions

Panel A		
	2001 Crisis	
Variables	(1) Patents	(2) Citations
Post	0.015 (0.022)	-0.268 (0.228)
$\Delta \tilde{L}_{i,s}$	-0.145 (0.126)	0.047 (0.212)
$Post \times \Delta \tilde{L}_{i,s}$	-0.046 (0.044)	0.009 (0.058)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	18,896	18,896
R ²	0.25	0.18

Panel B		
	2003Q4-2007Q3	
Variables	(1) Patents	(2) Citations
Post	0.004 (0.015)	-0.228*** (0.019)
$\Delta \tilde{L}_{i,s}$	-0.039 (0.070)	0.082 (0.119)
$Post \times \Delta \tilde{L}_{i,s}$	0.029 (0.038)	0.025 (0.040)
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Borrower Controls	Yes	Yes
Observations	37,088	37,088
R ²	0.27	0.28

Caveats and Future Direction

- Caveats:
 - **No stance** towards the optimality or the appropriateness of bank funding to finance innovation **under normal times**: Unveil only a propagation mechanism under recessionary conditions.
 - Though the typical instrument in finance literature, patent number and quality may be not perfect proxies for corporate innovation.
- Going forward:
 - Take advantage of state heterogeneity in the access to TARP funds to identify the effectiveness of the policy intervention.
 - Heterogeneity among firms? Firms with **higher ex-ante switching costs** appear to be affected disproportionately.
 - **Macro implications**: Is there any link between credit constraints and firms' innovation behavior over the business cycle?

Conclusions

- Frictions in the supply of relationship based financing have a significant impact on both the innovation output and the quality of innovation, implying that financial constraints amplify the procyclical R&D investment behavior.
- Financial constraints may improve firm-level innovative efficiency by alleviating agency problems that induce unproductive R&D investment.
- Government policies aimed at providing aggregate liquidity in the lending market in the presence of a supply-side shock may lead to positive spillovers on the economy by boosting innovative activity and, thereby, nurturing long-term economic growth.