Strapped for Cash: The Role of Financial Constraints for Innovating Firms

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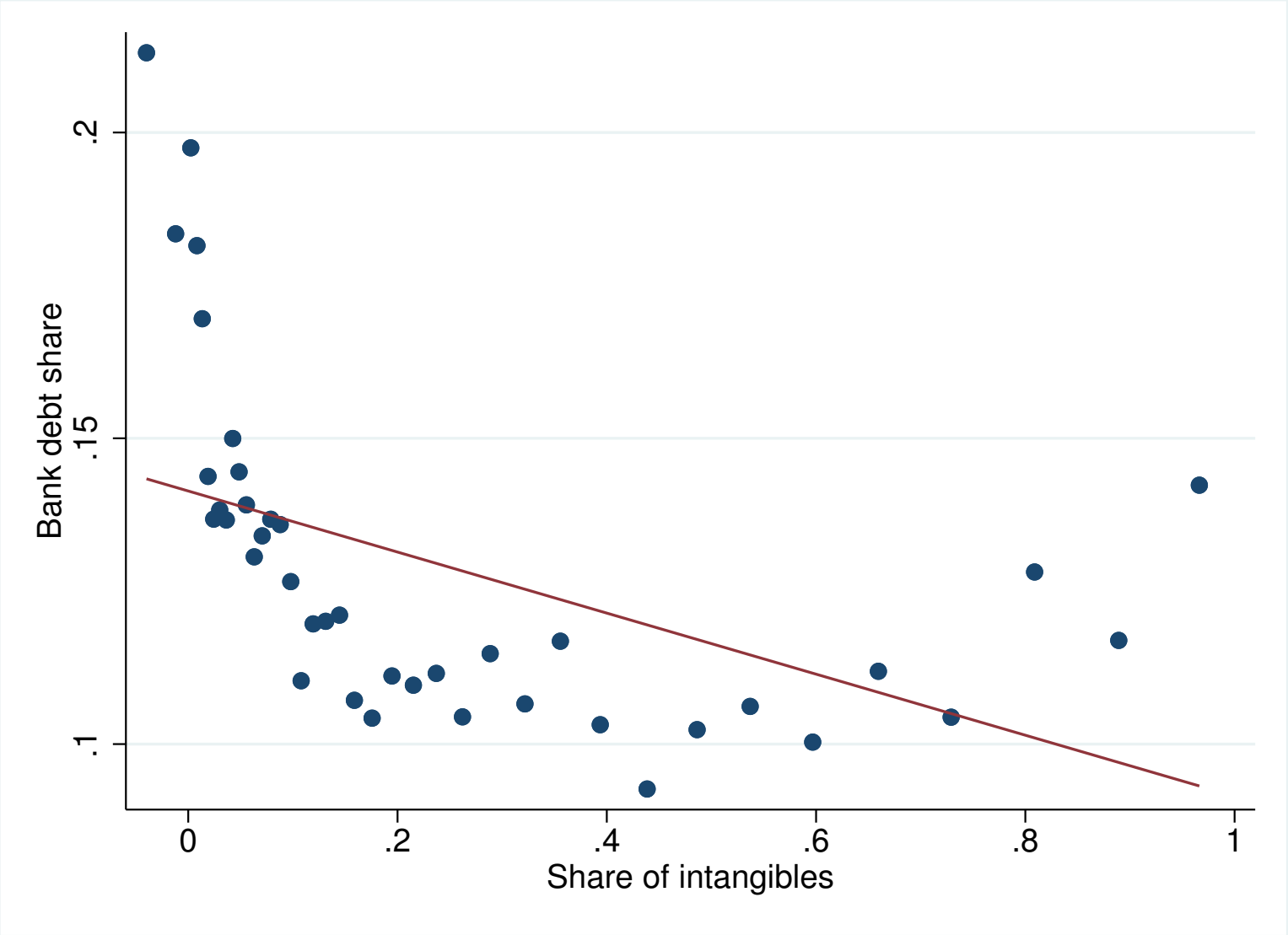
Strapped for cash?



Notes: Bank debt share is bank debt relative to sales. Share of intangibles is intangible assets relative to total assets. The figure shows a binned scatterplot after residualizing the x and y variables on NACE 2-digit fixed effects. Data from 2010.

Motivation

- Developed economies now invest more in intangible than tangible capital (Corrado and Hulten, 2010).
- Bank debt important in the life-cycle of firms.
  - Dominant source of financing for EU SMEs (ECB, 2019).
- Intangible-intensive firms have less access to bank credit?
  - Asymmetric information: Firms may have better information about investment returns than investors.
  - Collateral hard to secure on the basis of intangible assets.
  - Particularly salient for young firms

This paper

- How do credit constraints affect innovative firms' financing and performance and what are the overall implications for growth?

- *Micro*: Impact of reduced credit constraints for innovative firms.
  - Exploit a 2015 reform allowing firms to use intangible assets – patents – as collateral.
  - Diff-in-diff comparing exposed firms to unexposed firms before/after reform.

- *Macro*: Aggregate impact on labor productivity & misallocation.
  - Develop simple quantitative framework: Credit constraint $\longrightarrow$
    - Distort investment / capital $\longrightarrow$ productivity loss.
    - Dispersion in MPK $\longrightarrow$ misallocation.
  - Use well-identified moments from the DiD regressions to quantify the overall impact of reduced financial constraints for innovative firms.

Outline

- Data
- Micro: Reform details, empirical strategy, results
- Macro: Quantitative framework, quantification, results
- Conclusions

Data I

- Administrative firm register data from Statistics Norway.
  - Covers all firms in all sectors
  - Key variables: firm age, number of employees
- Administrative firm-level accounting data from Statistics Norway
  - All joint-stock firms in all sectors
  - Key variables: Sales, employment, balance sheet data (incl details on tangible and intangible assets)

Data II

- Bank data from the Norwegian Tax Authority (Skatteetaten).
  - Yearly data on all loans given by financial institutions registered in Norway (firm-bank-year)
  - Key variables: value of loan, interest paid
- Patent data from the Norwegian Patent Office
  - key variables: patent applications, status of patent
- Shareholder data by firm
  - # shareholders, shareholder type (venture capital, international), and issue of new stock
- Link all datasets with a unique firm identifier.
- Main analysis 2010-2018.

Reduced form

The reform

- The use of collateral is regulated by law. Bill passed on 23 January 2015 to allow firms to use patents as collateral.
- Prior to this, patents could only be used as collateral in conjunction with physical assets ("driftstilbehøret").
  - Hence not applicable to small and/or intangible-intensive firms.
- The reform was introduced to alleviate financial constraints for the growing number of firms with primarily intangible rather than tangible assets.
- Not part of a bigger tax reform. Effective as of 1st July 2015.

Testable hypotheses

- If constrained, we would expect to see:
  - More market borrowing
  - Higher capital stock - sales - employment
  - Interest rate R unchanged (not a move along the MRPK curve)

- If borrowing $\uparrow$ but no change in firm outcomes, suggests that firm is substituting from other forms of financing to market borrowing.

Empirics : Methodology

Diff-in-diff: Compare firms affected by the reform to other firms pre/post 2015:

$$y_{it} = \alpha_i + \beta P_i \times Post_t + \gamma X_{it} + \delta_{st} + \varepsilon_{it},$$

- $P_i = 1$ if firm i has ≥ 1 patent applications between 2010 and 2015.
- α_i firm FE, δ_{st} industry-year FE (NACE 2-digit).
- $Post_t = 1$ if $t > 2015$.

- X_{it} : Log employment, log fixed assets, share of intangibles, dummy for having received public funding
  - Measured at baseline and interacted with year dummies.

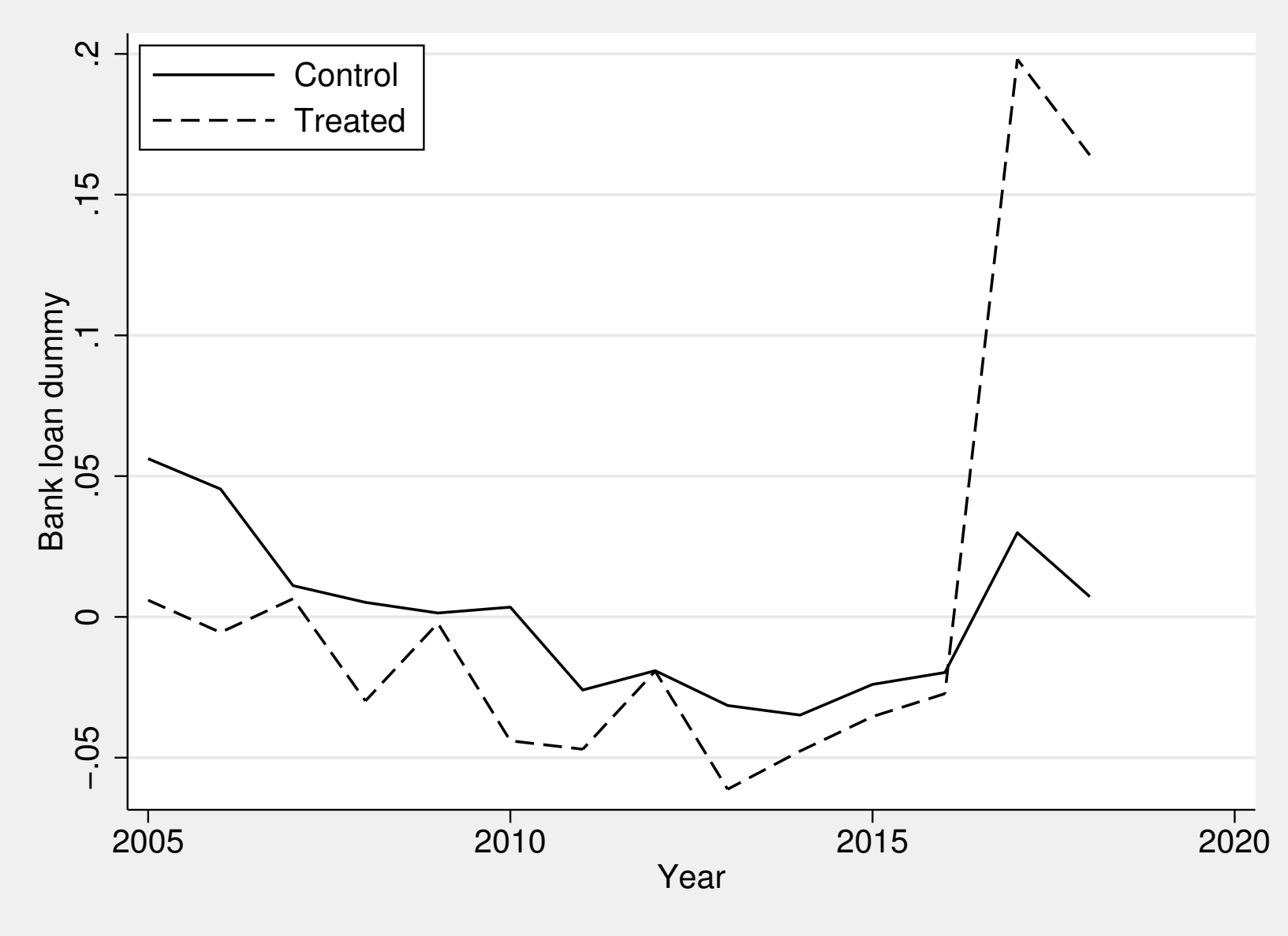
Outcome variables

- Measures of credit:
  - Bank loan dummy
  - Log bank debt
  - Total bank debt relative to sales
  - Number of bank connections
  - Interest rate, $i_{it} = \frac{Interest_{it}}{(Debt_{it}+Debt_{it-1})/2}$
  - Equity share: equity/(total assets).

- Measures of firm performance:
  - Log sales.
  - Log number of employees
  - Capital (fixed assets)

- Equity funding
  - new stocks
  - new investors: in total, venture capital, international

Pre-trends



Notes: The figure shows the average of the bank loan dummy after residualizing the variable on all controls and fixed effects.

Results : Credit

	Bank loan dummy	Log bank debt	$\frac{Bank\ Debt}{Total\ Sales}$	Equity share	No of Banks	Interest rate
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t \times P_i$	0.048**	-0.025	0.015**	-0.014	0.142***	0.003
	(0.021)	(0.202)	(0.007)	(0.009)	(0.047)	(0.004)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	726,781	331,002	697,520	624,593	726,781	334,158

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Results : Firm performance

	Log employment	Log sales	Log capital
	(1)	(2)	(3)
$Post_t \times P_i$	0.065**	-0.008	0.112
	(0.031)	(0.041)	(0.072)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes
Observations	759,910	718,073	568,370

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Taking stock

- More bank borrowing (extensive margin).
- Higher employment
  - Impact on employment (and sales) stronger for relatively young firms.
- Interest rate unchanged.
- Suggests that treatment firms are indeed credit constrained.

Quantitative framework

Quantitative framework

- How big was the credit friction (pre-reform) ?
- Quantify change in aggregate output per worker. Mechanisms:
  - Capital deepening (aggregate K/L up).
  - Reduced misallocation (MRPK equalized, for constant aggregate K)

To answer these questions, we need a model.

- Simple monopolistic competition framework, in the spirit of Hsieh & Klenow (2009).

Quantification

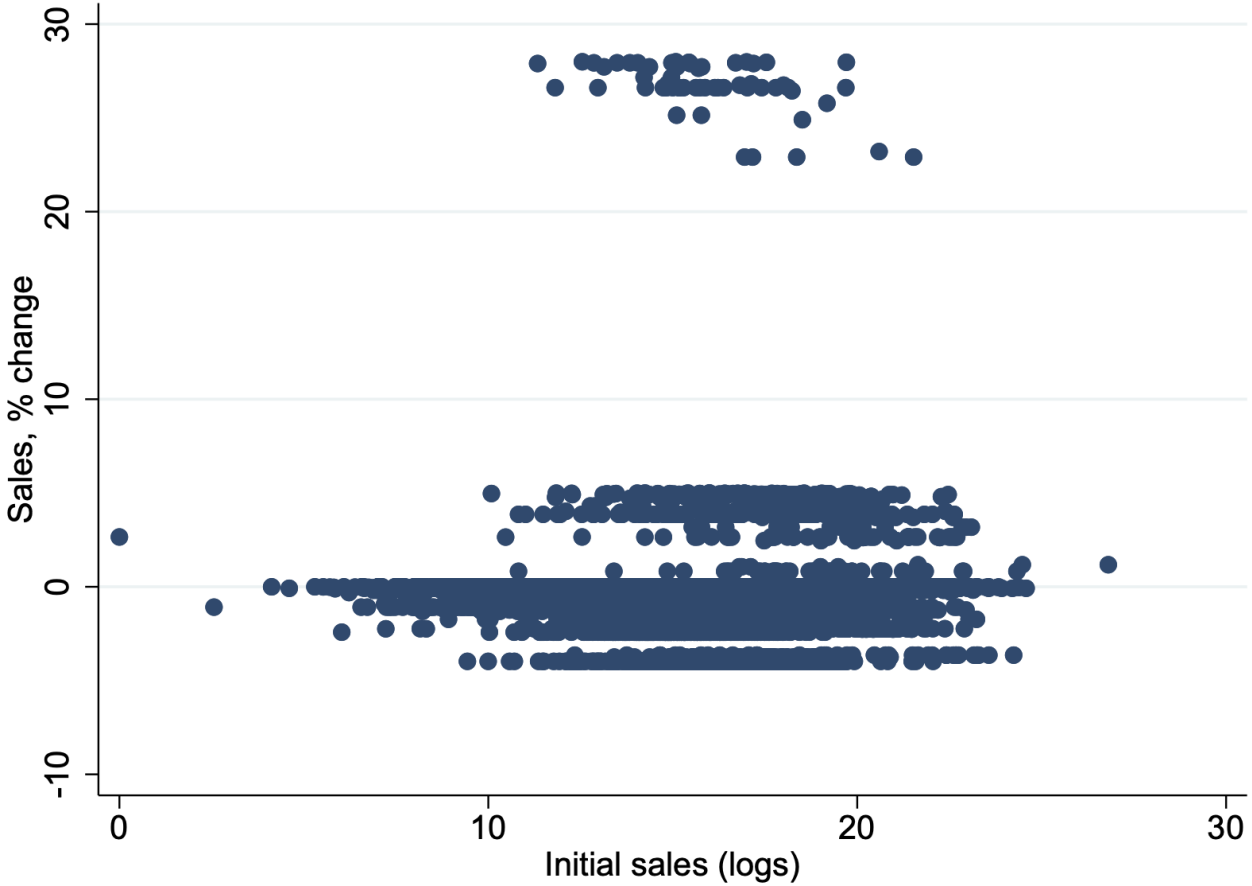
- Exercise: Shock the model by eliminating the credit friction τ for the treated firms, holding everything else constant.

- Data requirements:

β	DiD estimate, ln *Employment*$_i$	0.07 (mean)	
α_s	Capital share	0.30 (mean)	1 - (wage costs)/(total costs)
σ	Elasticity of substitution	4	Broda & Weinstein (2006)
ω_{si}	Sales shares		Our data, 2014.

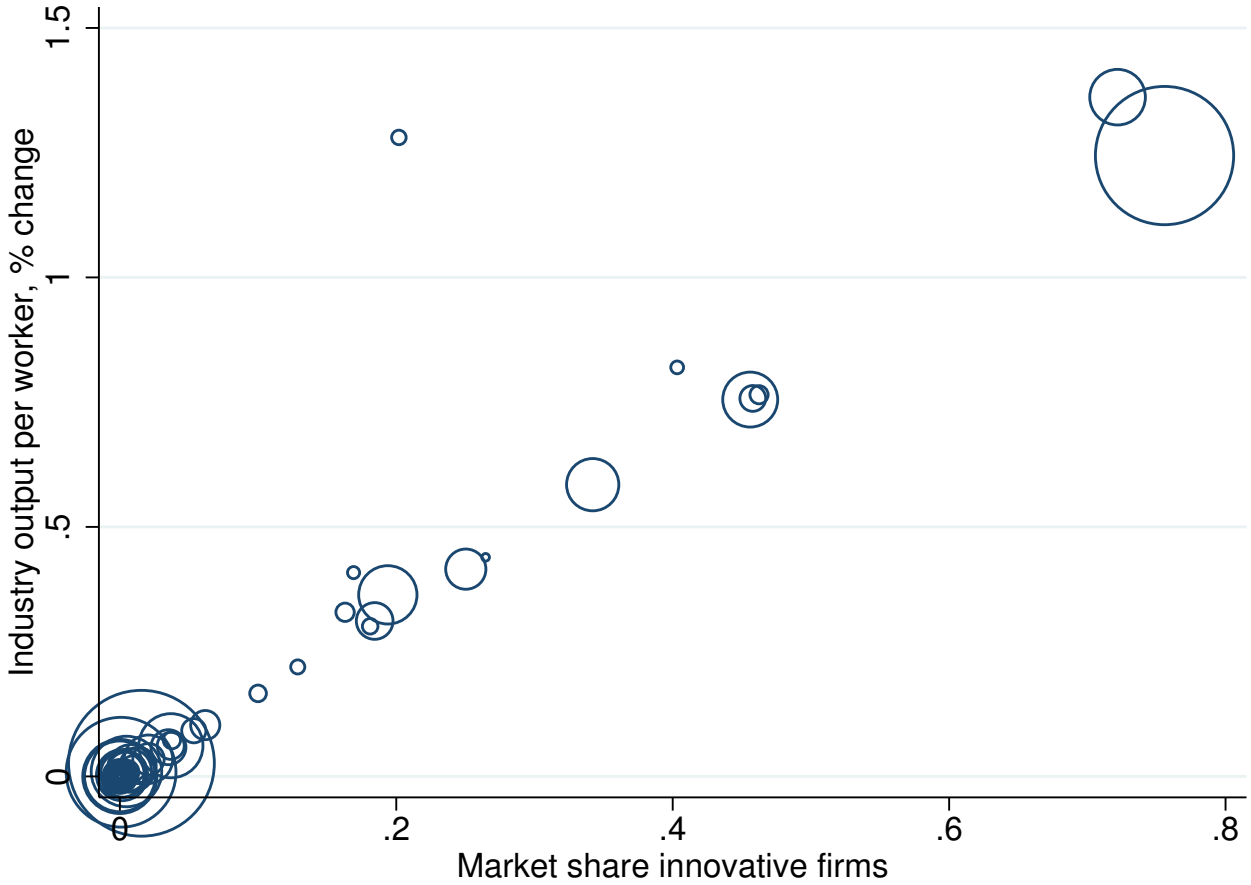
- Result: Pre-reform $\tau_i^{Treated} = 1.10$ (median).
  - MRPK 10% higher for treatment than control firms before the reform.

Results : Reallocation



- Innovative (treated) firms: 17.8 $\longrightarrow$ 18.2% of aggregate sales.
  - 6.7 $\longrightarrow$ 7.0% of aggregate employment.
- $\approx$ 3000 workers reallocated from control to treated firms.

Results : Industry output per worker



- Up to 1.5% increase in industry output per worker.
- Gains concentrated in sectors where treated firms have big market share.

Results : Misallocation

- Industry output per worker ↑ because
  1. Capital deepening (aggregate K/L up).
  2. Reduced misallocation (MRPK equalized, for constant aggregate K).

- 1. is quantitatively dominant.
- TFP losses from misallocation smaller than typical estimates in the literature (e.g., Midrigan and Xu, 2014).

Summary and conclusions

- The reform had a significant impact on firm's bank borrowing:
  - More likely to get bank loans and the number of bank connections.
  - No impact on the interest rate.

- The reform had a significant impact on the real economy:
  - Increased employment and sales (for young firms).

- Together, findings consistent with credit (collateral) constraints.
  - Policies to increase the pledgeability of patents alleviate financial constraints on innovation.

- Quantitative model suggests large improvements in output due to capital deepening
  - Misallocation plays a smaller role.

Thank you!

Results : Credit and Young firms

	Bank loan dummy	Log bank debt	$\frac{Bank\ Debt}{Total\ Sales}$	Equity share	No of Banks	Interest rate
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t \times P_i$	0.042*	-0.048	0.012*	-0.002	0.141***	0.004
	(0.023)	(0.213)	(0.07)	(0.010)	(0.050)	(0.004)
$Post_t \times P_i \times Young_i$	0.065	0.344	0.029	-0.093***	.041	-0.001
	(0.062)	(0.624)	(0.023)	(0.033)	(0.133)	(0.009)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	726,781	331,002	697,520	624,593	726,781	334,158

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

$Young_i = 1$ if a firm is 6 years or younger in 2015

Results : Firm performance and Young Firms

	Log employment	Log sales	Log capital
	(1)	(2)	(3)
$Post_t \times P_i$	0.048	-0.027	0.072
	(0.032)	(0.041)	(0.074)
$Post_t \times P_i \times$ Young_firm	0.195**	0.240*	0.263
	(0.094)	(0.158)	(0.274)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes
Observations	759,910	718,073	726,781

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Equity

- Is equity a substitute or complement to debt?
- Outcome variables:
  - New stocks: net issue dummy = 1 if firm issues new stock.
  - Number of sharesholders
  - (Venture capital funding)
  - (Funding from international investors)

Results: Equity funding

	Net issue dummy	Log shareholders
	(1)	(2)
$Post_t \times P_i$	-0.004	-0.077*
	(0.016)	(0.042)
$Post_t \times P_i \times$ Young_firm	0.139***	0.219*
	(0.049)	(0.122)
Controls	Yes	Yes
Firm FE	Yes	Yes
Industry*year FE	Yes	Yes
Young firm*year FE	Yes	Yes
Observations	665,483	665,480

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Complementarities: Removing collateral constraint leads to issue of new stock.

How different are firms with intangibles?

	Firms w/ intangibles		Firms w/o intangibles	
	Mean	Median	Mean	Median
Age	8.48	8	9.54	10
Employees	23.39	2	14.03	5
Bank connections	0.63	0	0.91	1
Bank debt dummy	0.31	0	0.50	1
N	11,696		65353	

How different are firms with patents?

	Firms w/ patents		Firms w/o patents	
	Mean	Median	Mean	Median
Age	10.10	11	9.37	10
Employees	125.73	15	14.25	4
Bank connections	1.13	1	0.86	1
Bank debt dummy	0.52	1	0.47	0
N	835		76214	

Patenting firms and bank debt

	Bank loan dummy	Bank loan dummy	Bank loan dummy	Bank loan dummy
	(1)	(2)	(3)	(4)
P_i	0.065**	-0.043	-0.041	0.017
	(0.030)	(0.031)	(0.031)	(0.034)
Log emp		0.079***	0.073***	0.063***
		(0.009)	(0.009)	(0.007)
Age			0.005***	0.003***
			(0.001)	(0.001)
Industry FE	No	No	No	Yes
Observations	84,063	84,063	84,063	84,063

Data from 2013. Standard errors in parenthesis are clustered on industry. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Overall results

	Log employment	Sales	Inv. dummy	Intang. inv. dummy
	(1)	(2)	(3)	(4)
$Post_t \times P_i$	0.060*	0.011	0.002	0.019
	(0.031)	(0.043)	(0.017)	(0.020)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes
Observations	759,910	749,764	759,910	759,910

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Back

Results : Trade

	Export dummy	Log exports	Import dummy	Log imports
	(1)	(2)	(3)	(4)
$Post_t \times P_i$	-0.003	0.133	-0.012	0.026
	(0.013)	(0.099)	(0.011)	(0.073)
$Post_t \times P_i \times$Young_firm	0.137***	0.366	0.082**	0.399
	(0.046)	(0.442)	(0.042)	(0.262)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes
Observations	759,910	103,149	759,910	306,745

Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Log exports is log(1+exports), log imports is log(1+imports). Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding, all interacted with year dummies.

Results: Exit

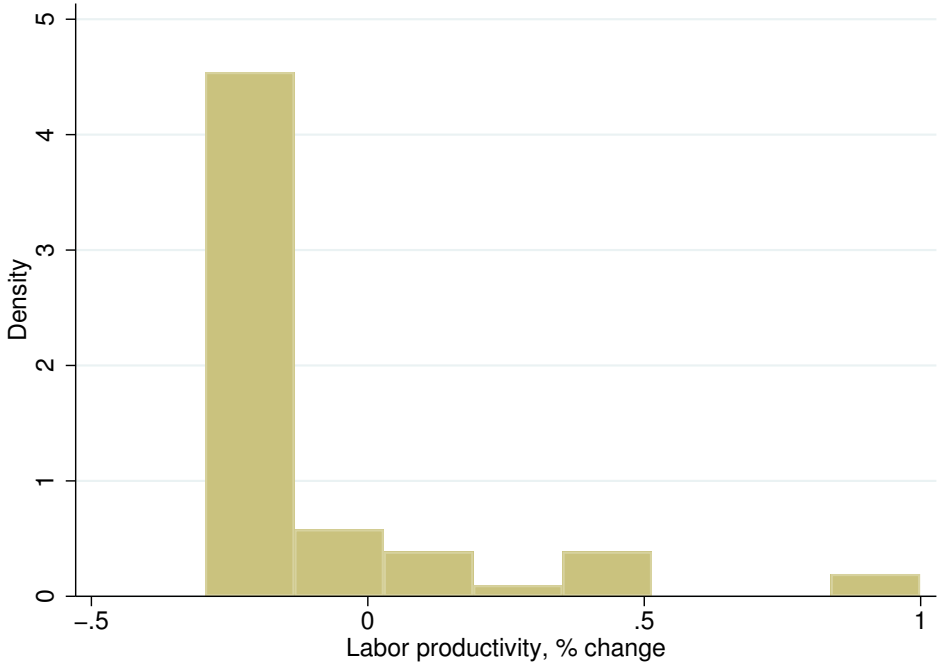
	Exit by 2018
	(1)
P_i	-0.04**
	(0.017)
Controls	Yes
Industry FE	Yes
Observations	85,007

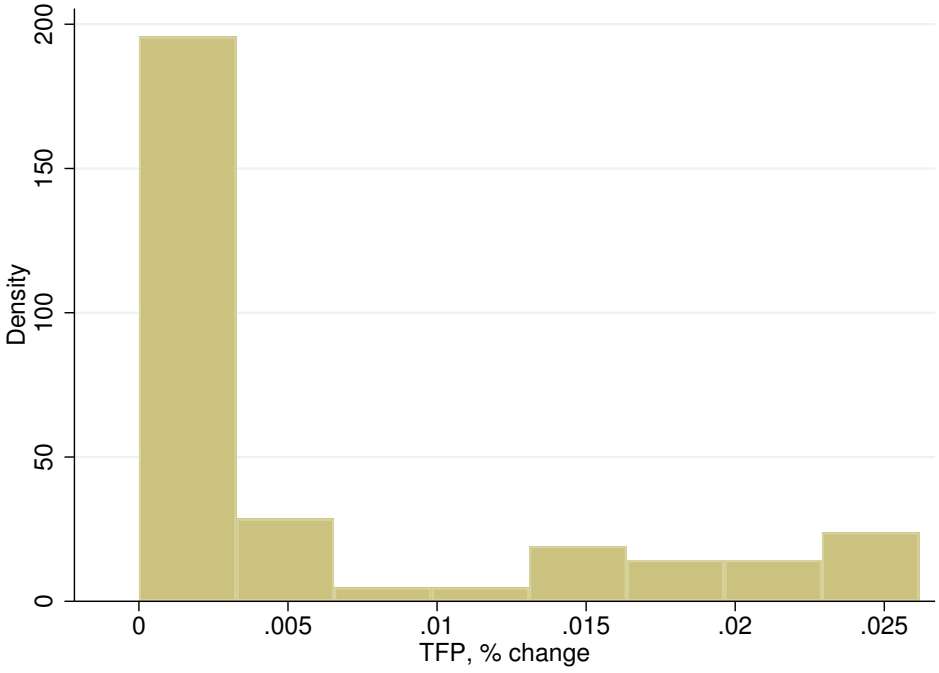
Standard errors in parenthesis are clustered on firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data from 2015. Controls include baseline levels of: log employment, log fixed assets, share of intangibles and a dummy for public funding.

Back

Survival: Removing collateral constraint leads to ireduced exit rates.

Extension : Endogenous R





- Replace open economy assumption with endogenous R and fixed K.
- Some sectors lose as K is reallocated to other sectors.
- Aggregate growth is *only* due to misallocation
  1. across firms
  2. across sectors