On Competition in US banking when technology is noncovex

Oleg Badunenko
Brunel University London, UK

Jérémie Bertrand
IESEG School of Management, France

Kristiaan Kerstens
IESEG School of Management, France

Paul-Olivier Klein
IAE Lyon School of Management, France

The first slide: what this is all about

[measuring] banks' market power when technology is nonconvex.

Contributions:

1. A method to measure marginal costs under nonconvex technologies.
2. Application to the US banking data over 27 years: 1997-2023
3. The results are contrasted to a typical application
4. The results have important implications for reconsideration and effective implementation of policies to improve competition in banking

The first slide: what this is all about (cont.)

The issues

- Market power is measured by the Lerner index where the main challenge is to obtain marginal costs
- obtain marginal costs for a function that is not smooth
- comparison to approaches used in the literature

The Lerner Index

- The Lerner Index (which measures the mark-up of a bank) is defined as

$$L = \frac{P - MC}{P} \quad (1)$$

- P is obtained from the data
- The marginal costs are not directly observable
- To calculate marginal costs in practice, it is necessary to assume a cost function

Marginal Cost

- The concept implies the unit change of cost due to a change in output:

$$MC = \frac{\Delta C}{\Delta Y} \tag{2}$$

- If the cost function is differentiable,

$$MC = \frac{\partial C}{\partial Y} \tag{3}$$

An example

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How does competition affect bank systemic risk?

Deniz Anginer [a,b,*], Asli Demirguc-Kunt [b], Min Zhu [b]

[a] Virginia Polytechnic Institute and State University, United States
[b] World Bank, United States

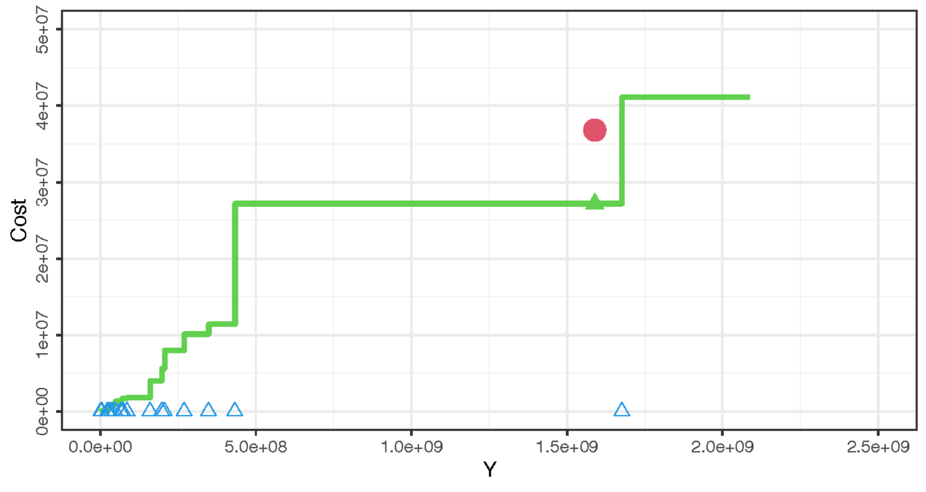
We follow the methodology used in Demirguc-Kunt and Martinez-Peria (2010) and first estimate the following log cost function for each country:

$$\begin{aligned}\log(C_{it}) = {} & \alpha + \beta_1 \times \log(Q_{it}) + \beta_2 \times (\log(Q_{it}))^2 + \beta_3 \times \log(W_{1,it}) + \beta_4 \times \log(W_{2,it}) \\ & + \beta_5 \times \log(W_{3,it}) + \beta_6 \times \log(Q_{it}) \times \log(W_{1,it}) + \beta_7 \times \log(Q_{it}) \times \log(W_{2,it}) \\ & + \beta_8 \times \log(Q_{it}) \times \log(W_{3,it}) + \beta_9 \times (\log(W_{1,it}))^2 + \beta_{10} \times (\log(W_{2,it}))^2 \\ & + \beta_{11} \times (\log(W_{3,it}))^2 + \beta_{12} \times \log(W_{1,it}) \times \log(W_{2,it}) + \beta_{13} \times \log(W_{1,it}) \times \log(W_{3,it}) \\ & + \beta_{14} \times \log(W_{2,it}) \times \log(W_{3,it}) + \Theta \times \text{Year Dummies} \\ & + \Omega \times \text{Bank Specialization Dummies} + \varepsilon_{it} \qquad (7)\end{aligned}$$

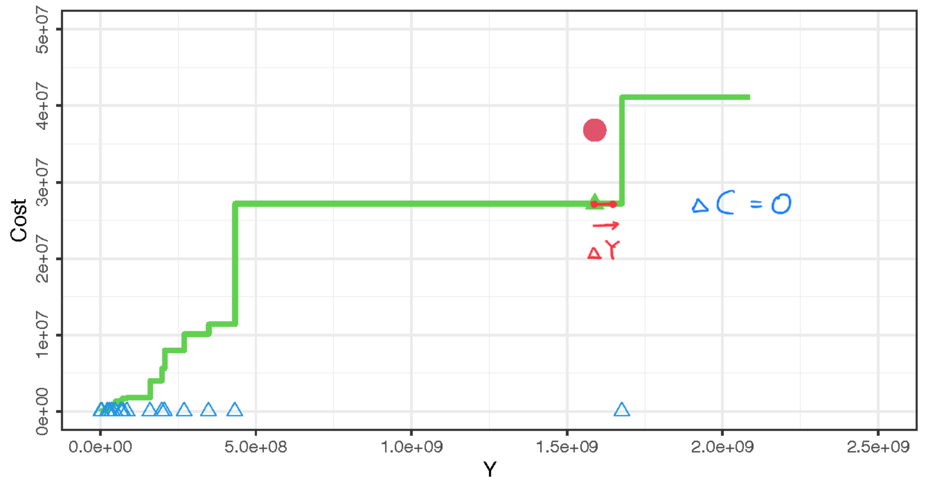
We then use the coefficient estimates from the previous regression to estimate marginal cost for bank i in calendar year t:

$$\begin{aligned}MC_{it} & = \partial C_{it} / \partial Q_{it} \\ & = C_{it}/Q_{it} \times [\beta_1 + 2 \times \beta_2 \times \log(Q_{it}) + \beta_6 \times \log(W_{1,it}) + \beta_7 \times \log(W_{2,it}) + \beta_8 \times \log(W_{3,it})] \qquad (9)\end{aligned}$$

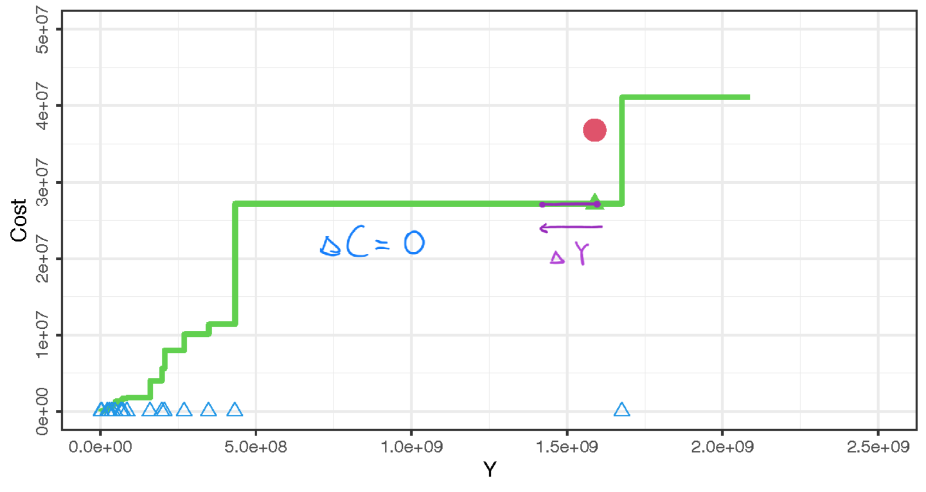
Marginal Cost with Nonconvex Cost Function



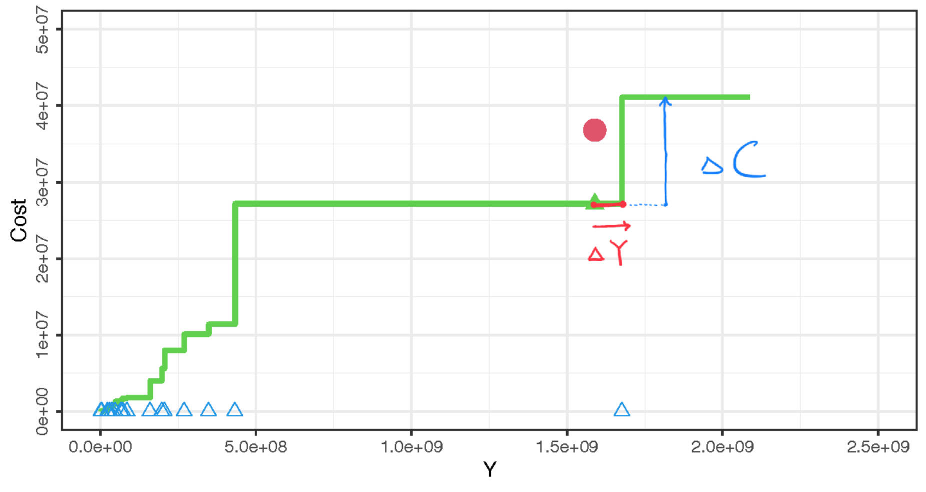
Marginal Cost with Nonconvex Cost Function



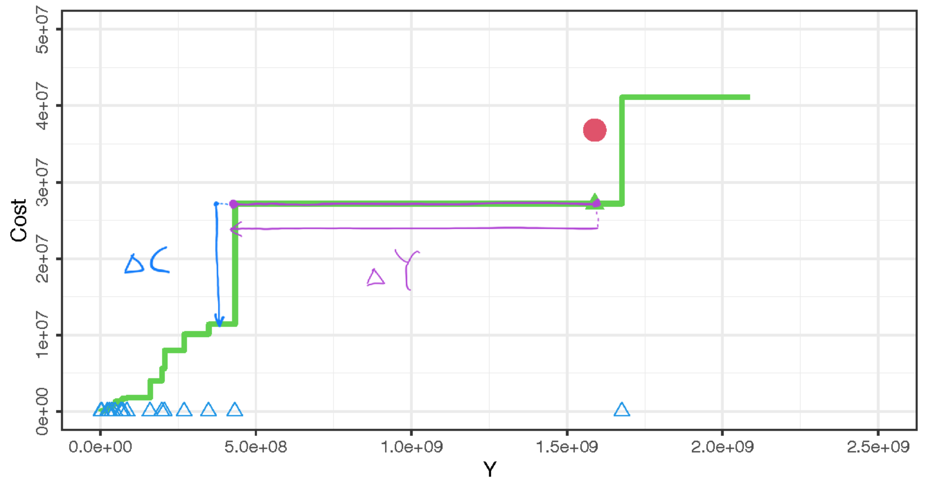
Marginal Cost with Nonconvex Cost Function



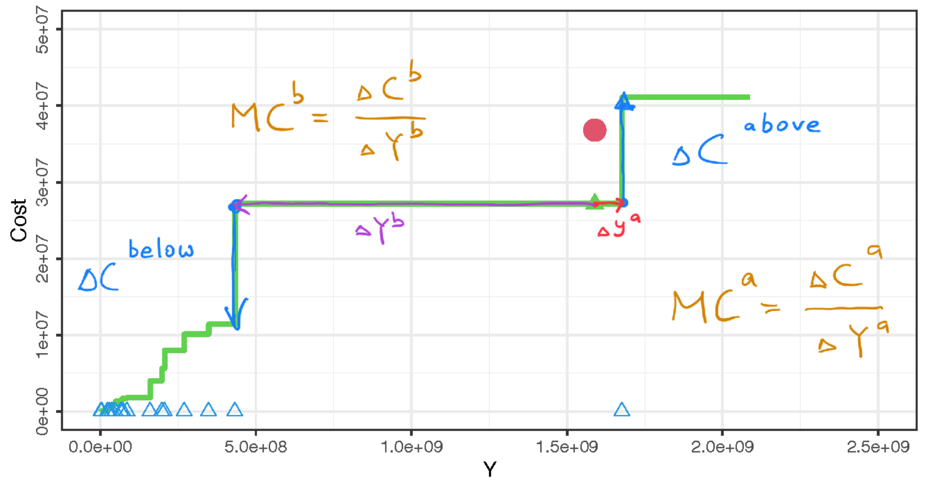
Marginal Cost with Nonconvex Cost Function



Marginal Cost with Nonconvex Cost Function



Marginal Cost with Nonconvex Cost Function



Algorithm

Find Change Points

1. Sort Y to get Y^s
2. For bank k, calculate C_k^{min}
3. Below:
   - Set $i = 1$ calculate C_{k-i}^{min} at fixed input prices at P_k and Y_{k-i}^s
   - If $C_{k-i}^{min} = C_k^{min}$, increase $i = 2$ and calculate C_{k-i}^{min} at P_k and Y_{k-i}^s

   repeat until $C_{k-i}^{min} \neq C_k^{min}$
4. Above:
   - Set $i = 1$ calculate C_{k+i}^{min} at fixed input prices at P_k and Y_{k+i}^s
   - If $C_{k+i}^{min} = C_k^{min}$, increase $i = 2$ and calculate C_{k+i}^{min} at P_k and Y_{k+i}^s

   repeat until $C_{k+i}^{min} \neq C_k^{min}$

Algorithm (cont.)

Calculate Marginal Costs

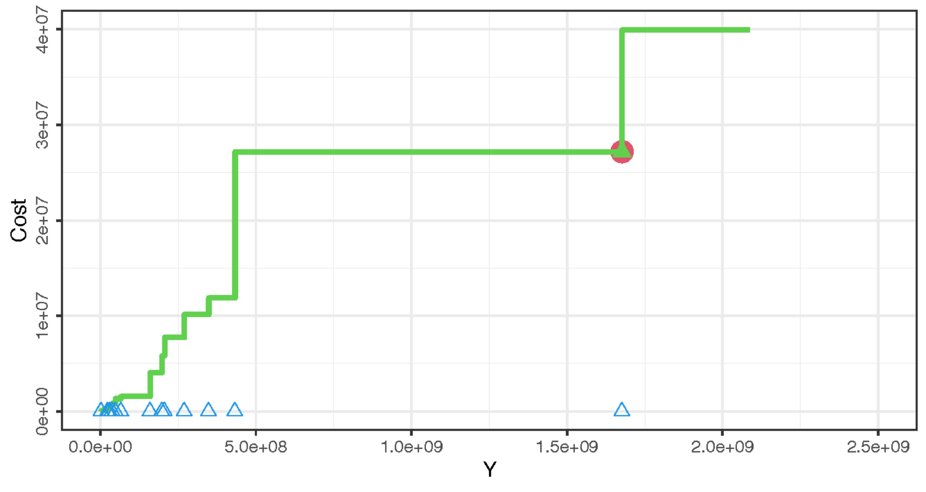
1. Below:
   - At the found change point $k - i$ calculate

$$MC^b = \frac{C_k^{min} - C_{k-i}^{min}}{Y_k^s - Y_{k-i}^s} \tag{4}$$

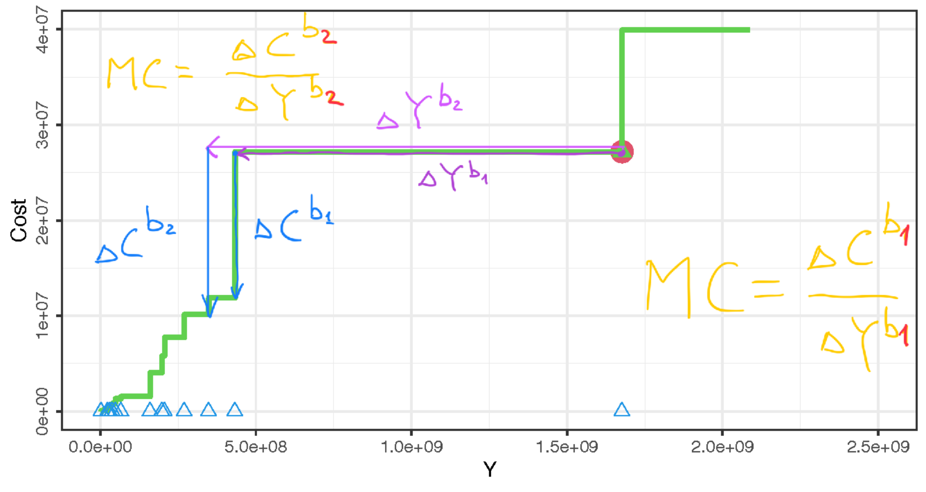
2. Above:
   - At the found change point $k + i$ calculate

$$MC^a = \frac{C_{k+i}^{min} - C_k^{min}}{Y_{k+i}^s - Y_k^s} \tag{5}$$

Marginal Cost with Nonconvex Cost Function 2



Marginal Cost with Nonconvex Cost Function 2



Algorithm (cont.)

Calculate Marginal Costs

1. Below 1
2. Below 2

Calculate Marginal Costs

1. Above 1
2. Above 2

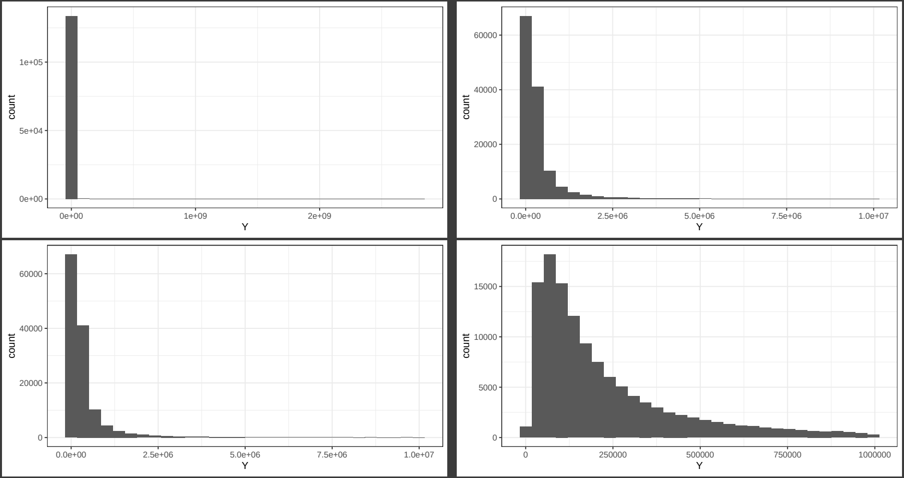
Calculate Marginal Costs

Get a minimum of two

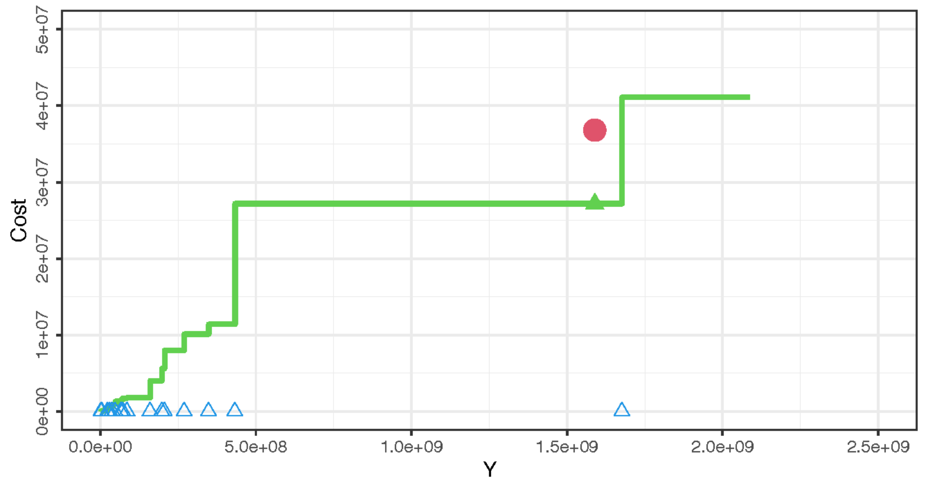
Data, sources

- Call reports on US commercial banks
- Sample:
  - Years 1997-2023
  - Total assets $>$ \$1m in at least one of the 27 years
  - $\sum T_i = 87K$ (about 3.3K per year)
- Output Y: total assets
- Output price P: operating income divided by total assets
- 4 Inputs [prices]: purchased funds, deposits, labor, capital

Total assets (zoomed in)



Nonconvex Cost Function ($k = 188$)



The Lerner Index

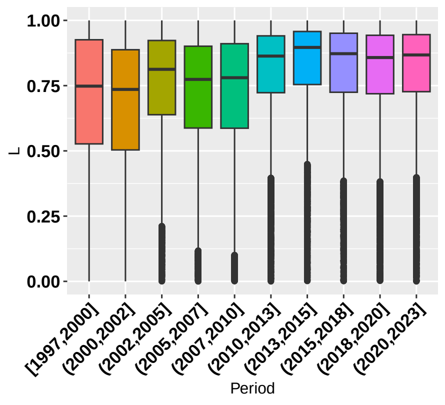
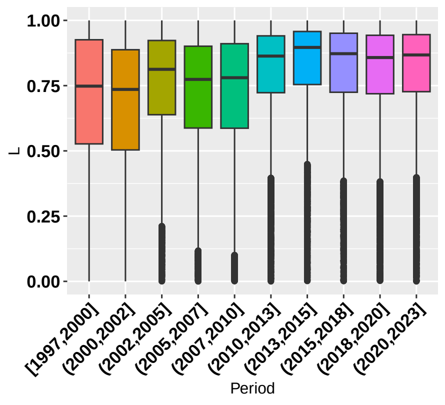


Figure: Left based on the NC technology

The Lerner Index



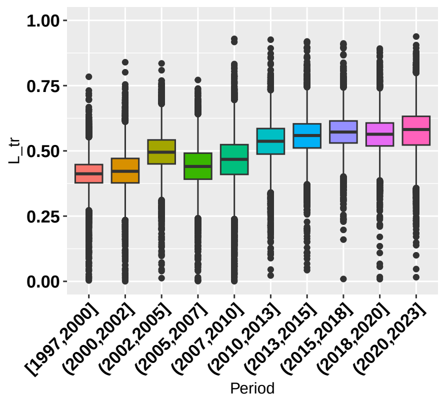


Figure: Left based on the NC technology; right: traditional.

The Lerner Index

Figure: correlation: 0.22

Stability

$$Z = \frac{(ROA + E/A)}{\mathbf{sd}_{ROA}}, \quad (6)$$

ROA is the return on assets, E/A is the equity to assets ratio, and $\mathbf{sd}_{ROA}$ is the standard deviation of ROA over the last 3 periods. Higher values of the Z-score come from either greater income or higher capital and indicate lower probabilities of bank insolvency, thus providing a direct measure of bank stability.

$$\ln Z_{it} = \sum_t \beta_t D_t L_{i,t-1} + controls_{it} + macro_{i,t-1} \quad (7)$$

Traditional Approach

Cost function

$$\ln C_i = \beta_0 + \beta_y \ln Y_i + 0.5\beta_{yy} (\ln Y_i)^2 + \sum_j \beta_{wj} \ln w_{ji} + \sum_j \sum_k \beta_{wjk} \ln w_{ji} \ln w_{ki} + \sum_j \beta_{wjk} \ln w_{ji} \ln Y_i \quad (8)$$

The marginal costs are calculated as

$$MC_i = \frac{\partial C_i}{\partial Y_i} = \frac{\partial \ln C_i}{\partial \ln Y_i} \frac{C_i}{Y_i} = \frac{\partial \ln C_i}{\partial \ln Y_i} AC_i \quad (9)$$

Literature 1 / 3

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How does competition affect bank systemic risk?

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Table 4
Competition and systemic risk: additional results.

Variables	(1) ΔCoVar	(2) Distance to Default	(3) Log (zscore)
Panel A: Alternative measures of risk			
Lerner	−0.007**	−0.685***	1.332***
	(0.003)	(0.264)	(0.176)
Observations	10,909	10,914	8018

Literature 2 / 3

J. Int. Financ. Markets Inst. Money 46 (2017) 199–215

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Is there a competition-stability trade-off in European banking? ☆

Aurélien Leroy [a,*], Yannick Lucotte [b]

[a] LEMNA, University of Nantes, IEMN–IAE, Chemin de la Censive du Tertre, BP 52231, 44322 Nantes, France
[b] PSB Paris School of Business, Department of Economics, 59 rue Nationale, 75013 Paris, France

4.2. Competition and systemic risk

We now turn to the results obtained by considering the SRISK as the dependent variable. As emphasized in introduction, to the best of our knowledge, only the recent paper of Anginer et al. (2014) has previously investigated the link between competition and systemic risk at the bank level. However, unlike our study, Anginer et al. (2014) do not consider the SRISK as a measure of systemic risk, but use the $\Delta CoVar$ and a measure based on the correlation between the distance-to-default of each bank and the distance-to-default of the market. Table 4 presents our regression results. As above, specifications (1) to

Table 2
Competition and bank individual risk: results obtained with the Z-score.

Dependent variable	Z-score FE	Z-score FE	Z-score FE	Z-score FE	Z-score IV	Z-score IV
Lerner	2.911*** (0.577)	3.148*** (0.588)	2.851*** (0.568)	2.338*** (0.662)	6.300*** (1.522)	7.352*** (1.581)
Size	0.418		0.145	0.095	0.538	

Literature 3 / 3

J. Finan. Intermediation 22 (2013) 218–244

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Bank competition and stability: Cross-country heterogeneity ☆

Thorsten Beck [a], Olivier De Jonghe [b,*], Glenn Schepens [c]

[a] CentER, European Banking Center, Tilburg University and CEPR, P.O. Box 90153, 5000 LE Tilburg, The Netherlands
[b] CentER, European Banking Center, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands
[c] Department of Financial Economics, Ghent University, W. Wilsonplein 5D, 9000 Ghent, Belgium

Table 5
The market power-bank soundness relationship: full sample regressions

Variables	ln(Z-score)	-ln(sd(ROA))	Eq/TA	ln(Z-score5)	ln(Z-score)	ln(Z-score)	ln(Z-score)	ln(Z-score)	ln(Z-score)
Lerner	1.946***	0.841***	7.443***	1.845***	1.814***		1.987***	1.988***	2.324***
	(0.105)	(0.117)	(0.487)	(0.114)	(0.0862)		(0.109)	(0.109)	(0.139)
Share of wholesale funding	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Stability

$$\ln Z_{it} = \sum_t \beta_t D_t L_{i,t-1} + controls_{it} + macro_{i,t-1} \Big| T_i > 5 \qquad (10)$$

where

controls: (i) ln TA, (ii) diversification, (iii) llp, (iv) ln assets growth, (v) Eq/Assets;

macro: lagged (i) rgdpg, (ii) interest rate, (iii) unempl, (iv) all banks credit, (v) all banks TA

Market power and stability

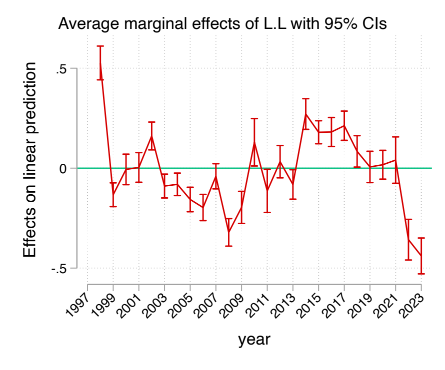

Figure: Left based on the NC technology

Market power and stability

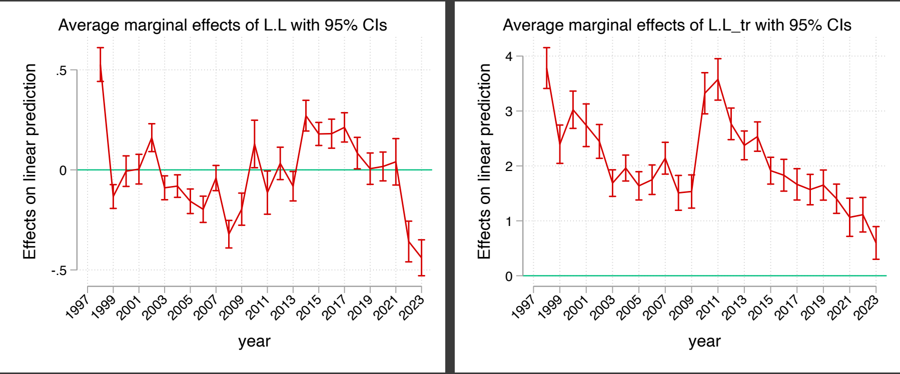

Figure: Left based on the NC technology; right: traditional.

Profitability

$$ROA_{it} = \sum_t \beta_{2,t} D_t L_{i,t-1} + controls_{it} + macro_{i,t-1} \Big| T_i > 5 \qquad (11)$$

where

controls: (i) ln TA, (ii) diversification, (iii) llp, (iv) ln assets growth, (v) Eq/Assets;

macro: lagged (i) rgdpg, (ii) interest rate, (iii) unempl, (iv) all banks credit, (v) all banks TA

Market power and profitability

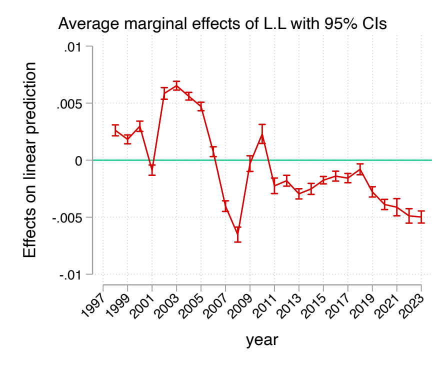

Figure: Left based on the NC technology

Market power and profitability

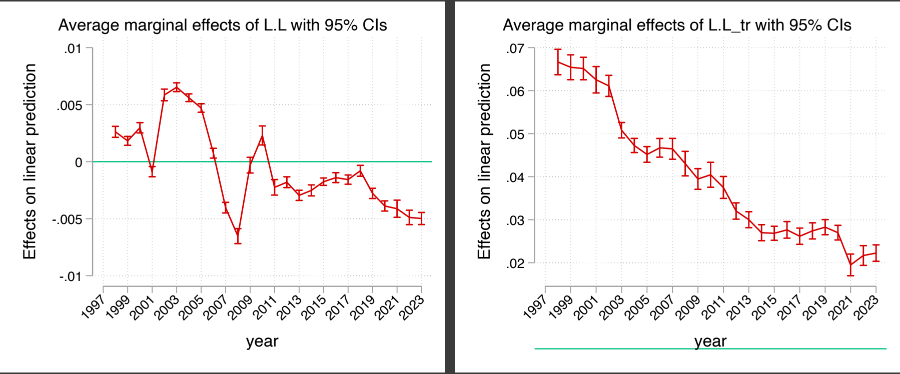

Figure: Left based on the NC technology; right: traditional.

Concluding Remarks

- Seemingly competitive environment in banking
- Deceitful if market power is calculated using an improper cost function
- We offer a method of calculating the Lerner Index when the cost function is nonconvex
- Huge differences with the traditional approach

The Last Slide

Thank you for your attention