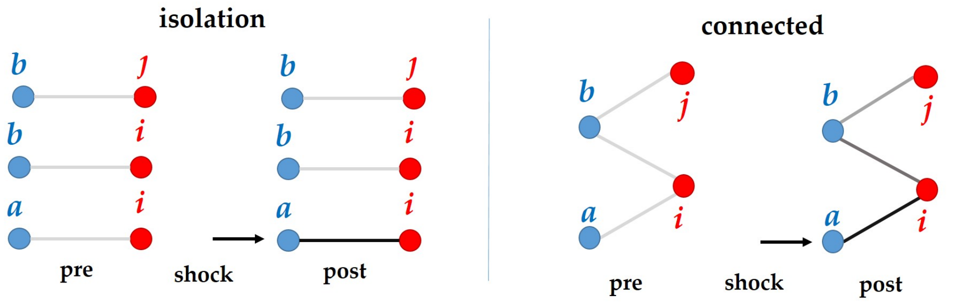
Reallocation Effects in Credit Markets

Stefano Pietrosanti and Edoardo Rainone

Bank of Italy

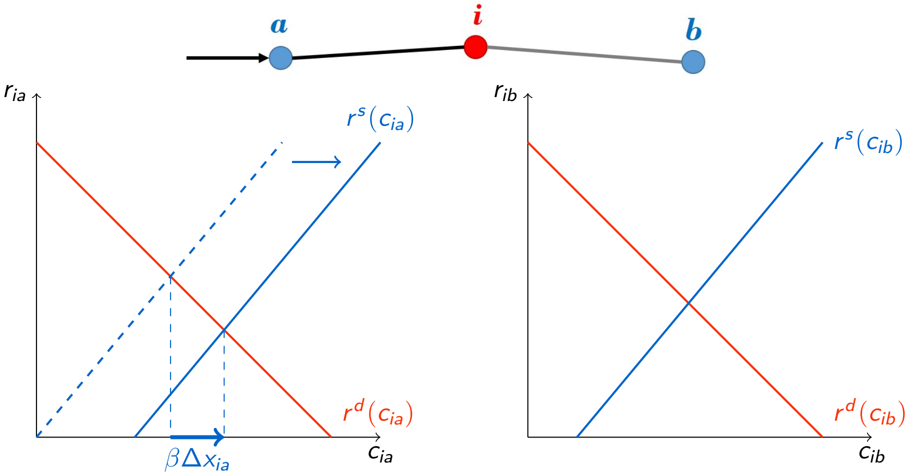
Innovation: Connecting the Dots

Model credit relationships **as interdependent**

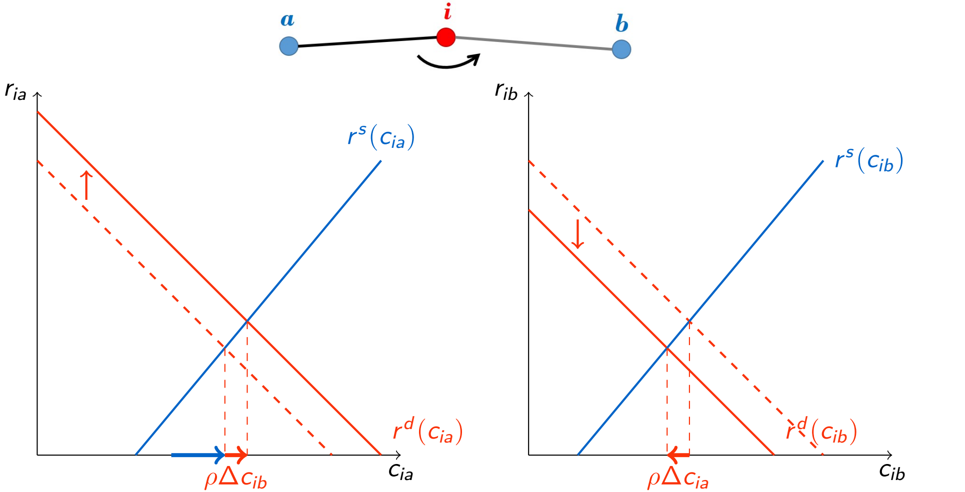


- **theory**: banks and firms joint optimization
- **estimation**: network econometrics

A supply shock to *ia* ...



... can trigger demand reallocation spillovers to *ib*



Econometric Model:

- Like in Khwaja and Mian (AER, 2008)...
- but banks and firms *optimize jointly.*

System of Simultaneous Equations

Isolated Credit Model (ICM)

$$c_{ia} = \tilde{\beta} x_{ia} + \tilde{\delta}_i + \tilde{\gamma}_a + \varepsilon_{ia},$$

$$c_{ib} = \tilde{\beta} x_{ib} + \tilde{\delta}_i + \tilde{\gamma}_b + \varepsilon_{ib},$$

$$c_{jb} = \tilde{\beta} x_{jb} + \tilde{\delta}_j + \tilde{\gamma}_b + \varepsilon_{jb}$$

Credit Network Model (CNM)

$$c_{ia} = \rho c_{ib} + \beta x_{ia} + \delta_i + \gamma_a + \epsilon_{ia},$$

$$c_{ib} = \rho c_{ia} + \phi c_{jb} + \beta x_{ib} + \delta_i + \gamma_b + \epsilon_{ib},$$

$$c_{jb} = \phi c_{ib} + \beta x_{jb} + \delta_j + \gamma_b + \epsilon_{jb}$$

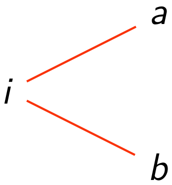
Khwaja and Mian (2008)-inspired. The modified Khwaja and Mian for the CNM model here.

Where credit allocation acts through firms, ρ...

$$c_{ia} = \rho c_{ib} + \beta x_{ia} + \delta_i + \gamma_a + \epsilon_{ia},$$

$$c_{ib} = \rho c_{ia} + \phi c_{jb} + \beta x_{ib} + \delta_i + \gamma_b + \epsilon_{ib},$$

$$c_{jb} = \phi c_{ib} + \beta x_{jb} + \delta_j + \gamma_b + \epsilon_{jb}$$



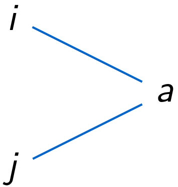
Firm Credit Substitution Effect (FCS)

...and through banks, ϕ

$$c_{ia} = \rho c_{ib} + \beta x_{ia} + \delta_i + \gamma_a + \epsilon_{ia},$$

$$c_{ib} = \rho c_{ia} + \phi c_{jb} + \beta x_{ib} + \delta_i + \gamma_b + \epsilon_{ib},$$

$$c_{jb} = \phi c_{ib} + \beta x_{jb} + \delta_j + \gamma_b + \epsilon_{jb}$$



Bank Credit Reallocation Effect (BCR)

The Credit Network Model (CNM)

Generalization to many relationships of the theoretical model:

$$c_{ib} = \alpha + \phi \sum_{j \in \mathbb{F} \setminus i} a_{ib,jb} c_{jb} + \rho \sum_{k \in \mathbb{B} \setminus b} a_{ib,ik} c_{ik} + \delta_i + \gamma_b + x_{ib}\beta + \epsilon_{ib}, \quad (1)$$

In matrix form, we have

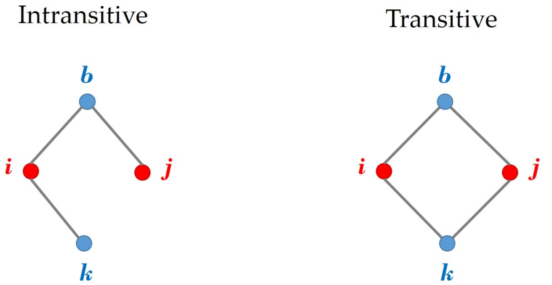
$$\begin{aligned} C &= \alpha + \phi A_B C + \rho A_F C + X\beta + \Delta + \Gamma + \epsilon, \\ &= +\phi A_B C + \rho A_F C + Z\mu + \epsilon. \end{aligned} \quad (2)$$

- Nests the commonly used models ($\rho = \phi = 0$),
- Using the same information set (A_B, A_F are known by construction).
- Link spatial autoregressive model (link-SAR, Rainone; 2020) with heterogeneous spillovers.

Identification OPIV 2SLS Math ;

Proposition 2.1

Identification is possible as long as not all firms borrow from all banks (intransitive quadriads, exogeneity) and spillovers are different from zero (relevance).



We call the solution **Overlapping Portfolio IV (OPIV)**.

Monte Carlo Simulation:

- ICM bias of treatment effects
- ICM bias of FEs
- CNM performance

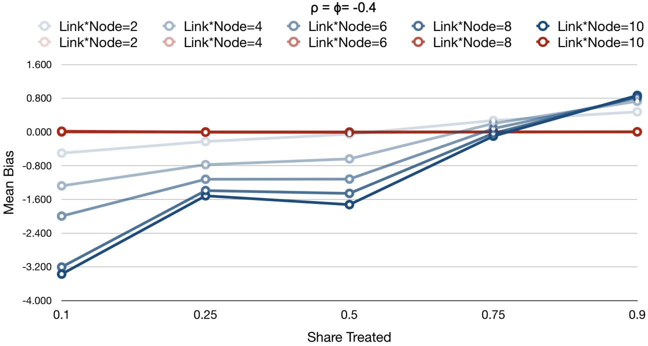
ICM Bias depends on knowns $(\sum X, \sum\sum A)$...

Estimated ICM:

$$C = a + X\beta + U$$

Mean Bias from ICMs.

Mean Bias from CNMs .



Formal intuition

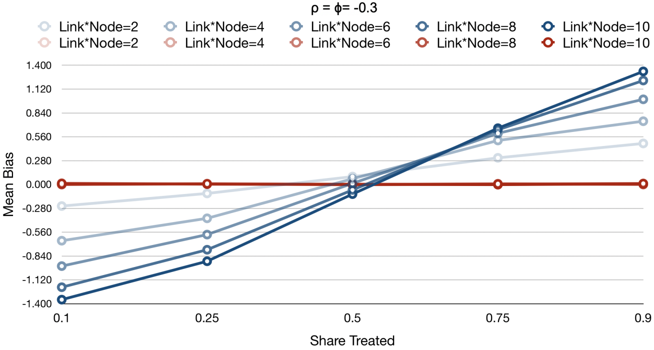
...and Unknowns (ρ, ϕ)!

Estimated ICM:

$$C = a + X\beta + U$$

Mean Bias from ICMs.

Mean Bias from CNMs .



Formal intuition

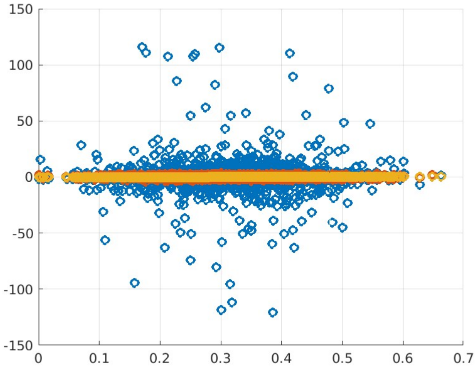
FEs' Estimates Are Highly Biased as Well

Estimated ICM:

$$C = a + X\beta + \mathbf{\Delta} + \mathbf{\Gamma} + U$$

We add FEs.

True FEs on x, estimates on y.



True values, ICM estimates, CNM estimates.

Banks And Firms Amplify Shocks Based on Their Centrality

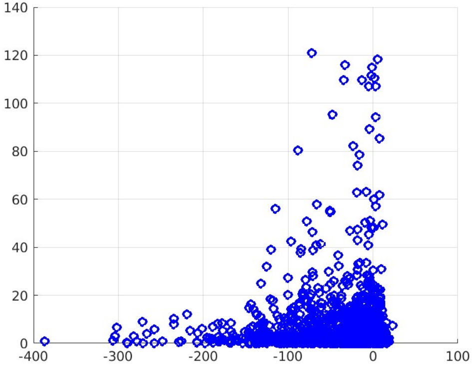
Estimated ICM:

$$C = a + X\beta + \mathbf{\Delta} + \mathbf{\Gamma} + U$$

We add FEs.

$$\text{Centrality} = D'_{node}(I - \phi A)^{-1} D_{node}$$

Centrality x, ICM estimates y.



We Document Empirically:

- The economic relevance of spillovers
- A large ICM bias for treatment and fixed effects both
- The behavior of spillovers over the business cycle

Setting and Data

We apply the tool to Jiménez et al.'s "Hazardous Times for Monetary Policy":

→ Measure less capitalized banks' risk-taking before the GFC.

Dataset:

- 2002 - 2022 all loans $>$ 30 k euro.
- 150k firms; 500/400 banks; 3 rel per firm; 1,000 per bank, on avg each year.
- **Outcome**: Log changes in credit granted.

Specification

Isolated Credit Model

$$\Delta \log \left(\text{granted}_{fbt}\right) = \beta \Delta \text{Overnight Rate}_t * I(\text{Risk})_{ft-1} * ln(\text{Capital})_{bt-1} + \ldots$$

$$\delta_{ft} + \gamma_{bt} + \mu \text{Controls}_{fbt} + \varepsilon_{fbt}$$

Credit Network Model; N.L. = Network Lag

$$\Delta \log \left(\text{granted}_{fbt}\right) = \beta \Delta \text{Overnight Rate}_t * I(\text{Risk})_{ft-1} * ln(\text{Capital})_{bt-1} + \ldots$$

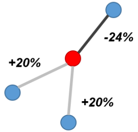
$$\phi \text{N.L.} \Delta \log \left(\text{granted}_{fbt}\right) + \rho \text{N.L.} \Delta \log \left(\text{granted}_{fbt}\right) + \ldots$$

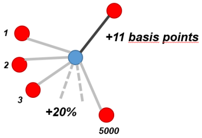
$$\delta_{ft} + \gamma_{bt} + \mu \text{Controls}_{fbt} + \varepsilon_{fbt}$$

Large Treatment Bias, Large Firm Spillovers

Dep. Var.:	$\Delta \log(\text{granted}_{fbt})$		Mean Dep.: 0.03	SD ln(Bank Eq./Asset): 0.2836			
	ICM		CNM Second Stage				
						Spillovers	
Years		Coeff.	SE	Coeff.	SE		Coeff.	SE
2002-2008	$\hat{\beta}$	0.007	0.002	0.021	0.0008	$\hat{\phi}*$	0.0054	0.0001
						$\hat{\rho}$	-0.6031	0.0044
	N	2,188,359					2,188,359	
							First Stage F_{SW}	
							Bank	Firm
							69,216	769

Reallocation extent





Fixed Effects are Highly Biased

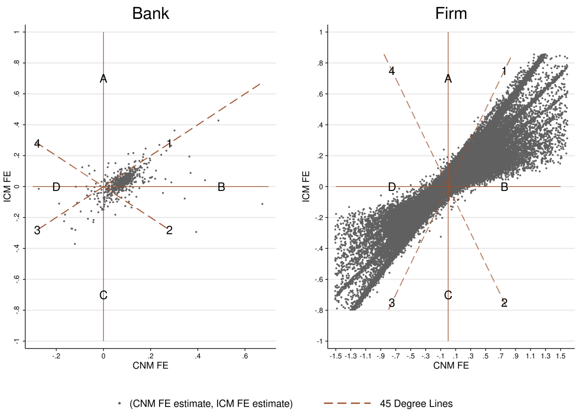
Mean Absolute Bias:

Bank = 2.3; Firm = 1.3

Median Absolute Bias:

Bank = 0.6; Firm = 0.5

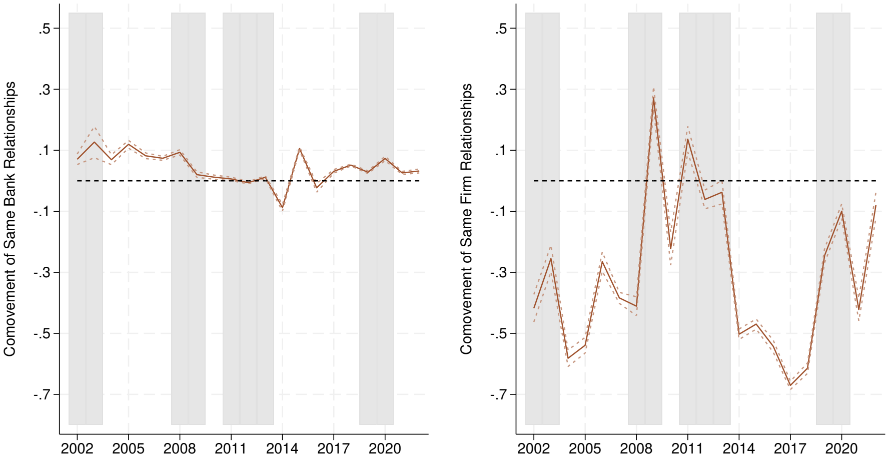
579 banks, 123 sign flips!



Firms' Credit Substitutability Strong Procyclical Patterns

Treat: DG

Treat: DG IV



What We Are Learning.

Addressing Interdependence in Credit Markets is Important

- **Network nature** of credit markets matters.
- CR Interdependence → **large and complex bias**.
- **Econometric method** to estimate unbiased effects and analyze substitution.
- → *When* firms can substitute, very large bias is possible.
- → Strong procyclical pattern for firm-credit substitution emerges.

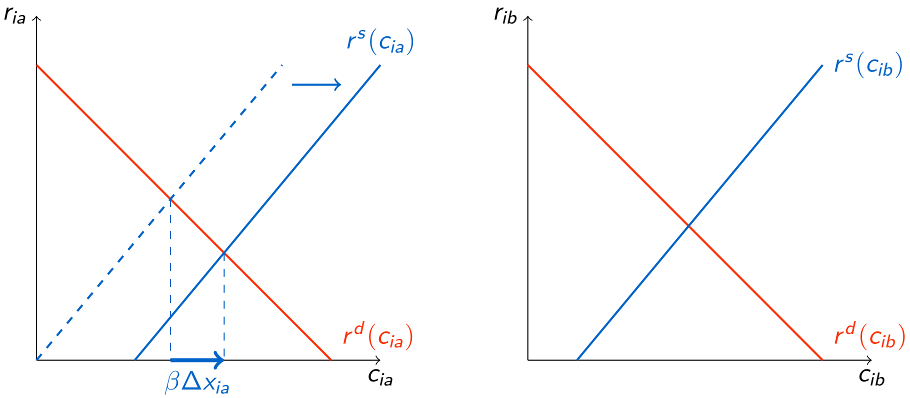
THANKS!

stefano.pietrosanti@bancaditalia.it
edoardo.rainone@bancaditalia.it

Support Material.

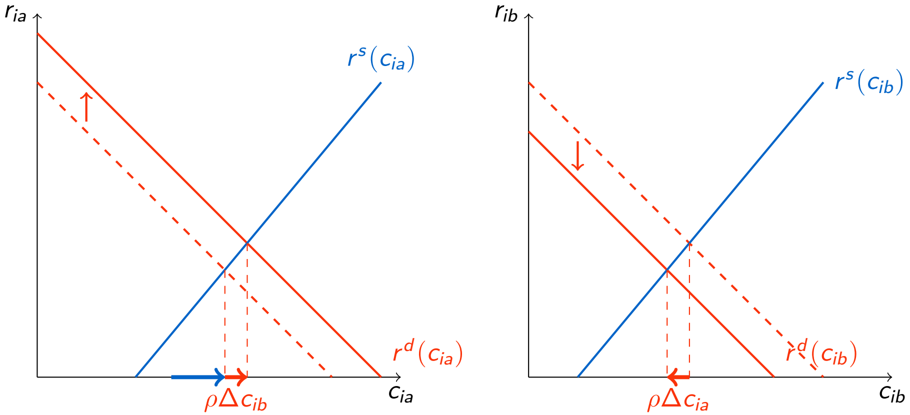
a's supply expands, credit from a to i grows by $\beta \Delta x_{ia}$

$$\Delta c_{ia} = \rho \Delta c_{ib} + \beta \Delta x_{ia} + e_{ia};\ \Delta c_{ib} = \rho \Delta c_{ia} + e_{ib}$$



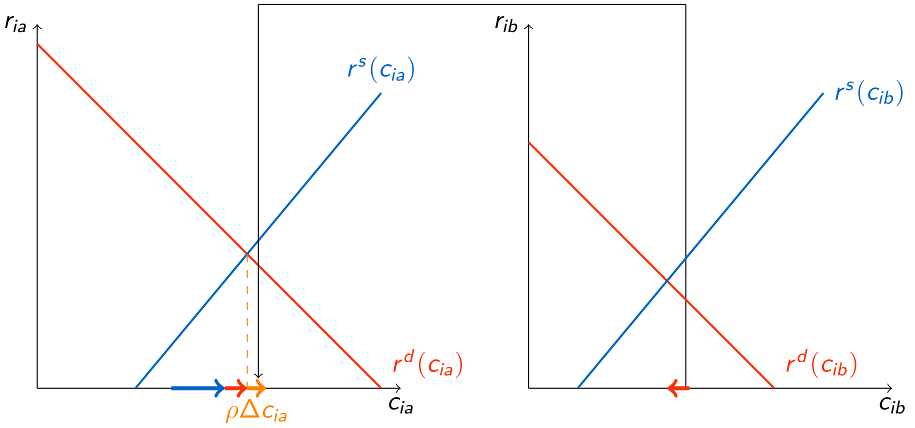
i reallocates ⇒ OLS will be biased...

$$\Delta c_{ia} = \rho \Delta c_{ib} + \beta \Delta x_{ia} + e_{ia};\ \Delta c_{ib} = \rho \Delta c_{ia} + e_{ib}$$



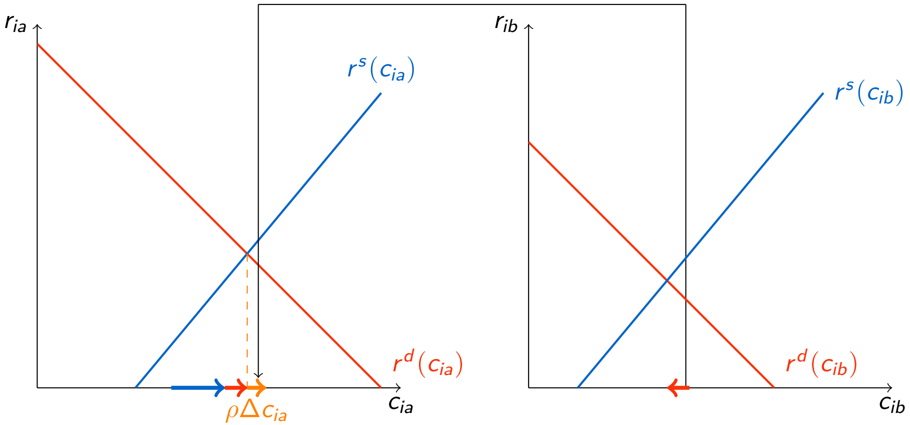
...and FEs may be dangerous... Propositions

$$\Delta c_{ia} - \Delta c_{ib} = \beta \Delta x_{ia} + \rho \Delta c_{ib} - \rho \boldsymbol{\Delta c_{ia}}$$



Notice that *no demand bias* was there! Propositions

$$\Delta c_{ia} - \Delta c_{ib} = \beta \Delta x_{ia} + \rho \Delta c_{ib} - \rho \boldsymbol{\Delta c_{ia}}$$



Khwaja and Mian (2008) with Full Portfolio Opt. Back

Bank b picks $r_{ib,jb}(c_{ib}, c_{jb})$ to maximize profit:

$$\pi_b(c_{ib}, c_{jb}) = \big(r_{ib} - \omega f(c_{ib}, x_{ib}, c_{jb}, \nu_{ib})\big)c_{ib} + \big(r_{jb} - \omega f(c_{jb}, x_{jb}, c_{ib}, \nu_{jb})\big)c_{jb}$$

$$f(c_{ib}, x_{ib}, c_{jb}, \nu_{ib}) = c_{ib} - \xi x_{ib} + \theta c_{jb} - \nu_{ib}$$

$\rightarrow$ Firm i picks $c_{ia}(e_i, c_{ib})$, $c_{ib}(e_i, c_{ia})$ to maximize profit:

$$\pi_i(c_{ia}, c_{ib}) = R(c_{ia}, c_{ib})(c_{ia} + c_{ib}) - \textstyle\sum_{K=a,b} c_{iK} r_{iK}\left(c_{iK}, c_{jK}\right)$$

$$R(c_{ia}, c_{ib}) = \big(e_i - \alpha(c_{ia} + c_{ib})\big)$$

Banks and Firms Joint Maximization

- The f function captures the cost imposed on the bank by the fraction of each loan which cannot be funded with costless debt.
- c_{ib}, c_{jb} are the quantity of credit supplied to firms i and j;
- x_{ib} is some observable relationship's characteristic that changes the marginal cost of lending to firm i for bank b by $-\xi$ dollars;
- ν_{ib} is an unobservable random component.
- c_{jb} enters the function capturing the supply-side of interdependence in lending decisions due to opportunity costs. Everything else equal, if bank b already lends one more dollar to firm j, this rises the cost of lending to i by θ dollars. We specify the cost function as linear, ω is thus a parameter that captures the baseline cost to the bank of one more dollar of commitment.
- We choose this specification to match as closely as possible the original by KM.
- The assumption of a common ω parameter across banks implies that banks face the same capital market.

- e_i is the productivity of firm f's use of funds,
- α tracks the quadratic decrease in returns to scale,
- r_{fK} is the loan's cost derived above.

Back

Bank Problem

Bank b: $\max_{c_{ib},\, c_{jb}} \big(r_{ib} - \omega(c_{ib} - \xi x_{ib} - \theta c_{jb} - \nu_{ib})\big) c_{ib} + \big(r_{jb} - \omega(c_{jb} - \xi x_{jb} - \theta c_{ib} - \nu_{jb})\big) c_{jb}$

Bank a: $\max_{c_{ia}} \big(r_{ia} - \omega(c_{ia} - \xi x_{ia} - \nu_{ia})\big) c_{ia}$

FOC deliver:

$$r_{ib} = \omega c_{ib} - \omega \underbrace{(\xi x_{ib} + \nu_{ib} - \theta c_{jb})}_{u_{ib}}$$
$$r_{jb} = \omega c_{jb} - \omega \underbrace{(\xi x_{jb} + \nu_{jb} - \theta c_{ib})}_{u_{jb}}$$
$$r_{ia} = \omega c_{ia} - \omega \underbrace{(\xi x_{ia} + \nu_{ia})}_{u_{ia}} \tag{3}$$

Back

Firm problem

Firm i: $\max_{c_{ia},\, c_{ib}} \big(e_i - \alpha(c_{ia} + c_{ib})\big)(c_{ia} + c_{ib}) - \sum_{K=a,b} c_{iK}\omega(c_{iK} - u_{iK})$

Firm j: $\max_{c_{jb}} \big(e_j - \alpha c_{jb}\big) c_{jb} - c_{jb}\omega(c_{jb} - u_{jb})$

FOC deliver:

$$e_i - 2\alpha c_{ia} - 2\alpha c_{ib} - 2\omega c_{ia} + \omega(\xi x_{ia} + \nu_{ia}) = 0$$
$$e_i - 2\alpha c_{ib} - 2\alpha c_{ia} - 2\omega c_{ib} + \omega(\xi x_{ib} + \nu_{ib} - \theta x_{jb}) = 0$$
$$e_j - 2\alpha c_{jb} - 2\omega c_{jb} + \omega(\xi x_{jb} + \nu_{jb} - \theta x_{ib}) = 0$$

Which simplifies to:

$$c_{ia} = -\frac{\alpha}{\alpha+\omega} c_{ib} + \frac{1}{2(\alpha+\omega)} e_i + \frac{\omega}{2(\alpha+\omega)}(\xi x_{ia} + \nu_{ia})$$
$$c_{ib} = -\frac{\alpha}{\alpha+\omega} c_{ia} + \frac{1}{2(\alpha+\omega)} e_i + \frac{\omega}{2(\alpha+\omega)}(\xi x_{ib} + \nu_{ib} - \theta c_{jb})$$
$$c_{jb} = \frac{1}{2(\alpha+\omega)} e_j + \frac{\omega}{2(\alpha+\omega)}(\xi x_{jb} + \nu_{jb} - \theta c_{ib})$$

Back

System of Simultaneous Equations

And delivers the following structural demand system:

$$c_{ia} = \rho c_{ib} + \beta x_{ia} + \delta_i + \epsilon_{ia}$$
$$c_{ib} = \rho c_{ia} + \phi c_{jb} + \beta x_{ib} + \delta_i + \epsilon_{ib}$$
$$c_{jb} = \phi c_{ib} + \beta x_{jb} + \delta_j + \epsilon_{jb}$$

Calling:

$$\rho = -\frac{\alpha}{\alpha+\omega}$$
$$\phi = -\frac{\theta\omega}{2(\alpha+\omega)}$$
$$\beta = \frac{\xi\omega}{2(\alpha+\omega)}$$
$$\delta_{i,j} = \frac{1}{2(\alpha+\omega)} e_{i,j}$$
$$\epsilon_{ia,ib,jb} = \frac{\omega\nu_{ia,ib,jb}}{2(\alpha+\omega)}$$

we can derive the following reduced form system:

$$c_{ia} = \frac{\rho(1+\rho-\phi^2)\delta_i+\rho\phi\delta_j}{1-\phi^2-\rho^2} + \beta\frac{(1-\phi^2)x_{ia}+\rho\phi x_{jb}+\rho x_{ib}}{1-\phi^2-\rho^2} + \frac{(1-\phi^2)\epsilon_{ia}+\rho\phi\epsilon_{jb}+\rho\epsilon_{ib}}{1-\phi^2-\rho^2}$$
$$c_{ib} = \frac{(1+\rho)\delta_i+\phi\delta_j}{1-\phi^2-\rho^2} + \beta\frac{\rho x_{ia}+\phi x_{jb}+x_{ib}}{1-\phi^2-\rho^2} + \frac{\rho\epsilon_{ia}+\phi\epsilon_{jb}+\epsilon_{ib}}{1-\phi^2-\rho^2}$$
$$c_{jb} = \frac{\phi(1+\rho)\delta_i+(1-\rho^2)\delta_j}{1-\phi^2-\rho^2} + \beta\frac{\rho\phi x_{ia}+(1-\rho^2)x_{jb}+\phi x_{ib}}{1-\phi^2-\rho^2} + \frac{\phi\rho\epsilon_{ia}+(1-\rho^2)\epsilon_{jb}+\phi\epsilon_{ib}}{1-\phi^2-\rho^2}$$

Back

OLS is Biased and FEs do not Help Back

$$
\begin{aligned}
c_{ia} &= \beta x_{ia} + \delta_i + \varepsilon_{ia}, \\
c_{ib} &= \beta x_{ib} + \delta_i + \varepsilon_{ib}, \\
c_{jb} &= \beta x_{jb} + \delta_j + \varepsilon_{jb}.
\end{aligned} \tag{4}
$$

Proposition 5.1

The estimator of β for the system of equations in (4), the shift in banks' supply curve, is biased and the bias can be expressed as

$$
\begin{aligned}
\hat{\beta}_{FE} &= \frac{cov(c_{ia}-\bar{c}_i, x_{ia}-\bar{x}_i)}{var(x_{ia}-\bar{x}_i)} \\
&= \beta(1-\rho) + \rho(1-\rho)\frac{cov(c_{ib}, x_{ia})}{var(x_{ia})} - \rho\frac{cov(\delta_i, x_{ia})}{var(x_{ia})} - \phi\frac{cov(c_{jb}, x_{ia})}{var(x_{ia})}.
\end{aligned} \tag{5}
$$

Proposition 5.2

$\hat{\beta}_{FE} \neq \hat{\beta}_{NO\ FE}$ *is possible even in the absence of demand bias ($cov(x_{ia}, \delta_i) = 0$).*

FEs may be Biased as Well Back

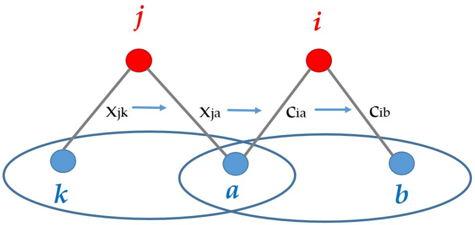
Proposition 5.3

Firm fixed effects' estimates contain supply shock spillovers and bank fixed effects' estimates contain demand shock spillovers. As such, they cannot be regarded as pure measures of each firm or bank demand and supply shocks, respectively.

$$\begin{aligned} \hat{\delta}_i &= \frac{(1+\rho)}{1-\phi^2-\rho^2}\delta_i + \frac{\phi}{1-\phi^2-\rho^2}\delta_j \\ \hat{\delta}_j &= \frac{\phi(1+\rho)}{1-\phi^2-\rho^2}\delta_i + \frac{(1-\rho^2)}{1-\phi^2-\rho^2}\delta_j \end{aligned} \tag{6}$$

Overlapping Portfolio Instrumental Variables Back

$$
\begin{aligned}
TIV_F &= E(A_F C) = E[(A_F(I - \rho A_F - \phi A_B)^{-1}(\alpha + Z\mu))] \\
&= E[A_F[\sum_{k=0}^{\infty}(\rho A_F + \phi A_B)^k](\alpha + X\beta + \Delta + \Gamma)] \\
&= E[(A_F + \phi A_F A_B + \cdots)(\alpha + X\beta + \Delta + \Gamma)]
\end{aligned}
\tag{7}
$$



Endogeneity

The simultaneity of equations in model (2) creates an intrinsic endogeneity problem if

$$E[(A_F C)'\epsilon] = E[(A_F(I - \phi A_F - \rho A_B)^{-1}(\alpha + Z\mu + \epsilon))'\epsilon] \neq 0,$$
$$E[(A_B C)'\epsilon] = E[(A_B(I - \phi A_F - \rho A_B)^{-1}(\alpha + Z\mu + \epsilon))'\epsilon] \neq 0.$$

The last inequalities hold if

$$E[(A_F(I - \phi A_F - \rho A_B)^{-1}\epsilon)'\epsilon] = \sigma_\epsilon^2 tr(A_F(I - \phi A_F - \rho A_B)^{-1}) \neq 0,$$
$$E[(A_B(I - \phi A_F - \rho A_B)^{-1}\epsilon)'\epsilon] = \sigma_\epsilon^2 tr(A_B(I - \phi A_F - \rho A_B)^{-1}) \neq 0.$$

2SLS Estimator

First order approximations of TIV_F and TIV_B are respectively:

$$EIV_F^1 = A_F X, \tag{8}$$
$$EIV_B^1 = A_B X. \tag{9}$$

The 2SLS estimator is consequently

$$\hat{\theta}_{2SLS} = (W' P_Q W)^{-1} (W' P_Q C), \tag{10}$$

where $Z = [A_F C, A_B C, Z]$, $P_Q = Q(Q'Q)^{-1}Q'$, $Q = [EIV_F, EIV_B, X]$ and $\hat{\theta}_{m,t,2SLS} = [\hat{\phi}_{2SLS}, \hat{\rho}_{2SLS}, \hat{\mu}_{2SLS}]$.

Treatment Effect Bias Expression Back

$$p_k = X'A^kX$$

$$\text{Bias} \; : \hat{\beta} - \beta = (X'X)^{-1}X'U = \beta(X'X)^{-1}\left(\sum_{k \text{ odd}} \phi^k p_k + \sum_{k \text{ even}} \phi^k p_k\right)$$

Low $\sum X$ $\rightarrow$ more - feedback loops.

Higher $\sum X$ $\rightarrow$ increase the importance of other + loops.

Higher $\sum\sum A$ $\rightarrow$ amplifies all the effects.

Treatment Effect Bias Indeterminate Sign

Simplifications: Assume $\phi = \rho$, ignore FE, X binary.

$$C = \phi AC + X\beta + \epsilon, \;\; \textit{we estimate } C = X\beta + U.$$

$$U = \phi A(I - \phi A)^{-1}[X\beta + \epsilon] + \epsilon, \Rightarrow X'U = \beta \sum_{k=1}^{\infty} \phi^k X' A^k X$$

number of k-distant treated edges $X'A^kX = p_k$

if $\phi < 0 \Rightarrow$

$$\text{Bias} \;\; : \hat{\beta} - \beta = (X'X)^{-1}X'U = \beta(X'X)^{-1}\left(\sum_{k \text{ odd}} \phi^k p_k + \sum_{k \text{ even}} \phi^k p_k\right)$$

Endogenous Treatment

Assume $\epsilon = \iota X + V$, with $V \perp X, \epsilon$.

$$X'U = S + X'(M + I)(\iota X + V)$$
$$= \underbrace{S}_{spillovers} + \underbrace{\iota X'X}_{endogeneity} + \underbrace{\iota X'MX}_{combination},$$

$$X'\epsilon = \iota X'X + \iota X'MX.$$

$D = B_{ICM} - B_{CNM} \neq 0$ does not imply that $\iota \neq 0$, but it does imply that $S \neq 0$.
Intuition: Net IVs are still uncorrelated with the error term, i.e. $E[\epsilon' AX] = 0$.

Back

Endogenous Networks

Dyadic network formation model with bank and firm and rel unobs.

$$g_{ib} = I(d(h_i, h_b, h_{ib}) \geqslant u_{ib}), \tag{11}$$

$$a_{ib,jb} = g_{ib}g_{jb} = I(d(h_i, h_b, h_{ib}) \geqslant u_{ib})I(d(h_j, h_b, h_{jb}) \geqslant u_{jb}). \tag{12}$$

Controlling for h_{ib}, the network A and ϵ_{ib} become mean independent

$$E(\epsilon_{ib}|A, h_{ib}) = E(\epsilon_{ib}|h_{ib}) =: k(h_{ib}). \tag{13}$$

Outcome equation that controls for $\hat{h}_{ib}$ nonparametrically,

$$c_{ib} = \alpha + \phi \sum_{j \in \mathbb{F} \setminus i} a_{ib,jb} c_{jb} + \rho \sum_{k \in \mathbb{B} \setminus b} a_{ib,ik} c_{ik} + \delta_i + \gamma_b + x_{ib}\beta + k(\hat{h}_{ib}) + u_{ib}, \tag{14}$$

where $u_{ib} := \epsilon_{ib} - k(\hat{h}_{ib})$.

Back

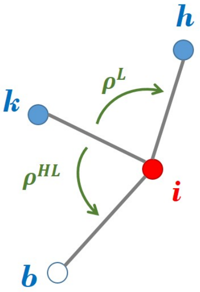
Heterogeneous Spillovers

Suppose there are H and L type banks

$$C = (\rho^H A_F^H + \rho^L A_F^L + \rho^{HL} A_F^{HL} + \rho^{LH} A_F^{LH})C + \phi A_B C + Z\mu + \epsilon. \quad (15)$$

where

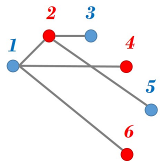
$$A_F = \begin{bmatrix} A_F^{L*} & A_F^{HL*} \\ A_F^{LH*} & A_F^{H*} \end{bmatrix}$$



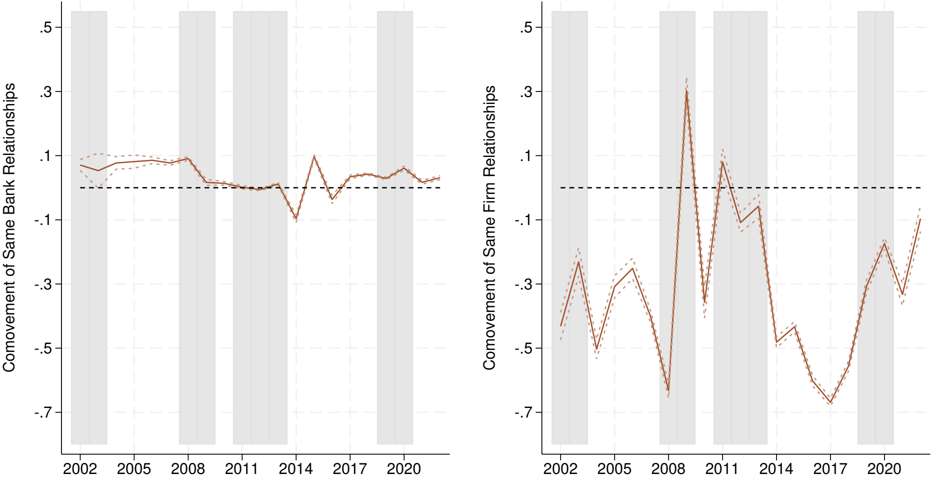
Back

Monte Carlo Setting

- **DGP**: $C = (I - \phi A_B - \rho A_F)^{-1}(\beta X + \Delta + \Gamma + \epsilon)$.
- X: random binary; FEs and $\epsilon \sim N(0,1)$; reps $= 500$
- Circular Network:
  - Node i linked to opposite nodes till $i + j$, $j \leqslant z_i$.
  - $z_i \sim U(0, m)$, $m =$ density parameter.
- $N = 2,000$; $\phi = \rho = 0.4$; $\beta = -2$; $m = 2(2)10$.
- Share treated $= .1, .25, .5, .75, .9$.



Risk as Drawn Granted Back



Risk as Drawn Granted, Altavilla et al. MP Shocks Back