Identifying Heterogeneous Supply and Demand Shocks (in European Credit Markets)

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Traditional setting

Identification of supply and demand relationships central to econom(etr)ics

Approach with granular data from credit registers:

$$\Delta l_{fb} = d_f + s_b + \epsilon_{fb} \ (\ldots + \ \Gamma X_{fb}) \, .$$

Rely on fixed effects to recover/absorb homogeneous shocks (Khwaja and Mian (2008), Amiti and Weinstein (2018), etc.)

Homogeneity is strong assumption and rules out key policy questions.

Credit markets: many-to-many bipartite market, a special network setting (e.g., Bonhomme (2020))

$\rightarrow$ Not specific to empirical banking:
workers/firms (AKM), imports/exports, primary dealers/buyers,...

Extending the setting

Our framework: use micro-data and study the bivariate model (in the cross-section!)

$$\begin{pmatrix} \Delta r_{fb} \\ \Delta l_{fb} \end{pmatrix} = A \begin{pmatrix} u^d_{fb} \\ u^s_{fb} \end{pmatrix} (\ldots + \Gamma X_{fb}) .$$

$\rightarrow$ Need credit register with quantities **AND** prices

Changes in quantity and price are driven by:

- relationship-specific demand and supply shocks
- an elasticity matrix

Goal: Identify A: supply and demand elasticities

$\Rightarrow$ identify shocks (u_{fb}) themselves from $A^{-1} \begin{pmatrix} \Delta r_{fb} \\ \Delta l_{fb} \end{pmatrix}$

Identification 1: Moments and assumption/restriction

Let $\eta_{fb} \equiv \begin{pmatrix} \Delta r_{fb} \\ \Delta l_{fb} \end{pmatrix}$, $\rightarrow$ use 2 novel moments: $\text{cov}(\eta_{fb}, \eta_{f'b})$ and $\text{cov}(\eta_{fb}, \eta_{fb'})$

$\text{cov}(\eta_{fb}, \eta_{f'b})$ is the covariance of η_{fb} across firms ($f' \neq f$), holding b fixed.

$$\text{Cov}\left(\begin{pmatrix} \Delta r_{fb} \\ \Delta l_{fb} \end{pmatrix}, \begin{pmatrix} \Delta r_{f'b} \\ \Delta l_{f'b} \end{pmatrix}\right) = \begin{pmatrix} \text{Cov}(\Delta r_{fb}, \Delta r_{f'b}) & \text{Cov}(\Delta r_{fb}, \Delta l_{f'b}) \\ \text{Cov}(\Delta l_{fb}, \Delta r_{f'b}) & \text{Cov}(\Delta l_{fb}, \Delta l_{f'b}) \end{pmatrix}.$$

Leading to: $\text{cov}(\eta_{fb}, \eta_{f'b}) \equiv \Sigma_{FF} = A\Lambda_{FF}A'$

where $\Lambda_{FF} = \begin{bmatrix} E\left[u^d_{fb}u^d_{f'b}\right] & 0 \\ 0 & E\left[u^s_{fb}u^s_{f'b}\right] \end{bmatrix}$, by Assumption $E[u^d_{fb}u^s_{f'b}] = 0$

Similarly, for $b' \neq b$: $\text{cov}(\eta_{fb}, \eta_{fb'}) \equiv \Sigma_{BB} = A\Lambda_{BB}A'$

where Λ_{BB} diagonal by Assumption $E[u^d_{fb}u^s_{fb'}] = 0$.

Identification 2: Unique solution

Proposition 1

If $\Lambda_{FF} \neq c\Lambda_{BB}$ for any scalar c, then the solution to

$$\Sigma_{FF} - A\Lambda_{FF}A' = 0$$
$$\Sigma_{BB} - A\Lambda_{BB}A' = 0$$

is unique up to scale, sign, and column ordering.

Solution in closed form: eigenvectors of $\Sigma_{FF}\Sigma_{BB}^{-1}$.

Argument follows Rigobon (2003): identification through heteroscedasticity

Roadmap

1. Methodological contribution
   - Establish **non-parametric identification**.
   - Establish consistency and asymptotic normality of $\hat{A}$.
   - Provide consistent estimators of asymptotic variance of $\hat{A}$.
   - Monte Carlo simulation: bias, size, pooling,...

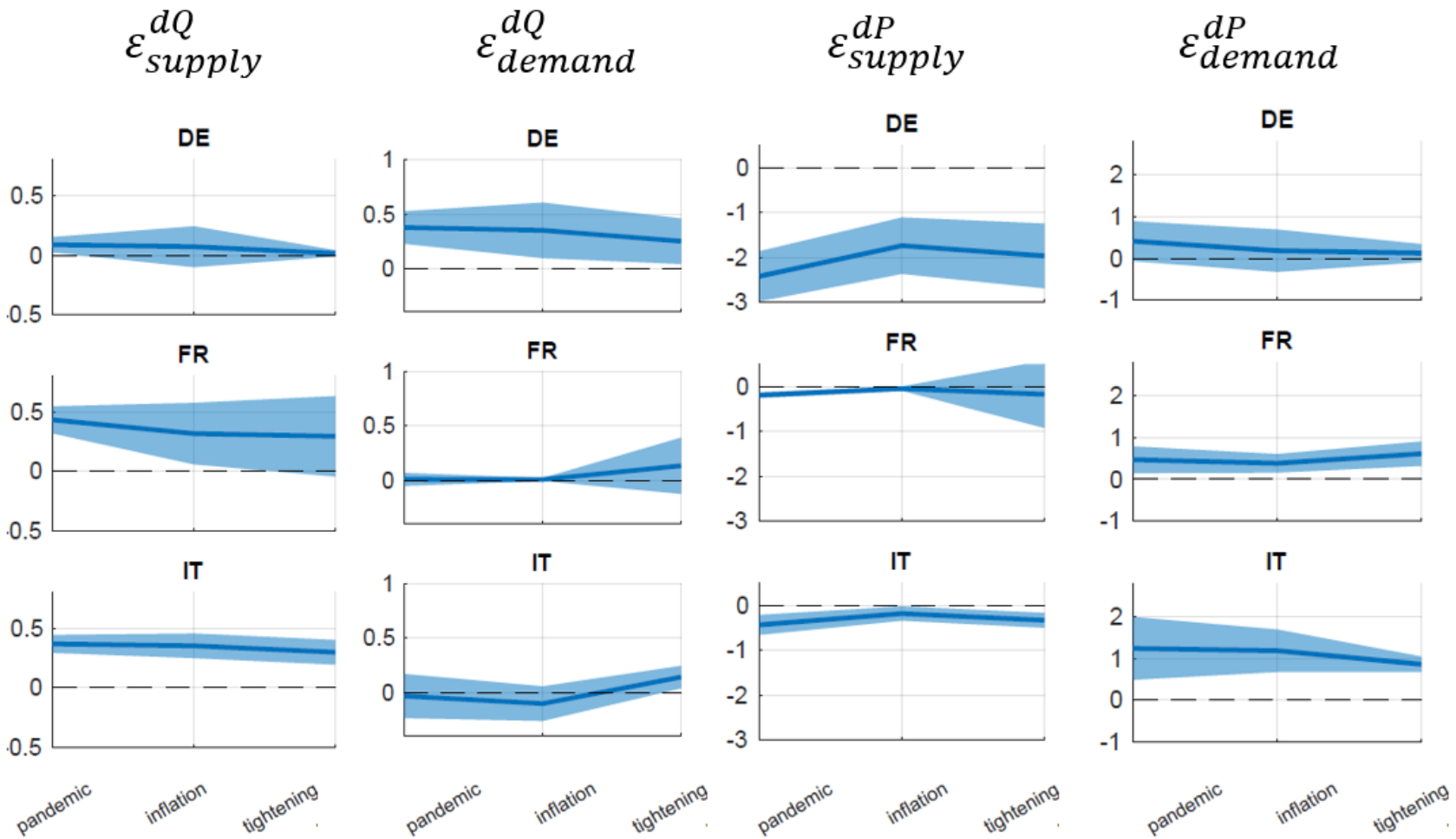
2. Empirical analysis, using Anacredit
   - Elasticities over time and across countries
   - Alternatively, cast them into supply and demand graphs
   - Document between AND within firm/bank heterogeneity
   - Study realized supply and demand shock distributions
   - Closing the circle: Δl_{fb} and Δr_{fb} versus u^d_{fb} and u^s_{fb}

Sample: period and countries

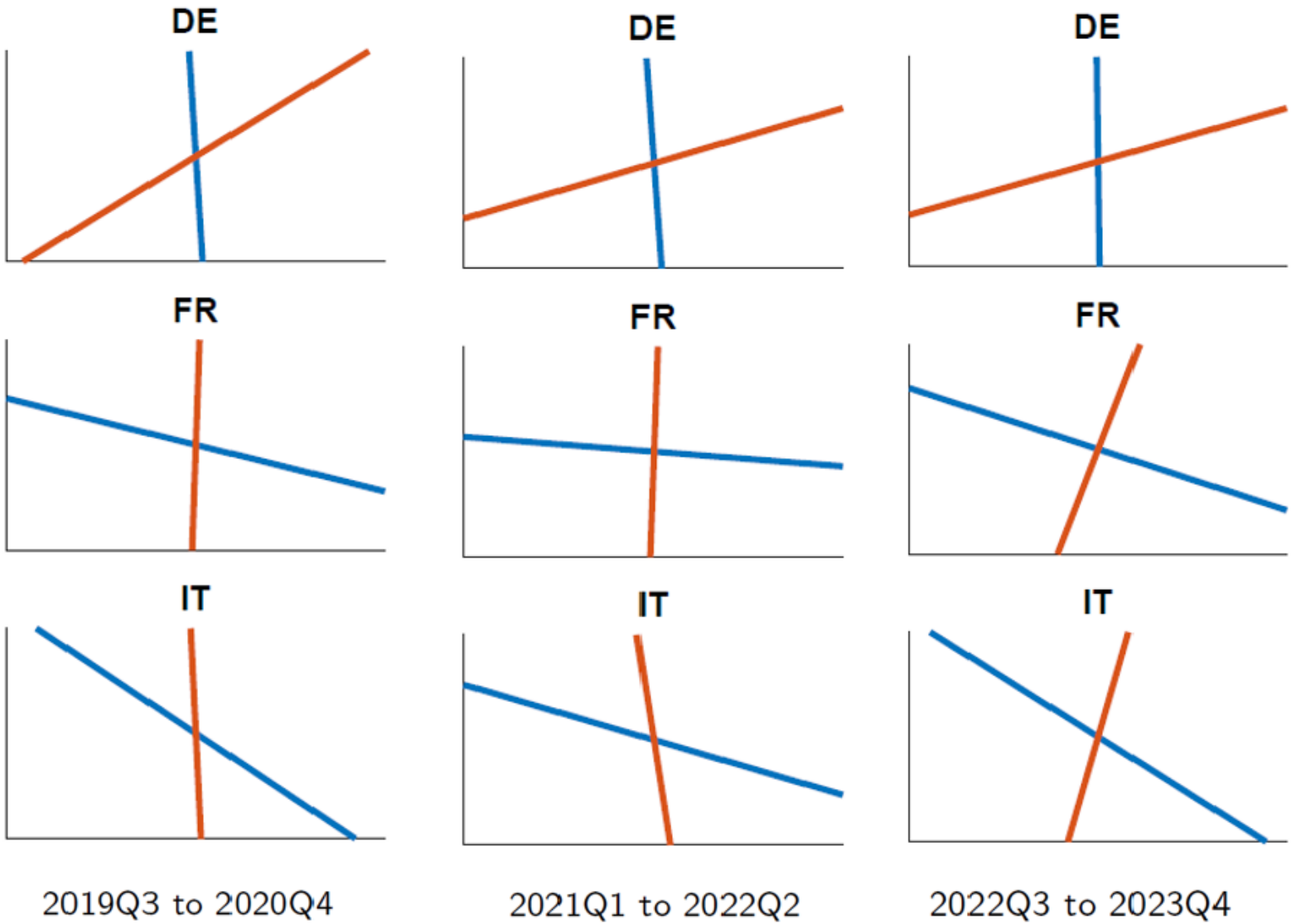
- We study supply and demand dynamics in 11 euro area credit markets, leveraging the **AnaCredit** database.
- Countries as in Kosekova et al. (forthcoming)
- Credit Types: Revolving credit, credit lines, and term loans.
- Metrics:
  - Δl_{fb}: "Midpoint" growth in committed amount
  - Δr_{fb}: Change in value-weighted interest rate
  - Both metrics are winsorized and demeaned.
- Three 6-quarter pooled samples used to study elasticity changes:
  - 2019Q3–2020Q4: Pandemic
  - 2021Q1–2022Q2: Inflationary build-up
  - 2022Q3–2023Q4: Monetary tightening

▸ Banks and firms per country

Elasticities Over Time



The Evolution of Supply and Demand Curves



Within variation is comparable to between variation

Table: Between and within variation

Collapse at the firm-time level

	p10	p25	p50	p75	p90	IQR	STD
Average demand innovation	-0.636	-0.199	0.005	0.192	0.628	0.391	0.665
Range of demand innovation	0.021	0.110	0.472	1.370	2.899	1.260	1.324
Std dev demand innovation	0.014	0.071	0.291	0.811	1.699	0.739	0.792

Collapse at the bank-time level

	p10	p25	p50	p75	p90	IQR	STD
Average supply innovation	-0.360	-0.127	-0.002	0.135	0.377	0.262	0.453
IQR of supply innovation	0.006	0.061	0.245	0.578	1.236	0.516	0.751
Std dev supply innovation	0.188	0.439	0.803	1.178	1.576	0.739	0.554

Heterogeneous firm credit demand and bank credit supply

- For $>$50% of firms, the within range is larger than the between IQR (demand)
- For $>$50% of firms, The within firm st.dev. is $>$40% of between firm st.dev.
- Median within-bank IQR $\approx$ Median between-bank IQR
- 75% of banks have a Within-bank st. dev. larger than the between st. dev.

The impact of monetary policy, central bank information and macroprudential policy

Focus on PD and Fixed-rate borrowing

	(1)	(2)	(3)	(4)	(5)	(6)
	Demand innovation (f,b,t)			Supply innovation (f,b,t)		
Probability of Default (f,b,t)	0.016	0.011	-0.006	-0.212***	-0.207***	-0.185***
	(0.024)	(0.024)	(0.026)	(0.050)	(0.049)	(0.050)
Monetary Policy (t) × Probability of Default (f,b,t)	-0.397	-0.416	-0.044	-0.012	0.034	-0.446
	(0.264)	(0.255)	(0.202)	(0.175)	(0.183)	(0.307)
Central Bank Information (t) × Probability of Default (f,b,t)	-2.087***	-2.127***	-2.271***	-0.466	-0.349	-0.162
	(0.534)	(0.516)	(0.574)	(0.302)	(0.307)	(0.329)
Share of fixed rate loans (f,b,t-1)		-0.127***	-0.125***		0.141***	0.141***
		(0.022)	(0.021)		(0.018)	(0.018)
Monetary Policy (t) × Share of fixed rate loans (f,b,t-1)		-0.511***	-0.533***		0.721***	0.725***
		(0.127)	(0.127)		(0.238)	(0.237)
Central Bank Information (t) × Share of fixed rate loans (f,b,t-1)		0.021	0.033		0.700*	0.699*
		(0.300)	(0.313)		(0.366)	(0.365)
Quarterly Change in Macro-Prudential index (t) × Probability of Default (f,b,t)			0.037***			-0.047*
			(0.010)			(0.025)
Quarterly Change in Macro-Prudential index (t) × Share of fixed rate loans (f,b,t-1)			-0.017*			0.003
			(0.010)			(0.007)
Observations	5899787	5899787	5899787	5899787	5899787	5899787
R-squared	0.52	0.52	0.52	0.51	0.51	0.51
Adjusted R-squared	0.02	0.03	0.03	0.00	0.01	0.01
Firm×Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank×Industry×Location×Time FE	Yes	Yes	Yes	Yes	Yes	Yes
SE-cluster1	Bank	Bank	Bank	Bank	Bank	Bank

- Monetary Policy and Central Bank Information shocks from Jarociński and Karadi (2020)
- Changes in macro-prudential policy from the IMF's integrated Macroprudential Policy (iMaPP) Database (Alam et al. 2019)

ΔQ and ΔP vs. Demand and Supply Innovations

Enriching the toolbox

	(1) Credit growth (f,b,t)	(2) Change in Interest Rate (f,b,t)	(3) Demand innovation (f,b,t)	(4) Supply innovation (f,b,t)
Share of fixed rate loans (f,b,t-1)	0.045***	-0.229***	-0.157***	0.158***
	(0.007)	(0.020)	(0.018)	(0.016)
Share of collateralized loans (f,b,t-1)	0.047***	-0.021**	0.011	0.039***
	(0.013)	(0.010)	(0.013)	(0.012)
Share of Credit lines and Term Loans (f,b,t-1)	-0.137***	0.118***	0.088***	-0.130***
	(0.032)	(0.021)	(0.016)	(0.028)
Share of bank in a firm's overall borrowing (f,b,t-1)	-0.482***	-0.043***	-0.223***	-0.301***
	(0.032)	(0.010)	(0.022)	(0.019)
Bank Sectoral Market Share (f,b,t-1)	-0.030	-0.010	-0.023	-0.001
	(0.050)	(0.025)	(0.023)	(0.041)
Bank Sectoral Exposure (f,b,t-1)	0.225***	-0.069***	0.060	0.154***
	(0.053)	(0.023)	(0.038)	(0.031)
Observations	12711274	12711274	12711274	12711274
R-squared	0.42	0.45	0.43	0.43
Adjusted R-squared	0.05	0.11	0.08	0.07
Firm×Time FE	Yes	Yes	Yes	Yes
Bank×Time FE	Yes	Yes	Yes	Yes
SE-cluster1	Bank	Bank	Bank	Bank
SE-cluster2	-	-	-	-
Sample	201909-202312	201909-202312	201909-202312	201909-202312
Coverage	11 countries	11 countries	11 countries	11 countries

- If only information on quantities is available

ΔQ and ΔP vs. Demand and Supply Innovations

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- If only information on quantities is available
- Adding the price dimension, but using high-dimensional fixed effect

ΔQ and ΔP vs. Demand and Supply Innovations

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SE-cluster2	-	-	-	-
Sample	201909-202312	201909-202312	201909-202312	201909-202312
Coverage	11 countries	11 countries	11 countries	11 countries

- If only information on quantities is available
- Adding the price dimension, but using high-dimensional fixed effect
- The full picture

Conclusion

Jointly model Δl_{fb} and Δr_{fb}, and assume elasticities apply to all relationships.

Replace homogeneity assumption with much weaker **correlation** assumption: u_{fb} vector is *correlated*, not *constant* across f and b dimensions.

- We identify from those very correlations
- Yields elasticity matrix, supply and demand curves, parameters for model calibration

We also identify and study a distribution of shocks for each firm/bank.

- Allows studying within firm/bank heterogeneity in credit demand and supply
- Provide guidance on interpretation and misspecification in HDFE approaches

Discipline models, motivate empirical assumptions, inform policy.

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Sample Description

Summary Statistics

	Pandemic			Inflation			Tightening		
	F	*B*	*N*	*F*	*B*	*N*	*F*	*B*	*N*
Austria	6,324	334	17,371	7,222	446	19,493	17,234	416	45,824
Belgium	12,511	19	27,129	13,398	20	29,297	16,891	21	37,107
Germany	59,059	848	151,185	60,468	808	155,567	95,451	774	242,030
Spain	108,521	99	323,796	100,198	101	302,326	114,485	96	328,883
Finland	7,649	172	16,324	7,019	158	15,026	13,749	144	30,155
France	60,156	129	142,101	74,498	132	176,373	57,476	131	135,142
Greece	3,536	16	9,645	4,042	15	10,074	8,165	14	20,072
Ireland	200	10	409	217	9	439	650	10	1,334
Italy	192,523	214	582,294	168,079	202	497,973	196,463	195	583,328
Netherlands	1,092	19	2,267	1,692	19	3,585	1,519	20	3,282
Portugal	22,700	110	62,724	25,288	103	68,216	29,881	99	80,965

Notes:
F refers to firms, *B* to banks, and *N* to observations.
Data is segmented into three periods: Pandemic (2019Q3–2020Q4), Inflation (2021Q1–2022Q2), and Tightening (2022Q3–2023Q4).

▸ Sample and data