The Ideal Loan and the Patterns of Cross-Border Bank Lending

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Motivation

Gravity equations explain many cross-border activities very well, while often it is unclear why

We need a theoretical foundation, in order to...

- find the proper specification
- interpret the results correctly

Theoretical gravity equations for bank loans

So far proposed theories to explain cross-border financial assets holdings focused on equity

- Portfolio investment (Martin und Rey 2004, JIE)
- Equity (Okawa und van Wincoop 2012, JIE)

Gravity equation results in general equilibrium

We offer a theoretical foundation for bank loans in a partial equilibrium that does *not* require portfolio optimization over all assets world wide

Bank loans as differentiated customer-bank relationship

The starting point:

- Bank loans are differentiated products, negotiated in a bank-firm-relationship
- A credit contract is *not* a homogeneous debt holding, where only the interest rate is relevant

OECD interest rate definition (MEI)

"...interest rates vary not only because of inflation ... but also because of a number of other influences, including the amount, purpose and period of the transaction, the credit-worthiness of the borrower, the collateral offered and/or guarantees/guarantors available, the competition for the transaction, government policy. As a consequence, there will be numerous rates applying to a large number number of transactions that are in effect at any one time in any one country."

Our steps

1. Specification of a possible firm-bank-relationship
2. Decision on the best offer by the firm
3. Aggregation over all firms
4. Derivation of the gravity equation for bank loans
5. Estimation with BIS data

Outline

The firm-bank-relationship

- A firm manager approaches a bank with the rough characteristics of a loan request
  - Amount needed, time schedule, and maturity
  - Fixed costs, interest rate and its adjustment
  - Collateral
  - Information requirements
- The bank makes a loan offer
- The manager approaches several banks to compare the offers

We assume, that...

- banks make take-it or leave-it offers
- the non-monetary characteristics of the offer can be quantified
- we therefore can compare credit costs c

Credit costs

Credit costs are specific for each relationship of firm g and bank k.

They depend on firm-specific, bank-specific and relationship-specific characteristics

Credit costs c_{gk}

$$c_{gk} = \beta r_{gk} + \underbrace{\gamma \tau_{gk}}_{\substack{\uparrow \\ \text{relationship-specific}}} + \overbrace{\delta a_k}^{\substack{\text{bank-specific} \\ \downarrow}}, \tag{1}$$

where r_{gk} denotes the interest rate

Average credit costs

Credit costs in (1) are data demanding → impossible to acquire for a large sample of different countries

We are interested on country characteristics anyway

We express the credit costs in (1) in country characteristics

Credit costs c_{gk}

$$c_{gk} = \beta r_j + \underbrace{\gamma \tau_{ij}}_{\substack{\uparrow \\ \text{bilateral variables}}} + \overbrace{\delta a_j}^{\substack{\text{credit country-specific} \\ \downarrow}} + \epsilon_{gk}, \tag{2}$$

Index i denotes the country of the firm, j the country of the bank. ϵ_{gk} might be known to the firm but not to the researcher

Credit choice

The firm minimizes its credit costs by choosing among the offers the most suitable.

The probability, that firm g from i chooses the offer by bank k from j equals

$$\begin{aligned}
\mathbf{P}_{igjk} &= \Pr\left(c_{igjk} = \min\left\{c_{l1}\cdots c_{ln_l}\right\};\quad l = 1\cdots N, jk \neq lh\right) \\
&= \Pr\left(\bar{c}_{ij} - \bar{c}_{il} + \epsilon_{igjk} < \epsilon_{igl1};\cdots;\bar{c}_{ij} - \bar{c}_{il} + \epsilon_{igjk} < \epsilon_{igln_l}\right) \\
&= 1 - \Pr\left(\bar{c}_{ij} - \bar{c}_{il} + \epsilon_{igjk} \geq \epsilon_{igl1};\cdots;\bar{c}_{ij} - \bar{c}_{il} + \epsilon_{igjk} \geq \epsilon_{igln_l}\right) \\
&= \underbrace{\prod_{l=1}^{N}\prod_{h=1}^{n_l}}_{lh\neq jk}\left[1 - F(\bar{c}_{ij} - \bar{c}_{il} + x)\right], l = 1\cdots N
\end{aligned}$$

We assumed that the non-observable components ϵ are iid.

Probability to choose bank k from j

The probability that firm g chooses bank k from j can be approximated by an extreme value distribution if the number of banks is large $n_j \to \infty$.

In our case of normally distributed residuals ϵ, the minima are Gumbel distributed with

$$1 - G(x) = \exp\left[-\exp\left(\frac{x - \mu}{\sigma}\right)\right] \tag{3}$$

where the location parameter μ and the scale parameter σ of the Gumbel distribution depend on variance of the residual σ_ϵ and the number of banks n_j: $\mu = \sigma_\epsilon \ln n_j, \quad \sigma = \sigma_\epsilon$

x is any realization of the residual ϵ

The probability to choose bank k from j

...can also be expressed as

$$\mathbf{P}_{gijk} = \int_{-\infty}^{\infty} \frac{1}{\sigma} \exp\left(\frac{x-\mu}{\sigma}\right) \left\{ \exp\left[-\exp\left(\frac{x-\mu}{\sigma}\right)\right]\right\} \prod_{l=1}^{N} \exp\left[-\exp\left(\frac{\bar{c}_{ij} - \bar{c}_{il} + x - \sigma \ln n_l}{\sigma}\right)\right] dx. \quad (4)$$

Solving the integral yields for the probability

$$\mathbf{P}_{gijk} = \frac{n_j \exp\left(-\frac{\bar{c}_{ij}}{\sigma}\right)}{\sum_{l=1}^{N} n_l \exp\left(-\frac{\bar{c}_{il}}{\sigma}\right)}. \quad (5)$$

A gravity equation for bank loans

Multiplying the probabilities with all bank loans demanded by firms in country i yields

$$BA_{ji} = \frac{n_j \exp\left(-\frac{\beta r_j + \gamma \tau_{ij} + \delta a_j}{\sigma}\right)}{\sum_{l=1}^{N} n_l \exp\left(-\frac{\beta r_l + \gamma \tau_{il} + \delta a_l}{\sigma}\right)} BL_i \qquad (6)$$

a gravity equation explaining cross-border bank loans from j to i

- The sum is a credit country-specific constant $\rightarrow$ fixed effect
- The equation can be estimated as log-linearized version OLS or Poisson

The BIS data

- Available upon request by the BIS
- Bilateral claims at the country-level disaggregated by various characteristics
- 2 approaches of aggregation: consolidated data (consolidated within the group), locational data (balance of payments principal)
  - We have chosen the locational data
- Split with respect to the type of borrower (bank vs non-bank)
  - We use only non-bank partners
- More than 80% of the claims have maturity → credits or bonds, not equity

Regression model

We estimate (6) as:

$$BA_{ji} = \exp\left[(\beta_1\, r_j + \beta_2\, \tau_{ij} + D_j - D_i)\right]\; n_j^{\beta_3}\; BL_i^{\beta_4}\; \varepsilon_{ij}. \tag{7}$$

in a two-stage approach with

1. $BA_{ji} = \exp\left[(\beta_1\, \tau_{ij} + D_j - D_i)\right]\, \varepsilon_{ij}$
2. $\tilde{D}_j = \gamma_1\, r_j + \gamma_2 \ln n_j + \gamma_3 a_j + \xi_j$

- We estimated the first stage Poisson
- The second stage GLS using the variance of the estimated fixed effects as weights

Explanatory variables

- r_j Prime rate of banks from WDI and ECB Statistical Data Warehouse
- τ_{ij} different distance-dependent variabls from CEPII
- a_j Measure for the quality of the bank market mainly from Financial Structure Database (Beck and Demirguc-Kunt)
- n_j effective number of banks approximated by the size of total assets of banks in country j

All variables are aggregated or averaged at country-level

Time period: 2003 to 2006

17 credit countries, 144 loan receiving countries

Results

Panel Gravity equation for cross-border bank loans

	PPML	OLS	OLS (1+BA_{ij})
distance	-0.26**	-0.73**	-0.83**
	[0.086]	[0.065]	[0.059]
contiguity	-0.02	-0.17	-0.33
	[0.171]	[0.174]	[0.179]
common language	0.40	0.81**	0.89**
	[0.205]	[0.103]	[0.100]
common legal origin	0.22*	0.13	-0.03
	[0.087]	[0.076]	[0.073]
Regional Trade Agreement	0.39**	0.69**	0.66**
	[0.136]	[0.132]	[0.120]
Common Currency	0.94**	1.46**	1.85**
	[0.124]	[0.125]	[0.129]
N	6331	4947	6331
R^2	0.857	0.64	0.66

Second stage

Second stage: pooled cross-section regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Banking Market Size$_j$	1.14**	1.18**	1.13**	1.16**	1.07**	1.08**	1.13**
	[0.116]	[0.153]	[0.134]	[0.111]	[0.112]	[0.109]	[0.113]
Interest Rate$_j$	-0.10**	-0.09**	-0.10**	-0.09**	-0.10**	-0.07**	-0.07**
	[0.010]	[0.012]	[0.010]	[0.010]	[0.008]	[0.008]	[0.009]
3 Bank Concentration Ratio		0.75					
		[0.775]					
Return on Assets			-2.84				
			[20.494]				
Cost Income Ratio				-1.44			
				[1.072]			
Z-Score					-0.04		
					[0.026]		
Bank Asset to GDP$_j$						1.08**	
						[0.220]	
Bank Credit to GDP$_j$							1.13**
							[0.233]
N	50	50	50	50	48	50	50
R^2	0.859	0.863	0.859	0.864	0.857	0.892	0.897

Discussion: Partial- versus general equilibrium models

- Partial equilibrium based analysis is a realistic modeling of cost comparison by firms
- It does neither require assumption of complete markets nor an optimization over all possible options with feed backs on all other loan contracts
- It accounts for relationship-specific loan contracts
- We work nevertheless with a possibly endogenous (affected by cross-border bank loans) interest rate

Summary

- We derived a gravity equation for bank loans from the cost minimization of firms
- Starting point: A loans contract is seen as a differentiated product
  - Credit costs depend *not* only on the interest rate
- Firms search for the best offer
- Aggregation over all firms in country i and all banks j yields a gravity equation
- Estimation using BIS Data