Macroprudential policy spillovers and international banking - Taking the gravity approach

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Goal of this paper

Research questions

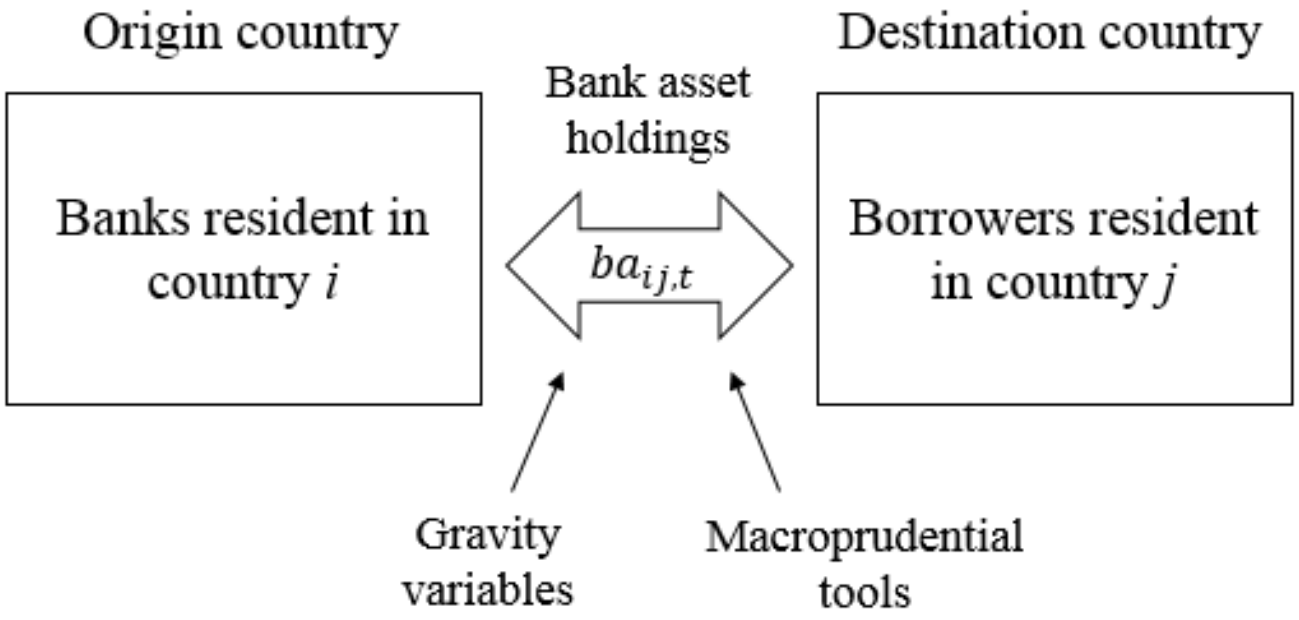
- Can a **gravity model** give insights on the cross-border spillovers of national macroprudential policy via international lending?
- Does the implementation of macroprudential measures (MPMs) in the origin country or the destination country have an effect on the bilateral cross-border bank asset holdings?

Preview of the results

- The gravity approach confirms the spillovers: Macroprudential regulation clearly affects cross-border bank lending
- The effects are of opposite sign for AEs and for EMDEs

The initial idea of the paper

Figure 1: The effect of MPMs



Motivation for the approach

... and contributions of the paper:

- Consider in parallel *new data on MPMs* and bilateral *locational* cross-border bank asset holdings - **not combined before** - Cerutti et al. (2017)
- Provide a *multi-country look* at the spillovers from MPMs via international lending with a **set of countries larger than in previous studies** - Buch and Goldberg (2017), Avdjiev et al. (2017), Reinhardt and Sowerbutts (2015)
- Use the *gravity model applied for international banking* to study the spillovers from MPMs - **only two prior papers**: Cerutti and Zhou (2018), Houston et al. (2012)
- Estimate the model using *Poisson pseudo-maximum-likelihood* (PPML) procedure, a method most able to handle the problems of the data and provide **more reliable results** - Santos Silva and Tenreyro (2006), Brei and von Peter (2018)

Overview of data

The independent variable of interest

- Index for the use of MPMs

The dependent variable

- Bilateral cross-border bank asset holdings

Other controls - standard in the literature

- Economic mass of origin and destination countries: GDP
- Gravity controls: distance, contiguity, common language, common currency
- "Financial sophistication": GDP per capita
- Country and time fixed effects

The use of MPMs

- Update of Cerutti et al. (2017), based mostly on the Macroprudential Policy Survey conducted by the IMF
- Annual index for 2000-2017 and 160 countries
- An aggregate index and two sub-indices: for 10 measures targeting financial institutions (*mpif*) and for 2 measures targeting borrowers (*mpib*)

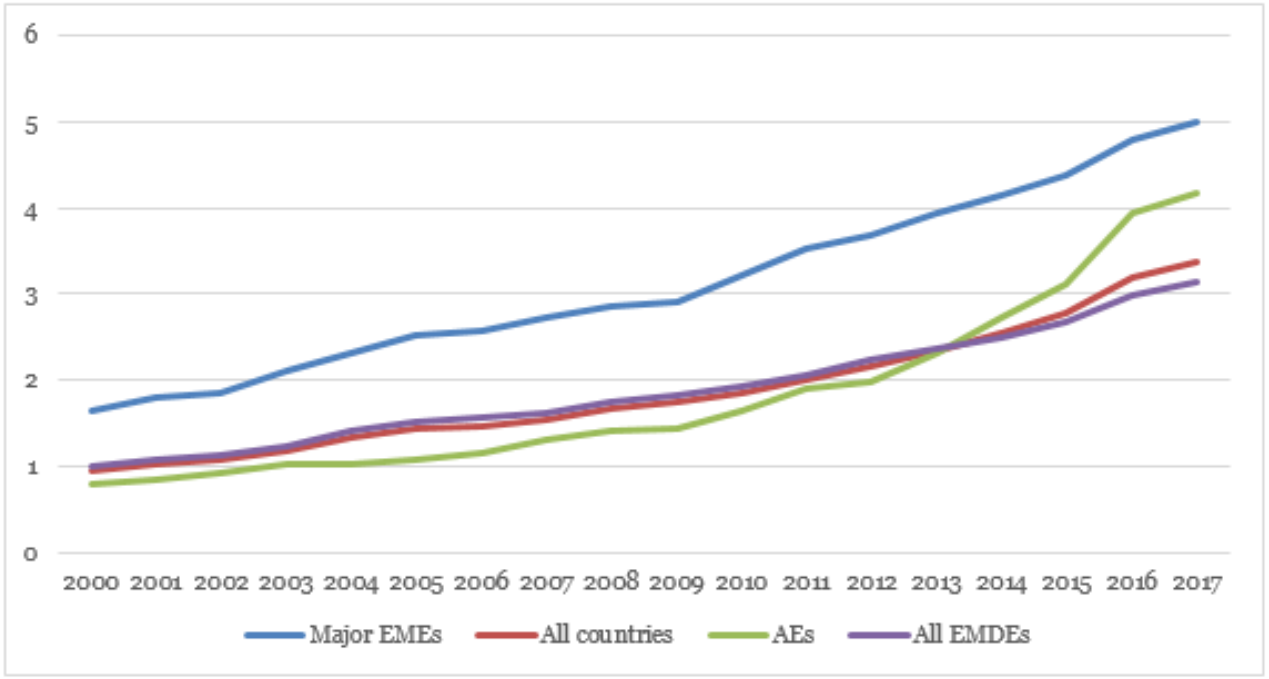
Not without caveats - Simplicity in the interest of coverage:

- Simply documents the number of MPMs implemented
- NOT changes in intensity, whether binding regulation or recommendation, differences in details across countries etc.
- The MPMs aggregated are very different and may have very different channels of effect

The use of MPMs

A clear upward trend in the implemented MPMs - note the differences between country groups!

Figure 1: Average number of MPMs implemented across different country groups: major emerging economies, all countries, advanced economies, and all emerging and developing economies. Source: GMPI.



From Norring, 2019: Use of Macroprudential Policy Measures in Emerging Market Economies. An NBC Info Note.

The dependent variable

Bilateral cross-border bank asset holdings

- From BIS Locational Banking Statistics
- A network of bilateral holdings for pairs of origin countries and destination countries that are both BIS reporting countries or where either the origin country or the destination country is a BIS reporting country (following Brei and von Peter, 2018)
- To match with the coverage of the GMPI-data: 38 reporting countries, 119 counterpart countries and annual data for 2000-2017

Bilateral cross-border bank asset holdings

Table 1: Summary statistics of the dependent variable

	ba_{ij}	$ba_{ij} > 0$
N of pairs	10 146	6 847
N of periods	18	18
N of observations	182 035	87 627
Mean*	2 300	4 779
Standard deviation*	23 223	33 294
Min*	0	1
Max*	1 481 374	1 481 374
Share of 0s	52 %	-
Median*	0	65

*In millions of dollars.

NB: The distribution is very skewed towards zeros and small holdings of bank assets

Other independent variables - totally standard

Economic mass

- Annual GDP (IMF's World Economic Outlook)

Frictions

- Population-weighted distance (CEPII's gravity database)
- Gravity controls: contiguity, common language, common colonial history, common currency (CEPII's gravity database)
- "Financial sophistication": GDP per capita (IMF's WEO)

Other controls

- Time fixed effects to control macroeconomic conditions
- Country fixed effects to control all country-specific, time-invariant features

The gravity equation to be estimated using PPML

NB: In multiplicative form, not log-linearized! Dependent variable in levels, continuous independent variables in logs

$$\begin{aligned} ba_{ij,t} =& \alpha_t * log(gdp_{i,t})^{\beta_1} * log(gdp_{j,t})^{\beta_2} * log(distw_{ij})^{\theta} \\ & * e^{\lambda' z_{ij}} * log(gdpcap_{i,t})^{\beta_3} * log(gdpcap_{j,t})^{\beta_4} \\ & * mpif_{i,t}^{\gamma_1} * mpif_{j,t}^{\gamma_2} * mpib_{i,t}^{\gamma_3} * mpib_{j,t}^{\gamma_4} \\ & * O_i * D_j * T_t, \qquad (1) \\ & i, j = 1, ..., 157 \text{ and } t = 1, ..., 18, \end{aligned}$$

where the origin and destination country fixed effects are included in O_i and D_j respectively, and the gravity controls are included in the term z_{ij}. **The coefficients γ_1, γ_2, γ_3 and γ_4 measure the effect of implemented macroprudential policies.** The coefficient θ measures the distance effect and composite coefficient λ arises from the theoretical microfoundations of the gravity equation.

Results of the PPML estimation

In a nutshell:

- Marginal effects broadly as expected: Effects of economic masses positive (when significant), of distance negative and of other controls largely as in previous studies
- The effects of **MPMs targeting financial institutions** highly significant, but the sign of the effect completely dependent on the income group:
  - For AEs the effect is always negative
  - For EMDEs the effect is always positive
- For **MPMs targeting borrowers**, the results are more similar for different country groups, but not consistent and significant across the board

MPMs targeting financial institutions appear to reduce cross-border lending:

Table 2: First results with full sample

Specification:	(1) Standard gravity		(2) Add *mpib* and *mpif*		(3) No offshore centers	
$mpib_i$	-	(-)	0.117***	(0.034)	0.111***	(0.033)
$mpib_j$	-	(-)	0.011	(0.029)	0.010	(0.030)
$mpif_i$	-	(-)	-0.056**	(0.025)	-0.088****	(0.024)
$mpif_j$	-	(-)	-0.015	(0.026)	-0.058***	(0.019)
$log(gdp_i)$	0.088	(0.267)	-0.175	(0.257)	0.134	(0.314)
$log(gdp_j)$	0.861***	(0.316)	0.812***	(0.301)	1.425****	(0.395)
$log(distw_{ij})$	-0.678****	(0.045)	-0.678****	(0.045)	-0.600****	(0.055)
contig	0.004	(0.118)	0.005	(0.118)	-0.035	(0.102)
comlangof	0.406****	(0.085)	0.406****	(0.085)	0.387****	(0.082)
col45	-0.055	(0.144)	-0.054	(0.144)	0.360**	(0.170)
comcur	0.672****	(0.010)	0.671****	(0.010)	0.706****	(0.102)
$log(gdpcap_i)$	0.392	(0.279)	0.682**	(0.268)	0.261	(0.316)
$log(gdpcap_j)$	0.078	(0.352)	0.141	(0.320)	-0.671*	(0.385)
R^2	0.8705		0.8725		0.910	
Pairs	10 146		10 146		8 942	
Observations	182 035		182 035		160 426	
Mean of ba_{ij}	2 301 mln $		2 301 mln $		2 282 mln $	
Median of ba_{ij}	0 mln $		0 mln $		0 mln $	
Min of ba_{ij}	0 mln $		0 mln $		0 mln $	
Max of ba_{ij}	1 481 374 mln $		1 481 374 mln $		1 481 374 mln $	

Significance at the 10%, 5%, 1% and 0.1% levels denoted by *, **, *** and ****.

A totally different story for AEs and EMDEs:

Table 3: Results for different country groups

Specification:	(6) Only AEs		(7) Only EMDEs	
$mpib_i$	0.111***	(0.037)	0.031	(0.189)
$mpib_j$	-0.003	(0.037)	-0.008	(0.118)
$mpif_i$	-0.137****	(0.027)	0.313****	(0.070)
$mpif_j$	-0.090****	(0.023)	0.287****	(0.065)
$log(gdp_i)$	-0.508	(0.780)	-0.512	(0.503)
$log(gdp_j)$	1.051	(0.792)	-1.487	(1.020)
$log(distw_{ij})$	-0.668****	(0.067)	-2.063****	(0.127)
$contig$	-0.065	(0.111)	-0.450	(0.421)
$comlangof$	0.348****	(0.092)	0.473*	(0.257)
$col45$	-0.455	(0.395)	-1.197	(0.782)
$comcur$	0.909****	(0.112)	1.833**	(0.746)
$log(gdpcap_i)$	0.824	(0.794)	0.310	(0.446)
$log(gdpcap_j)$	-0.432	(0.799)	0.497	(0.766)
R^2	0.9221		0.6118	
Pairs	1 012		2 244	
Observations	18 031		40 301	
Mean of ba_{ij}	17 539 mln $		48 mln $	
Median of ba_{ij}	418 mln $		0 mln $	
Min of ba_{ij}	0 mln $		0 mln $	
Max of ba_{ij}	1 481 374 mln $		39 695 mln $	

Significance at the 10%, 5%, 1% and 0.1% levels denoted by *, **, *** and ****.

For AEs, the marginal effect from *mpif* is always negative:

- For banks operating in AEs, the implementation of **a new MPM** is associated with **less cross-border lending** regardless of whether it is implemented in the origin or the destination country
- More MPMs in the destination country $\rightarrow$ banks retreat from a more heavily regulated market
  - Why: To optimize the regulatory environment?
- But also: More MPMs in the origin country $\rightarrow$ banks retreat from foreign markets
  - Why: Perhaps to reduce risks, or to be better positioned to comply with more regulation?
- **A logical explanation: No opportunities for regulatory arbitrage** - The coverage of macroprudential regulation on average very good?

For EMDEs, the marginal effect from *mpif* is always positive:

- For banks operating in EMDEs, the implementation of **a new MPM** is associated with **more cross-border lending** regardless of whether it is implemented in the origin or the destination country
- More MPMs in the destination country $\rightarrow$ banks increase lending to a more heavily regulated market
  - Why: To make use of a funding advantage emerging from gaps in regulation?
- But also: More MPMs in the origin country $\rightarrow$ banks increase lending to foreign markets
  - Why: To escape the more stringent regulation at home?
- **A logical explanation: Opportunities for regulatory arbitrage** - Perhaps there are on average more gaps in the regulatory coverage?

This does seem rather intuitive:

- **Different opportunities for regulatory arbitrage** emerges as a candidate for a logical explanation for the difference
- Plausible: the banking sectors, the regulatory framework and financial environment do differ in e.g. Netherlands and Thailand
- Validation of this hypothesis?
  - Would require a deeper dive into the use of MPMs, details of macroprudential regulation and characteristics of regulatory oversight
  - Also: There are differences in how many MPMs and what specific MPMs the different country groups tend to use
- A fertile ground for further research: What differentiates the use of MPMs in AEs and EMDEs?

Conclusions

Goal:

- Add to the knowledge on cross-border spillovers from macroprudential policy

Results:

- The effects of nationally implemented macroprudential policy instruments indeed leak across borders via international bank lending
- The spillover effects are negative for AEs and positive for EMDEs

Going forward:

- Is the difference really due to regulatory arbitrage, or is there something else at play?

Thank you!

All comments and suggestions are warmly welcome:
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References

- Avdjiev, S., Koch, C., McGuire, P., von Peter, G., 2017." International prudential spillovers: a global perspective". International Journal of Central Banking, Vol. 13, No. S1.
- Brei, M., von Peter, G., 2018. "The distance effect in banking and trade". Journal of International Money and Finance, 81, 116-137.
- Buch, C., Goldberg, L., 2017. "Cross-border prudential policy spillovers: How much? How important? Evidence from the international banking research network". International Journal of Central Banking 13 (S1).
- Cerutti, E., Zhou, H., 2018b. "Cross-border banking and the circumvention of macroprudential and capital control measures." IMF Working Paper, WP/18/217.
- Cerutti, E., Claessens, S., Laeven, L., 2017. "The use and effectiveness of macroprudential policies: New evidence". Journal of Financial Stability, 28 (2017) 203-224.
- Cerrutti, E., Correa, R., Fiorentino, E., Segalla, E., 2017. "Changes in Prudential Policy Instruments - A New Cross-Country Database". International Journal of Central Banking 13.
- Houston, J. F., Lin, C., Ma, Y., 2012. "Regulatory Arbitrage and International Bank Flows." Journal of Finance 67 (5): 1845-1895.
- Reinhardt, D. and Sowerbutts, R., 2015. "Regulatory arbitrage in action: evidence from banking flows and macroprudential policy". Bank of England Staff Working Paper No. 546.

Additional slides

Motivation for studying the use and effectiveness of macroprudential regulation

- The field has been expanding rapidly, but much better understanding still needed on the use and effectiveness of macroprudential policy tools
- Multi-country studies have been limited by the lack of data, but this no longer entirely true:
  - Cerrutti et al. (2017a): The use and effectiveness of macroprudential policies: New evidence
  - Cerrutti et al. (2017b): Changes in the prudential policy instruments - A new cross-country database
- **My contribution: combine the data from Cerrutti et al. (2017a) with data on cross-border bilateral bank asset holdings**

Motivation for studying the cross-border spillovers of macroprudential policies

- Evidence that the effects of macroprudential instruments occasionally spill over borders through international bank lending
  - Buch and Goldberg (2017): Cross-border regulatory spillovers: How much? How important? Evidence from the International Banking Research Network, & and the related papers
- This may reduce the effectiveness of national macroprudential policies due to regulatory arbitrage
  - Reinhardt and Sowerbutts (2015): Regulatory arbitrage in action: evidence from banking flows and macroprudential policy
- **My contribution: a multi-country look at spillovers and the effects on bilateral bank asset holdings with a large set of countries**

Motivation for using the gravity model of financial asset trade for international banking

- The gravity model has been a workhorse of international trade literature for decades (e.g. survey by Head and Mayer, 2014)
- The gravity model of trade in financial assets spread after Portes and Rey (2005) and IMF's CPIS-data
- The gravity model of international banking also produces *the classic gravity result*
  - Buch (2005): Distance and international banking
  - Brei and von Peter (2018): The distance effect in banking and trade
- **My contribution: using the gavity model for studying the spillovers from macroprudential policy**
  - Cerutti and Zhou (2018): Cross-border banking and the circumvention of macroprudential and capital control measures
  - Houston et al. (2012): Regulatory arbitrage and international bank flows

The use of MPMs

Table 4: MPMs targeting borrowers

Measure	**Abbreviation**
Debt-to-income ratio cap	DTI
Loan-to-value ratio cap	LTV
Index: DTI + LTV	*mpib*

Table 5: MPMs targeting financial institutions

Measure	**Abbreviation**
Time-varying/dynamic loan-loss provisioning	DP
General countercyclical capital buffer/requirement	CTC
Leverage ratio	LEV
Capital surcharges on SIFIs	SIFI
Limits on interbank exposures	INTER
Concentration limits	CONC
Limits on foreign currency loans	FC
FX and/or countercyclical reserve requirements	RRREV
Limits on domestic currency loans	CG
Levy/tax on financial institutions	TAX
Index: DP+CTC+LEV+SIFI+INTER+CONC +FC+RRREV+CG+TAX	*mpif*

The use of MPMs

Table 6: Summary statistics for *mpif* and *mpib*

Variable	**Mean**	**Std.dev.**	**Min**	**Max**	**Range**	**Obs.**
mpif	1.63	1.40	0	8	0-10	2 826
mpib	0.43	0.70	0	2	0-2	2 826

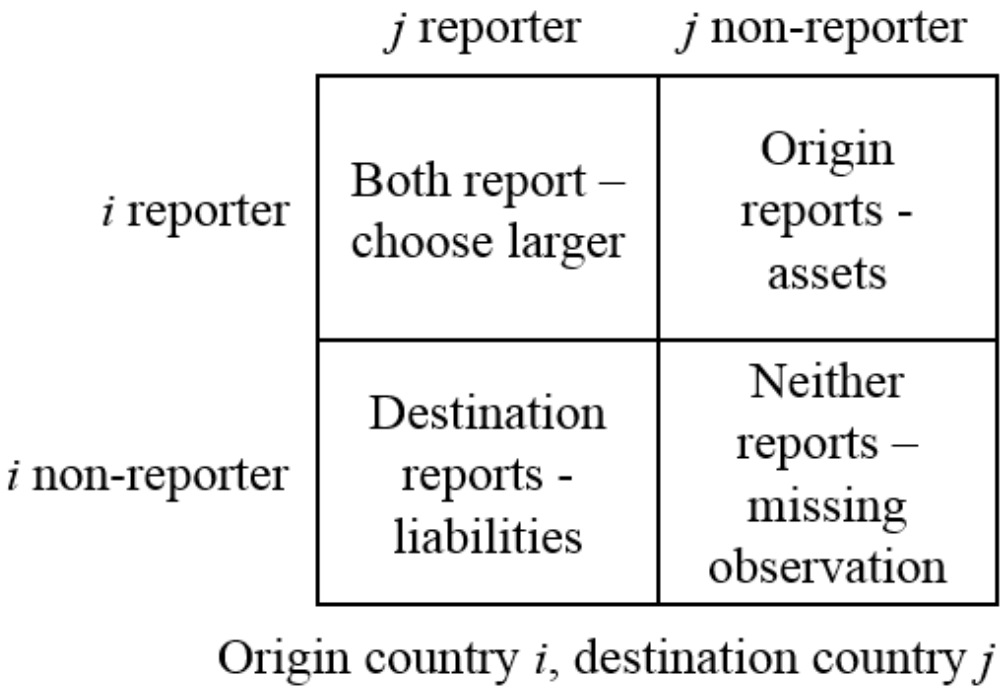
Table 7: Distribution of observations of *mpif* and *mpib*

	0	1	2	3	4	5	6	7-10
mpif	27%	29%	21%	15%	6%	2%	1%	0%
mpib	69%	19%	12%	-	-	-	-	-

NB: Countries tend to use only 0-2 measures.

Bilateral cross-border bank asset holdings

Figure 2: The matrix of bilateral bank asset holdings



→ Zeros are "true zeros", not missing observations

Other independent variables - totally standard

Economic mass

- Annual GDP (IMF's World Economic Outlook)

Frictions

- Population-weighted distance (CEPII's gravity database)
- Gravity controls: contiguity, common language, common colonial history, common currency (CEPII's gravity database)
- "Financial sophistication": GDP per capita (IMF's WEO)

Other controls

- Time fixed effects to control macroeconomic conditions
- Country fixed effects to control all country-specific, time-invariant features

The gravity framework

- Theoretical base: the structural gravity formulation in international trade developed by Anderson and van Wincoop (2003)
- Frictions in the context of international banking: different transaction and information costs instead of transport costs
- The structural gravity equation:

$$A_{ij,t} = \alpha Y_{i,t} Y_{j,t} O_i D_j d_{ij}^{\theta} e^{\lambda' z_{ij,t}} \tag{2}$$

where $A_{ij,t}$ is the assets held by the origin country i in the destination country j, $Y_{i,t}$ and $Y_{j,t}$ are the economic masses, usually GDPs, O_i and D_j the time-invariant fixed effects, d_{ij} the bilateral distance, and $z_{ij,t}$ is a vector containing controls for trade or information frictions between the country pair, such as a shared language, border or currency.

Possible estimations methods

Bilateral data on international lending:

Large share of zero observations, heteroskedasticity and clustering

Some methods that have been used in similar set-ups:

- Panel fixed effects OLS with zero observations excluded (e.g. Portes and Rey, 2005) - *basically the worst option*
- Panel probit with a dichotomous dependent variable (proposed by Drakos et al., 2014) - *lots of lost information*
- A two-stage model such as the double-hurdle model (developed by Cragg, 1971, and Heckman, 1976) - *strict distributional assumptions & a computational nightmare*
- **Poisson pseudo-maximum-likelihood (PPML) approach** (proposed by Santos Silva and Tenreyro, 2006)

Poisson pseudo-maximum-likelihood (PPML) approach

- Santos Silva and Tenreyro show that log-linearizing and OLS leads to large upward bias in results due to inappropriate handling of zeros, heteroskedasticity and clustering
- PPML allows for estimating the gravity equations in their multiplicative form
- PPML is consistent with zeros, heteroskedasticity and clustering
- In trade literature the PPML is considered the most theory-consistent method of estimating a gravity equation - use of the method in applications of gravity in financial asset trade still very limited

MPMs targeting financial institutions appear to reduce cross-border lending:

Table 8: First results with full sample

Specification:	(1) Standard gravity		(2) Add *mpib* and *mpif*		(3) No offshore centers	
$mpib_i$	-	(-)	0.117***	(0.034)	0.111***	(0.033)
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Median of ba_{ij}	0 mln $		0 mln $		0 mln $	
Min of ba_{ij}	0 mln $		0 mln $		0 mln $	
Max of ba_{ij}	1 481 374 mln $		1 481 374 mln $		1 481 374 mln $	

Significance at the 10%, 5%, 1% and 0.1% levels denoted by *, **, *** and ****.

The mean of, say, Netherlands and Thailand? Separate between AEs and EMDEs:

Table 9: Results for different origin countries

Specification:	(4) AEs as origin country		(5) EMDEs as origin country	
$mpib_i$	0.110***	(0.035)	0.152***	(0.049)
$mpib_j$	-0.009	(0.031)	0.134***	(0.048)
$mpif_i$	-0.131****	(0.025)	0.111****	(0.020)
$mpif_j$	-0.057***	(0.020)	-0.100****	(0.028)
$log(gdp_i)$	-0.382	(0.761)	0.867****	(0.234)
$log(gdp_j)$	1.345***	(0.390)	2.290***	(0.860)
$log(distw_{ij})$	-0.630****	(0.058)	-1.433****	(0.120)
contig	-0.063	(0.104)	-0.251	(0.271)
comlangof	0.398****	(0.092)	0.516****	(0.143)
*col*45	0.128	(0.247)	0.591***	(0.179)
comcur	0.738****	(0.109)	-2.444****	(0.493)
$log(gdpcap_i)$	0.752	(0.772)	-0.329*	(0.190)
$log(gdpcap_j)$	-0.620	(0.378)	-1.467	(0.916)
R^2	0.9155		0.7201	
Pairs	3 778		4 926	
Observations	67 720		88 424	
Mean of ba_{ij}	5 042 mln $		267 mln $	
Median of ba_{ij}	6 mln $		0 mln $	
Min of ba_{ij}	0 mln $		mln $	
Max of ba_{ij}	1 481 374 mln $		113 972 mln $	

Significance at the 10%, 5%, 1% and 0.1% levels denoted by *, **, *** and ****.