

# Macroprudential policy spillovers and international banking - Taking the gravity approach

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# Goal of this paper

## Research questions

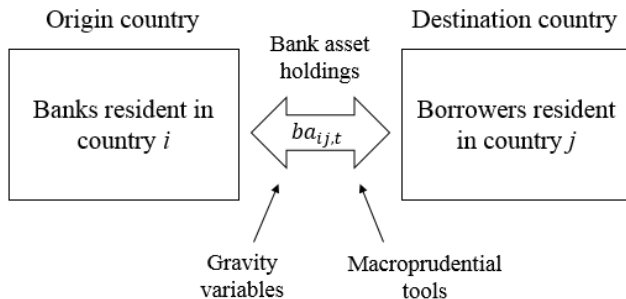
- Can a **gravity model** give insights on the cross-border spillovers of national macroprudential policy via international lending?
- Does the implementation of macroprudential measures (MPMs) in the origin country or the destination country have an effect on the bilateral cross-border bank asset holdings?

## 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*)

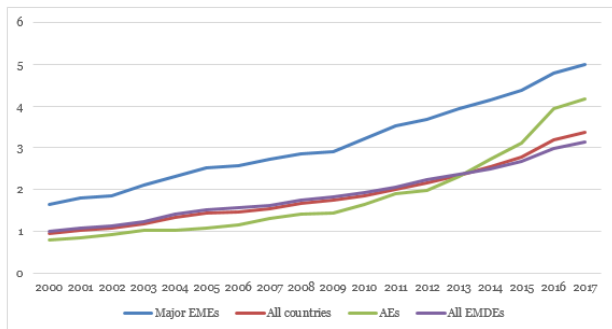
### Not without caveats - Simplicity in the interest of coverage:

- 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: GMP.**



# 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

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

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  $\gamma_1$ ,  $\gamma_2$ ,  $\gamma_3$  and  $\gamma_4$  measure the effect of implemented macroprudential policies.** The coefficient  $\theta$  measures the distance effect and composite coefficient  $\lambda$  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 <i>mpib</i> and <i>mpif</i>		(3) No offshore centers	
<i>mpib<sub>i</sub></i>	-	(-)	0.117***	(0.034)	0.111***	(0.033)
<i>mpib<sub>j</sub></i>	-	(-)	0.011	(0.029)	0.010	(0.030)
<i>mpif<sub>i</sub></i>	-	(-)	-0.056**	(0.025)	-0.088****	(0.024)
<i>mpif<sub>j</sub></i>	-	(-)	-0.015	(0.026)	-0.058***	(0.019)
<i>log(gdp<sub>i</sub>)</i>	0.088	(0.267)	-0.175	(0.257)	0.134	(0.314)
<i>log(gdp<sub>j</sub>)</i>	0.861***	(0.316)	0.812***	(0.301)	1.425****	(0.395)
<i>log(distw<sub>ij</sub>)</i>	-0.678****	(0.045)	-0.678****	(0.045)	-0.600****	(0.055)
<i>contig</i>	0.004	(0.118)	0.005	(0.118)	-0.035	(0.102)
<i>comlangof</i>	0.406****	(0.085)	0.406****	(0.085)	0.387****	(0.082)
<i>col45</i>	-0.055	(0.144)	-0.054	(0.144)	0.360**	(0.170)
<i>comcur</i>	0.672****	(0.010)	0.671****	(0.010)	0.706****	(0.102)
<i>log(gdpcap<sub>i</sub>)</i>	0.392	(0.279)	0.682**	(0.268)	0.261	(0.316)
<i>log(gdpcap<sub>j</sub>)</i>	0.078	(0.352)	0.141	(0.320)	-0.671*	(0.385)
<i>R</i> <sup>2</sup>	0.8705		0.8725		0.910	
Pairs	10 146		10 146		8 942	
Observations	182 035		182 035		160 426	
Mean of <i>ba<sub>ij</sub></i>	2 301 mln \$		2 301 mln \$		2 282 mln \$	
Median of <i>ba<sub>ij</sub></i>	0 mln \$		0 mln \$		0 mln \$	
Min of <i>ba<sub>ij</sub></i>	0 mln \$		0 mln \$		0 mln \$	
Max of <i>ba<sub>ij</sub></i>	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 → banks retreat from a more heavily regulated market
  - Why: To optimize the regulatory environment?
- But also: More MPMs in the origin country → 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 → 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 → 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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## **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
  - Reinhart 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

<b>Measure</b>	<b>Abbreviation</b>
Debt-to-income ratio cap	DTI
Loan-to-value ratio cap	LTV
Index: DTI + LTV	<i>mpib</i>

**Table 5:** MPMs targeting financial institutions

<b>Measure</b>	<b>Abbreviation</b>
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	<i>mpif</i>

## The use of MPMs

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

<b>Variable</b>	<b>Mean</b>	<b>Std.dev.</b>	<b>Min</b>	<b>Max</b>	<b>Range</b>	<b>Obs.</b>
<i>mpif</i>	1.63	1.40	0	8	0-10	2 826
<i>mpib</i>	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
<i>mpif</i>	27%	29%	21%	15%	6%	2%	1%	0%
<i>mpib</i>	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

	<i>j</i> reporter	<i>j</i> non-reporter
<i>i</i> reporter	Both report – choose larger	Origin reports - assets
<i>i</i> non-reporter	Destination reports - liabilities	Neither reports – missing observation

Origin country *i*, destination country *j*

→ 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:

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

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 <i>mpib</i> and <i>mpif</i>		(3) No offshore centers	
<i>mpib<sub>i</sub></i>	-	(-)	0.117***	(0.034)	0.111***	(0.033)
<i>mpib<sub>j</sub></i>	-	(-)	0.011	(0.029)	0.010	(0.030)
<i>mpif<sub>i</sub></i>	-	(-)	-0.056**	(0.025)	-0.088****	(0.024)
<i>mpif<sub>j</sub></i>	-	(-)	-0.015	(0.026)	-0.058***	(0.019)
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<i>log(distw<sub>ij</sub>)</i>	-0.678****	(0.045)	-0.678****	(0.045)	-0.600****	(0.055)
<i>contig</i>	0.004	(0.118)	0.005	(0.118)	-0.035	(0.102)
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<i>R</i> <sup>2</sup>	0.8705		0.8725		0.910	
Pairs	10 146		10 146		8 942	
Observations	182 035		182 035		160 426	
Mean of <i>ba<sub>ij</sub></i>	2 301 mln \$		2 301 mln \$		2 282 mln \$	
Median of <i>ba<sub>ij</sub></i>	0 mln \$		0 mln \$		0 mln \$	
Min of <i>ba<sub>ij</sub></i>	0 mln \$		0 mln \$		0 mln \$	
Max of <i>ba<sub>ij</sub></i>	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)
$col45$	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 \*\*\*\*.