Macroprudential policy cross-border spillovers and international banking - Any use for the gravity model?

Anni Norring

University of Helsinki

September 11, 2018

Introduction

Research questions

- Can the gravity model tell us something about the cross-border spillovers of macroprudential regulation through international lending?

- Does the implementation of macroprudential instruments in the origin country or the destination country have an effect on the bilateral cross-border bank asset holdings?

Preliminary results

- The gravity model appears to confirm that there are spillovers

- Changes in the use of macroprudential instruments have mostly statistically significant effects on the cross-border bank asset holdings

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 macoprudential 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**
  - With a clear emphasis on macroprudential regulation, differing from Houston et al. (2012): Regulatory arbitrage and international bank flows

Goal of this paper

- Consider in parallel new data on macroprudential instruments and bilateral cross-border bank asset holdings

- Provide a multi-country look at the spillovers of macroprudential policy via international lending with a set of countries larger than in previous studies

- Use the gravity model of international banking to study the effects of macroprudential policy that leak across borders via international lending

... in order to answer...

- Can the gravity model tell us something about the cross-border spillovers of macroprudential regulation through international lending?

- Does the implementation of macroprudential instruments in the origin country or the destination country have an effect on the bilateral cross-border bank asset holdings?

Data: The use of macroprudential instruments

- From the IMF Global Macroprudential Instruments Survey
- Annual index for 2000-2013
- 119 countries, 117 of which are BIS reporting countries or counterpart countries to BIS reporting countries
- Data includes two aggregate indices: for instruments targeting financial institutions (*mpif*) and those targeting borrowers (*mpib*)
  - *mpif* aggregates 10 tools that include e.g. different capital requirements, limits on interbank exposures, loan growth, leverage ratio etc.
  - *mpib* aggregates 2 tools; LTV-ratio and DTI-ratio
- Described in Cerrutti et al. (2017a) and used to show that there is a link between slower credit growth and the use of macroprudential policy

Data: The use of macroprudential instruments

Variable	Mean	Std. dev.	Min	Max	Range	Obs.
mpif	1.38	1.24	0	6	0-10	1 638
mpib	0.36	0.66	0	2	0-2	1 638

Table 1: Macroprudential indices targeting financial institutions and borrowers

Value	0	1	2	3	4	5	6	7-10
mpif	28.9%	29.9%	23.8%	11.7%	3.7%	1.7%	0.4%	-
mpib	74.6%	15.3%	10.2%	-	-	-	-	-

Table 2: Use of macroprudential tools: % of all observations with n tools implemented

Data: The dependent variable

Bilateral cross-border bank asset holdings

- From BIS Locational Banking Statistics
- I build 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):
  - O reports to BIS: use data on assets
  - O does not report to BIS, but D does: use data on liabilities
  - Neither O nor D reports to BIS: missing value
- Maximum coverage: 44 reporting countries, 216 counterpart countries and quarterly data since 1977
- For the purpose of this paper: 33 reporting countries, 84 counterpart countries and annual data for 2000-2013

Data: The dependent variable

	ba_{od}	$ba_{od} > 0$	$log(ba_{od} + 1)$	$log(ba_{od})$
N of pairs	6 112	4 674	6 112	4 674
N of periods	14	14	14	14
N of observations	85 560	51 013	85 560	51 013
Mean	6 277 587	11 281 030	6.73	12.10
Standard deviation	56 285 910	75 081 810	6.45	3.12
Min	0	0.01	0	2.30
Max	2 962 748 000	2 962 748 000	21.81	21.81
Share of 0s	44.35 %	-	44.35 %	-

Mean, standard deviations, min and max in thousands of US dollars.

Table 3: Summary statistics of the dependent variable.

Data: Other independent variables

Economic mass

- Annual GDP from World Bank
- *Size of the banking sector?*

Frictions, data from CEPII's gravity database

- Population-weighted distance
- Gravity controls: contiguity, common language, common colonial history, common currency
- Financial sophistication: income group, financial openness, membership in the WTO, membership in the EU

Other controls

- Time fixed effects, country fixed effects or a regional dummy

Introduction	Motivation	Goal of this paper	Data	Model	Estimation	Results	Conclusions
o	ooo	o	ooooo	●oooo	ooooo	oo	ooo

The gravity model of financial asset trade

The gravity equation in the most simple form:

$$
\begin{aligned}
log(asset_{od,t}) = &\alpha_1 log(M_{o,t}) + \alpha_2 log(M_{d,t}) \\
&+ \alpha_3 log(\tau_{od,t}) + u_{od,t}, \\
&o, d = 1, ..., N \text{ and } t = 1, ..., T.
\end{aligned}
\tag{1}
$$

The gravity equation in the form often estimated:

$$
\begin{aligned}
log(asset_{od,t}) = &\alpha_1 log(GDP_{o,t}) + \alpha_2 log(GDP_{d,t}) + \alpha_3 log(dist_{od}) \\
&+ \text{information variables} \\
&+ \text{transaction technology variables} \\
&+ \text{multilateral resistance} + \text{time dummies} \\
&+ \text{constant} + u_{od,t}, \\
&o, d = 1, ..., N \text{ and } t = 1, ..., T.
\end{aligned}
\tag{2}
$$

The gravity model for the purpose of this paper

$$
\begin{aligned}
log(ba_{od,t}) = & \alpha_1 log(GDP_{o,t}) + \alpha_2 log(GDP_{d,t}) + \alpha_3 log(distw_{od}) \\
& + \alpha_4 mpif_{d,t} + \alpha_5 mpif_{o,t} + \alpha_6 mpib_{d,t} + \alpha_7 mpib_{o,t} \\
& + \text{gravity controls} \\
& + \text{controls for financial sophistication} \\
& + \text{multilateral resistance} \\
& + \text{time dummies} \\
& + \text{constant} + u_{od,t}, \quad\quad\quad\quad\quad\quad\quad (3) \\
& o, d = 1, ..., 117 \text{ and } t = 1, ..., 14.
\end{aligned}
$$

Hypotheses in more detail

Hypotheses - regulations differ

- **Tightening capital requirements for financial institutions** leads to domestic agents borrowing more abroad
- **Tightening regulation that applies to domestic borrowers** does not lead to more borrowing from abroad, but instead banks might move lending to less regulated markets

Hypotheses in more detail

Tightening capital requirements for financial institutions

- Regulation that applies to domestic banks and foreign subsidiaries, but not foreign branches
- Tighter regulation in the destination country leads to higher banking flows from O to D as banks from the origin country take advantage of a funding differential
    - a higher $mpif_d$ is associated with a higher ba_{od}
- Tighter regulation in the origin country may lead to lower banking flows from O to D as banks from the origin country reduce cross-border activity to better comply with the more stringent regulation
    - a higher $mpif_o$ is associated with a lower ba_{od}

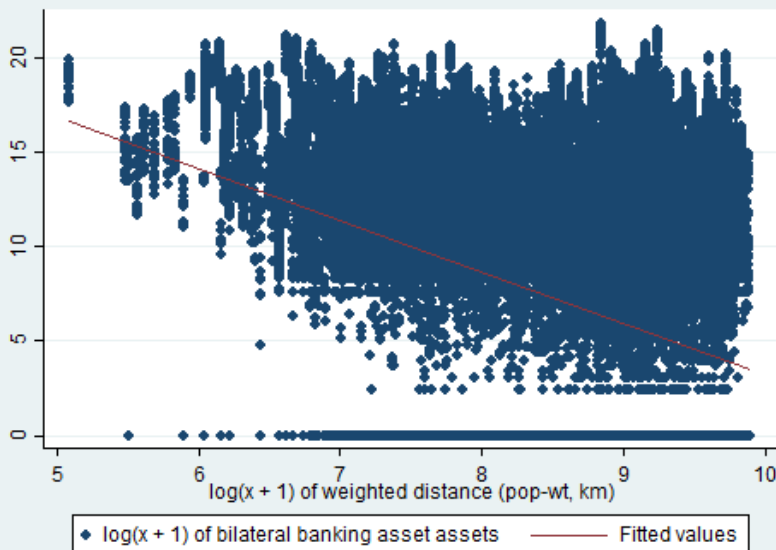## Hypotheses in more detail

Tightening regulation that applies to domestic borrowers

- Regulation that applies to all banks operating in the country
- Tighter regulation in the destination country leads to lower banking flows from O to D as banks from the origin country retreat from a more heavily regulated market
    - a higher $mpib_d$ is associated with a lower ba_{od}
- Tighter regulation in the origin country leads to higher banking flows from O to D as banks from from the origin country move lending to less regulated markets (regulatory arbitrage)
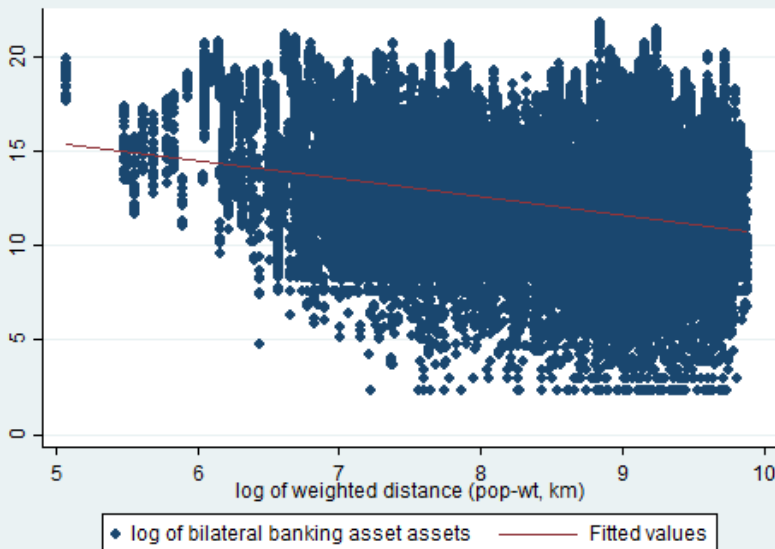   - a higher $mpib_o$ is associated with a higher ba_{od}

Possible estimations methods

- Panel fixed effects OLS with zero observations excluded (e.g. Portes and Rey, 2005)
- Poisson pseudo-maximum-likelihood (PPML) approach (proposed by Santos Silva and Tenreyro, 2006)
- Panel probit with a dichotomous dependent variable (proposed Drakos et al., 2014)
- My choice: the double-hurdle model
  - A method first proposed by Cragg (1971) and developed further by Heckman (1976)
  - Ensures an appropriate treatment of zero observations
  - Breaks the equation into a participation equation and a level equation
  - **Both parts can be determined by different processes**, i.e. an extension to Tobit

Why the double-hurdle?

log(x + 1) of weighted distance (pop-wt, km)

◆ log(x + 1) of bilateral banking asset assets   ——— Fitted values

Why the double-hurdle?

Why the double-hurdle?

	Probit (depvar dba_{od})	FE OLS (depvar $log(ba_{od})$)
$log(GDP_o)$	0.108****	0.356****
	(0.002)	(0.109)
$log(GDP_d)$	0.128****	1.385****
	(0.002)	(0.110)
$log(distw_{od})$	-0.229****	-1.104****
	(0.006)	(0.050)
$mpif_d$	-0.008*****	-0.026
effect positive	(0.002)	(0.017)
$mpif_o$	**-0.008******	**-0.046***
effect negative	(0.002)	(0.018)
$mpib_d$	0.012****	0.056**
effect negative	(0.003)	(0.026)
$mpib_o$	**0.013******	**0.068**
effect positive	(0.003)	(0.030)
gravity controls	Yes	Yes
financial soph. ctrls	Yes	Yes
regional	Yes	Yes

Significance at the 10%, 5%, 1% and 0.1% levels is
Sdenoted by *, **, *** and **** respectively.
Standard errors in parentheses.
The effects that are in line with hypotheses are bolded.

Table 4: Average marginal effects and hypotheses

The equation to be estimated

$$log(ba_{od,t}) = \alpha_1 log(GDP_{o,t}) + \alpha_2 log(GDP_{d,t}) + \alpha_3 log(distw_{od})$$
$$+ \alpha_4 mpif_{d,t} + \alpha_5 mpif_{o,t} + \alpha_6 mpib_{d,t} + \alpha_7 mpib_{o,t}$$
$$+ \text{gravity controls}$$
$$+ \text{controls for financial sophistication}$$
$$+ \text{multilateral resistance term}$$
$$+ \text{time dummies}$$
$$+ \text{constant} + u_{od,t}, \tag{4}$$
$$o, d = 1, ..., 117 \text{ and } t = 1, ..., 14.$$

- **The participation equation:** the effect of independent variables on the probability of $ba_{od,t}$ being positive
- **The level equation:** the effect of a change in independent variables on the level of $ba_{od,t}$ conditional on the level being positive

Marginal effects and hypotheses

Specification	(1)		(2)	
Depvar: $log(ba_{od} + 1)$	Participation	Level	Participation	Level
$log(GDP_o + 1)$	0.08****	0.59****	0.08****	0.62****
	(0.00)	(0.01)	(0.00)	(0.01)
$log(GDP_d + 1)$	0.09****	0.60****	0.09****	0.61****
	(0.00)	(0.01)	(0.00)	(0.01)
$log(distw_{od} + 1)$	-0.16****	-0.81****	-0.10****	-0.88****
	(0.00)	(0.01)	(0.00)	(0.01)
$mpif_d$	-0.01****	-0.17****	**0.02******	-0.10****
effect positive	(0.00)	(0.01)	(0.00)	(0.01)
$mpif_o$	**-0.02******	**-0.17******	0.02****	**-0.09******
effect negative	(0.00)	(0.01)	(0.00)	(0.01)
$mpib_d$	0.03****	0.28****	**-0.02******	**-0.25******
effect negative	(0.00)	(0.02)	(0.00)	(0.01)
$mpib_o$	**0.02******	**0.32******	-0.00	-0.14****
effect positive	(0.00)	(0.02)	(0.00)	(0.01)
gravity controls	No	No	Yes	Yes
financial soph. ctrls	No	No	Yes	Yes
regional	No	No	Yes	Yes

Significance at the 10%, 5%, 1% and 0.1% levels is denoted by *, **, *** and **** respectively.
Standard errors in parentheses.
The effects that are in line with hypotheses are bolded.

Table 5: Average marginal effects and hypotheses

Interpreting the marginal effects

Specification	(1)		(2)	
Depvar: $log(ba_{od} + 1)$	Participation	Level	Participation	Level
$log(GDP_o + 1)$, %-change	0.08%	0.59%	0.08%	0.62%
$log(GDP_d + 1)$, %-change	0.09%	0.60%	0.09%	0.61%
$log(distw_{od} + 1)$, %-change	-0.16%	-0.81%	-0.10%	-0.88%
$mpif_d$, unit change **effect positive**	-1%	-17%	**2%**	-10%
$mpif_o$, unit change **effect negative**	**-2%**	**-17%**	2%	**-9%**
$mpib_d$, unit change **effect negative**	3%	28%	**-2%**	**-25%**
$mpib_o$, unit change **effect positive**	**2%**	**32%**	*-0%*	-14%
gravity controls	No	No	Yes	Yes
financial soph. ctrls	No	No	Yes	Yes
regional	No	No	Yes	Yes

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

Table 6: The percent changes in the dependent variable associated with a change in controls

Conclusions

Can the gravity model tell us something about the cross-border spillovers of macroprudential regulation through international lending?

- This indeed appears to be the case
- Need for robustness checks using different estimation strategies
- Results should be interpreted very carefully

Does the implementation of macroprudential instruments in the origin country or the destination country have an effect on the bilateral cross-border bank asset holdings?

- There appears to be statistically significant marginal effects and they may be non-negligible
- Support for there being significant cross-border spillovers of macroprudential regulation

Thank you!

All comments and suggestions are warmly welcome:
anni.norring@helsinki.fi

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. (2016). "Cross-border prudential policy spillovers: How much? How important? Evidence from the international banking research network". NBER Working Paper 22874.
- Cerutti, E., Claessens, S., Laeven, L., 2017. "The use and effectiveness of macroprudential policies: New evidence". Journal of Financial Stability, 28 (2017) 203-224.
- Cerutti, E., Correa, R., Fiorentino, E., Segalla, E., 2017. "Changes in Prudential Policy Instruments - A New Cross-Country Database," International Journal of Central Banking 13.