Macroprudential policy cross-border spillovers and international banking - Taking the gravity approach

Anni Norring

PhD Working group September 2018

September 12, 2018

Goals of this paper

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?

Contributions of this paper

In order to answer the questions:

- 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
- Estimate the model using Poisson pseudo-maximum-likelihood (PPML) procedure, a method currently considered the most theory-consistent by the more advanced literature on international trade

Possible estimations methods

Bilateral data:

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) - *worst option*
- Panel probit with a dichotomous dependent variable (proposed Drakos et al., 2014) - *lots of lost information*
- A two-stage model such as the double-hurdle model (e.g. Cragg, 1971, 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

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

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

n	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)
- For the purpose of this paper: 33 reporting countries, 84 counterpart countries and annual data for 2000-2013

Data: The dependent variable

	ba_{od}	$ba_{od} > 0$
N of pairs	6 112	4 674
N of periods	14	14
N of observations	85 560	51 013
Mean	6 278	11 281
Standard deviation	56 286	75 082
Min	0	0.01
Max	2 962 748	2 962 748
Share of 0s	**44.35 %**	-

Mean, standard deviations, min and max in millions 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

Data: Other independent variables

Variable	Mean	Std. dev.	Min	Max	Obs.
$log(gdp_o)$	11.93	2.24	5.78	16.60	85 560
$log(gdp_d)$	11.93	2.24	5.78	16.60	85 560
$log(distw_{od})$	8.70	0.81	5.08	9.89	85 560

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

Mean, standard deviations, min and max of distance in kilometers.

Table 4: Continuous independent variables

Data: Other independent variables

Value of variable	0	1	2	Obs.
incomegr	11.52 %	43.81 %	44.67 %	85 560
finopen	44.37 %	55.63 %	-	85 560
contig	98.23 %	1.77 %	-	85 560
comlangof	88.15 %	11.85 %	-	85 560
*col*45	98.49 %	1.51 %	-	85 560
comcur	96.63 %	3.37 %	-	85 560
wto	8.62 %	91.38 %	-	85 560
eu	70.63 %	29.37 %	-	85 560

Table 5: Dichotomous controls: %-share of observations

The gravity equation to be estimated using PPML

$$
\begin{aligned}
ba_{od,t} =& \alpha_t * log(GDP_o, t)^{\beta_1} * log(GDP_o, t)^{\beta_2} * log(distw_{od})^{\theta} \\
& * mpif_{d,t}^{\gamma_1} * mpif_{o,t}^{\gamma_2} * mpib_{d,t}^{\gamma_3} * mpib_{o,t}^{\gamma_4} \\
& * O_{o,t} * D_{d,t} * e^{\lambda' z_{od,t}}, \qquad (1) \\
& o, d = 1, ..., 117 \text{ and } t = 1, ..., 14,
\end{aligned}
$$

where the origin and destination country fixed effects are included in O_{ot} and D_{dt} respectively, and the gravity and financial sophistication controls are included in the term $z_{od,t}$. 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.

Hypotheses - regulations differ

Hypothesis 1

Implementing macroprudential regulation aimed at domestic financial institutions leads to domestic agents borrowing more abroad.

Hypothesis 2

Implementing macroprudential regulation aimed at domestic borrowers does not lead to more borrowing from abroad, but instead domestic banks might move lending to less regulated markets.

Results of the PPML estimation

- Results are quite consistent over robustness checks with different specifications and with different subsets of the sample
- Effects broadly as expected: effects of economic masses positive (when significant), of distance negative and of other controls as in previous studies
- Effect of GDP of origin country insignificant: size of banking sector more appropriate?
- The effects of macroprudential regulation mostly statistically significant and with consistent signs, but the hypotheses are not confirmed

Results of the PPML estimation

Specification	(1)		(2)	
Depvar: ba_{od}				
$log(GDP_o)$	0.160	(0.204)	-0.338	(0.246)
$log(GDP_d)$	1.705****	(0.226)	1.122***	(0.364)
$log(distw_{od})$	-0.758****	(0.059)	-0.669****	(0.051)
$mpif_d$	-0.061**	(0.026)	-0.071***	(0.026)
$mpif_o$	-0.102****	(0.028)	-0.108****	(0.027)
$mpib_d$	0.024	(0.033)	0.030	(0.033)
$mpib_o$	0.097**	(0.045)	0.105**	(0.044)
Controls:				
gravity	No		Yes	
financial sophistication	No		Yes	
R^2	0.86		0.91	

Standard errors adjusted for 3 509 clusters. Reported in parantheses.

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

Table 6: Results of the PPML estimation

Effects of the macroprudential tools

Macroprudential regulation aimed at financial institutions:

- **Negative effect of macroprudential tools aimed at financial institutions** regardless of whether the implementing country is the origin country or the destination country
- Both $mpif_d$ and $mpif_o$ negative and highly significant
- Means that foreign banks retreat from more heavily regulated markets, but also that **domestic banks reduce foreign lending as a reaction to domestic regulation**
- Contrary to prior results showing that macroprudential regulation has an expansionary effect on cross-border lending

Effects of the macroprudential tools

Macroprudential regulation aimed at borrowers:

- **Positive effect of macroprudential tools aimed at borrowers** regardless of whether the implementing country is the origin country or the destination country
- Both $mpib_d$ and $mpib_o$ positive, but only $mpib_o$ significant
- Means that when domestic regulation is implemented, domestic banks move increase credit to foreign markets (in accordance with the hypothesis)

Robustness checks of the PPML estimation

Specification	(3)		(4)	
Depvar: ba_{od}				
$log(GDP_o)$	-0.329	(0.246)	-0.338	(0.246)
$log(GDP_d)$	1.121***	(0.364)	1.122***	(0.364)
$log(distw_{od})$	-0.678****	(0.049)	-0.669****	(0.051)
$mpif_d$	-0.071***	(0.026)	-0.071***	(0.026)
$mpif_o$	-0.108****	(0.027)	-0.108****	(0.027)
$mpib_d$	0.030	(0.033)	0.030	(0.033)
$mpib_o$	0.105**	(0.045)	0.105**	(0.044)
Controls:				
gravity	Smaller set		Yes	
financial sophistication	Smaller set		Yes	
Multilateral resistance:	Country fixed effects		Regional dummies	
R^2	0.91		0.91	
Standard errors adjusted for 3 509 clusters. Reported in parantheses.				
Significance at the 10%, 5%, 1% and 0.1% levels is denoted by *, **, *** and ****.				

Table 7: Results with a different set of controls

Robustness checks of the PPML estimation

Specification	(5)		(6)	
Depvar: ba_{od}				
$log(GDP_o)$	-0.473	(0.658)	0.173	(0.315)
$log(GDP_d)$	0.893	(0.773)	1.87***	(0.482)
$log(distw_{od})$	-0.602****	(0.054)	-0.587****	(0.059)
$mpif_d$	-0.100****	(0.031)	-0.097****	(0.027)
$mpif_o$	-0.118****	(0.031)	-0.128****	(0.030)
$mpib_d$	0.038	(0.039)	0.020	(0.033)
$mpib_o$	0.131**	(0.055)	0.104**	(0.047)
Controls:				
gravity	Yes		Yes	
financial sophistication	Yes		Yes	
Sample	Advanced economies		No offshore centers	
Observations	12 012		73 296	
R^2	0.93		0.91	
Standard errors adjusted for k clusters. Reported in parantheses.				
Clusters	497		2 990	
Significance at the 10%, 5%, 1% and 0.1% levels is denoted by *, **, *** and ****.				

Table 8: Results with a different sample

Conclusions

- My results show that the effects of macroprudential tools do have a statistically significant effect on the bilateral holdings of bank assets.
- The average effects are however rather small in absolute size, and thus the results support the notion that at least so far, the cross-border spillovers from macroprudential policies have been rather modest.
- Note: the most of the bilateral holdings are very small, in fact zero, thus skewing the mean and thus the average effects downwards. The effects on the very large holdings could potentially be substantial.

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

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 are statistically significant marginal effects from implementing macroprudential policies to international lending, but the size of these effects is rather limited
- Support for there being cross-border spillovers of macroprudential regulation

What's next?

Robustness checks

- The size of the banking sector in the origin country en lieu the GDP? Logic: supply of credit depend on the size of the banking sector, demand for credit depends on the size of the economy

Very preliminary thoughts on the second paper:

- Perhaps an extension of this, making more use of the more recent developments on the trade side of gravity equations?
- e.g. Eaton-Kortum-framework linking a structural model to a gravity equation
- e.g. a dynamic gravity model with endogenous country size and asset accumulation (Olivero, Yotov 2012)

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.
- 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.
- 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.