

# Measuring potential risk from level of credits default: Colombia Use Case

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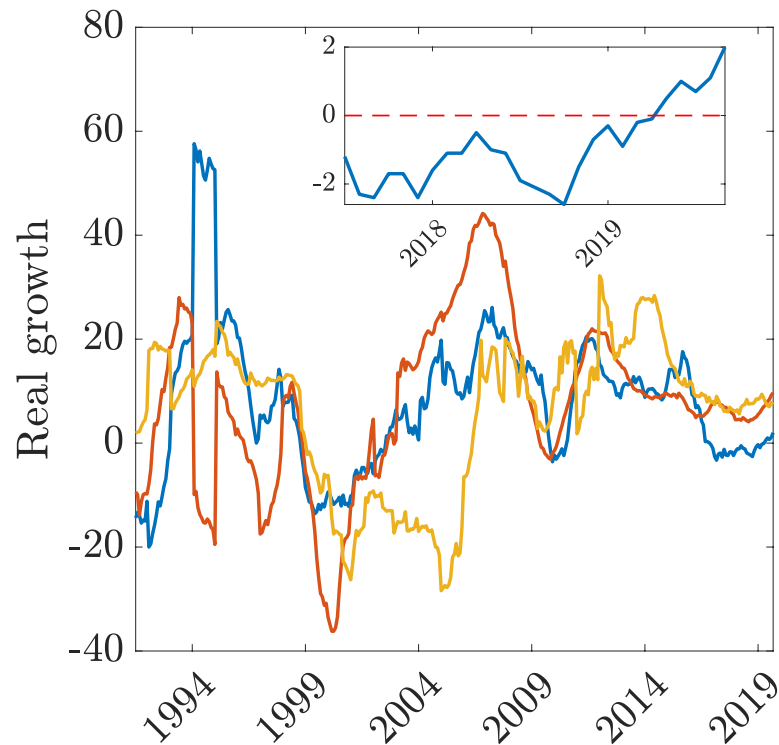
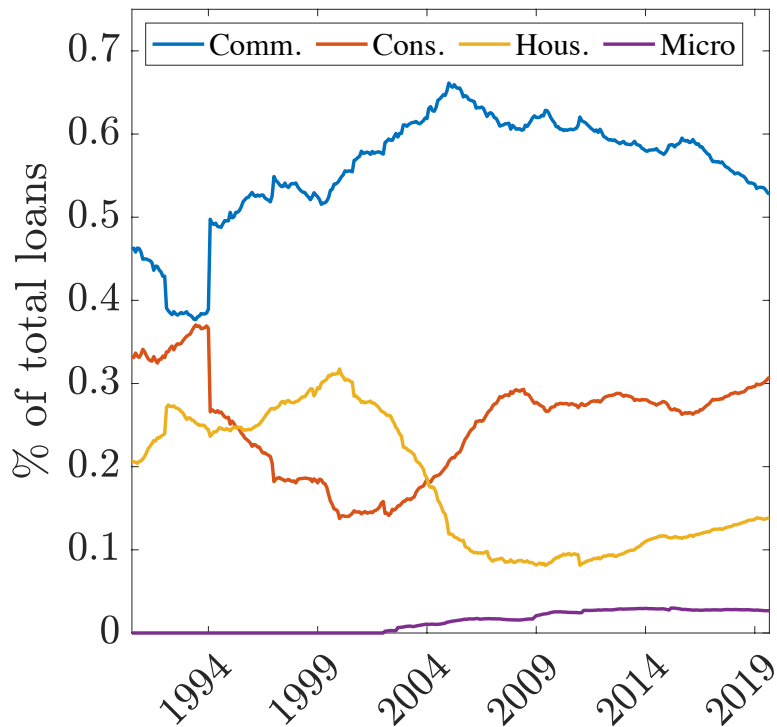
# Motivation

- Protect financial stability is the goal from the Central Bank.
- Develop tools to identify potential risks.
- In particular, develop a model that could calculate the probability of default for each loan and then to the entire system.
- Our goal is to use the information contained in such a network to develop metrics of financial stability and to build predictive models.

## Overview of the data

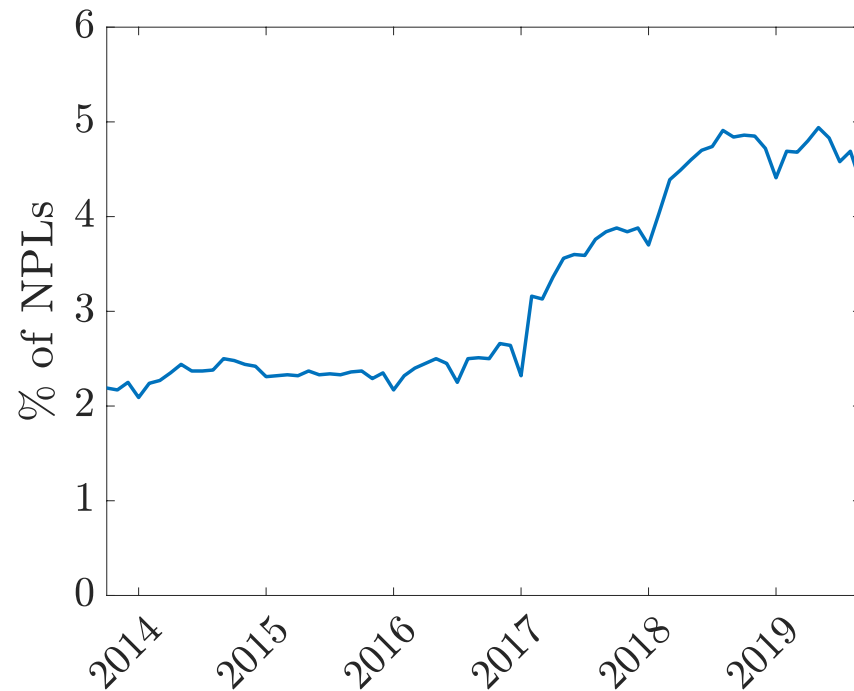
- **All loans in the Colombian economy** over the past 3 years on a quarterly time scale
  - Commercial
  - Consumer
  - Housing
  - Microcredit
- Details provided include (anonymised) identities of lenders and borrowers, the amount of capital, and the rating of the loan (5 classes)
- **Goal:** to identify risks / instabilities / anomalies in the credit system, in particular to determine the large-scale consequences of non-payment

## Overview of all loans



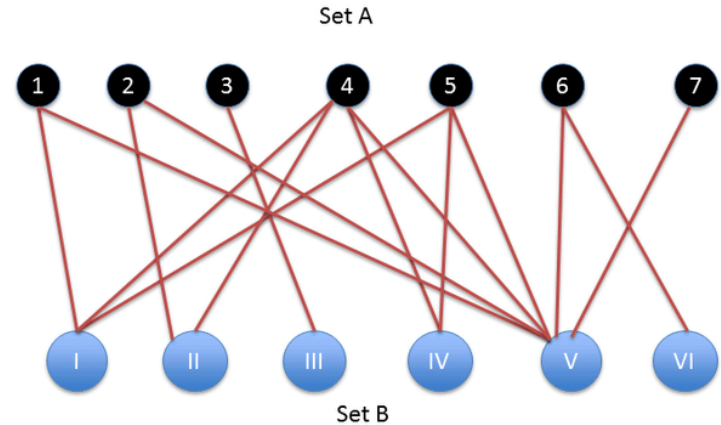
## Overview of all loans

- In the following: **commercial loans** only (other types to be investigated in the future)
- Account for **more than 50% of all loan volume**
- **Concentrated** in relatively low amount of debtors (500K vs millions in other loan types)
- Real growth has been declining over last couple years, with a corresponding **increase in credit risk**



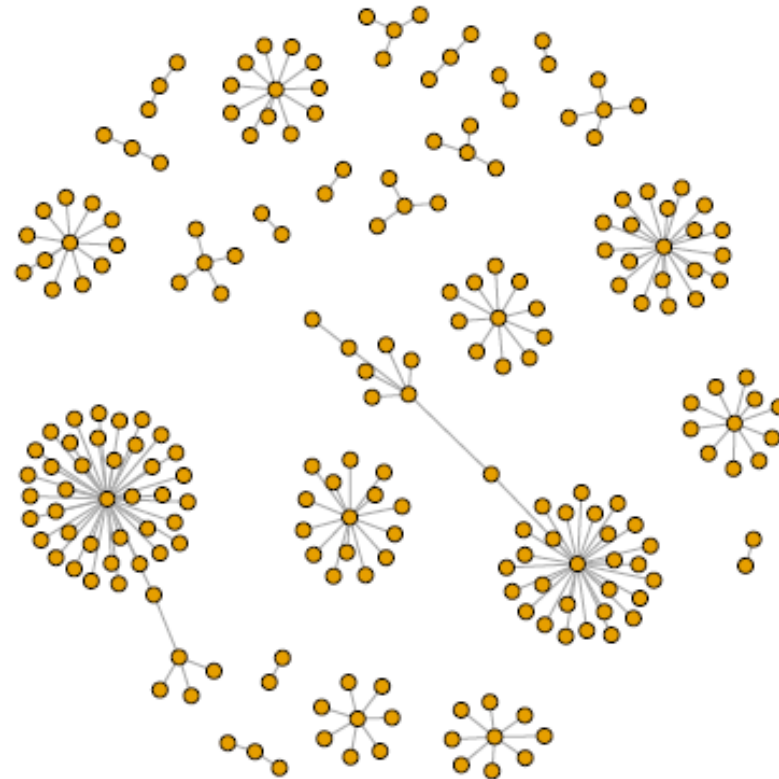
## Overview of the plan

- Describe the Colombian credit system as a **bipartite network** of lenders and borrowers
- Perform **network validation** to identify a backbone of links that are statistically significant due to their size (capital) and the characteristics of the lenders and borrowers involved
- Use the information contained in these links to perform a **prediction exercise** (to be completed)
- **WHY**: validated backbones typically contain most of the information in a network (i.e., no noise) and are rather **stable over time**



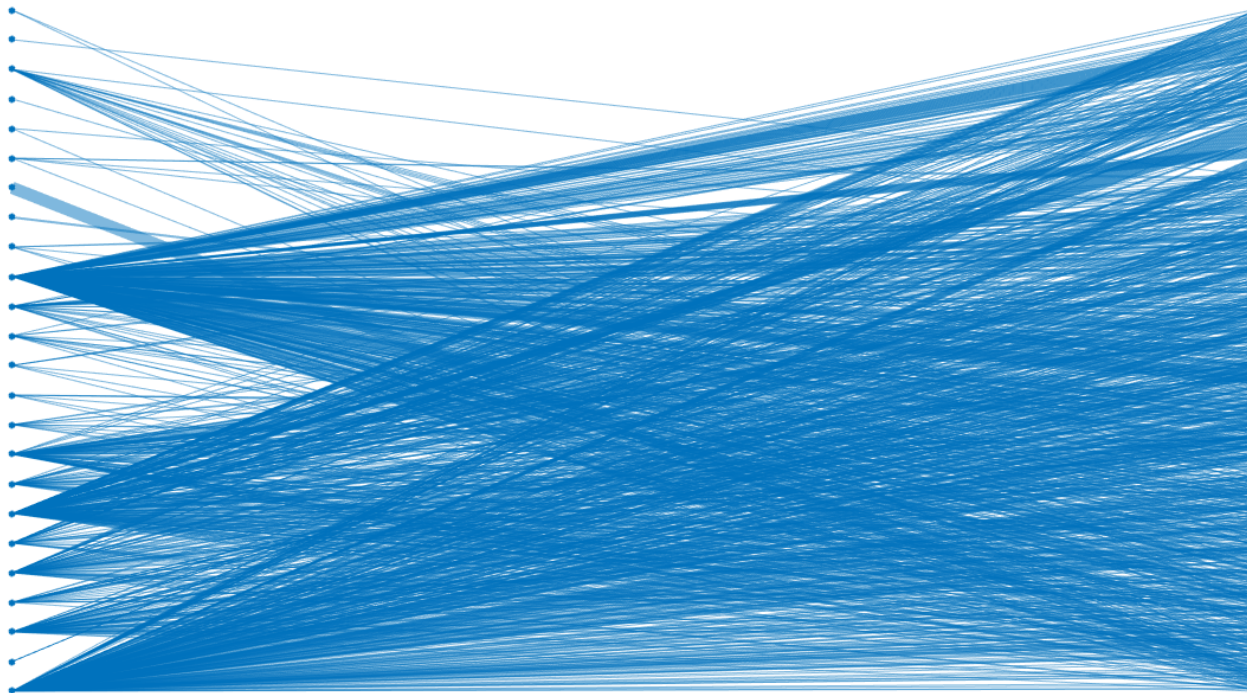
# Bipartite Network

- For the sample analyzed, the credit firm bank bipartite network shows around 9 subgroups, where 2 subgroups presented more concentration compared with the rest of the banks.
- Around 14 subgroups have a less connections among them.



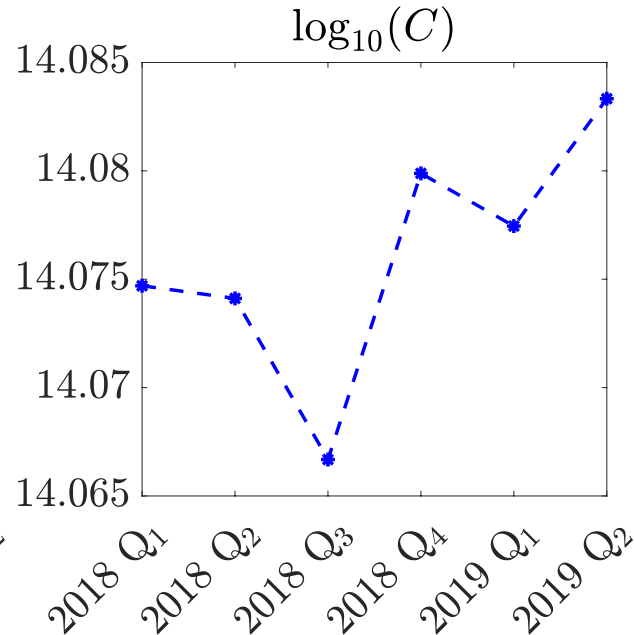
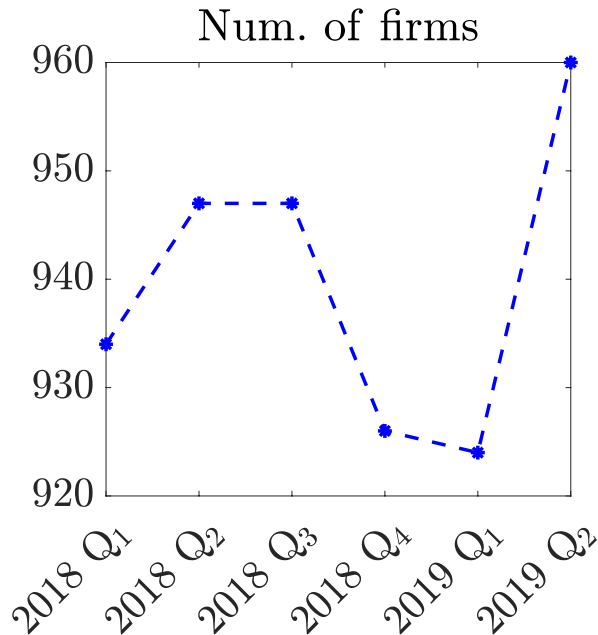
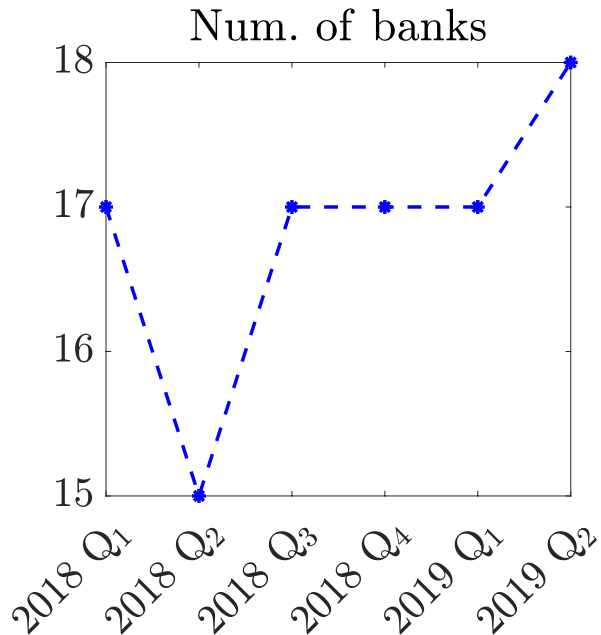
## Validated networks

- Example of network validated by Pólya filter for Q1 of 2018, commercial loans



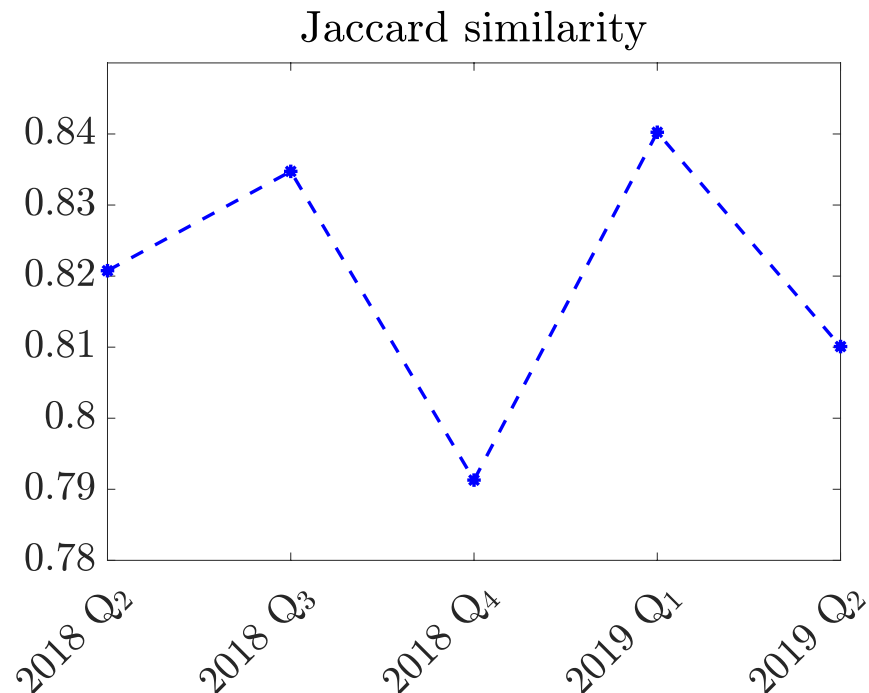


## Concentration



- **Over 6 quarters:** Total num. of banks = **27**; Total num. of firms = **1315**  
(Pólya filter maximum likelihood parameter roughly stable around **3.35**)

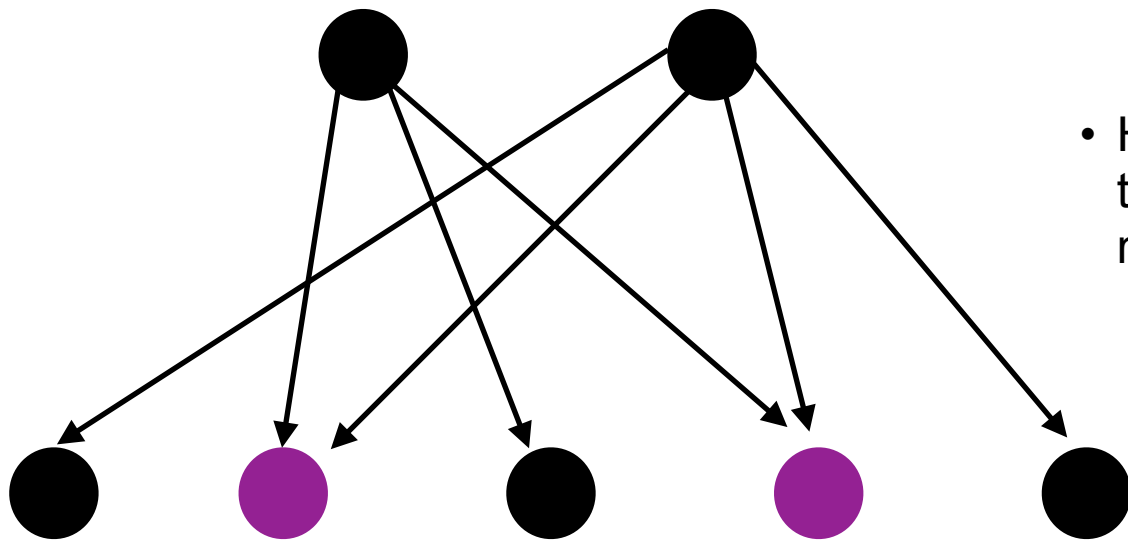
## Stability over time



$$J = \frac{|\text{intersection}|}{|\text{union}|}$$

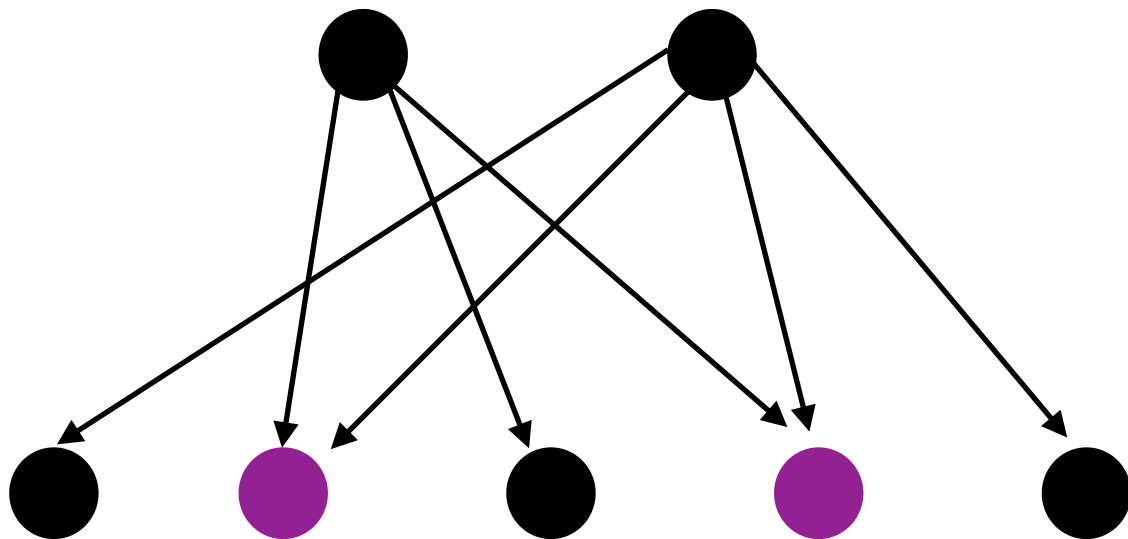
- Very strong **link persistence** in the validated networks (predictive power)

## Looking for similar profiles: Projected networks



- How often do banks lend to the same borrowers? And how much?

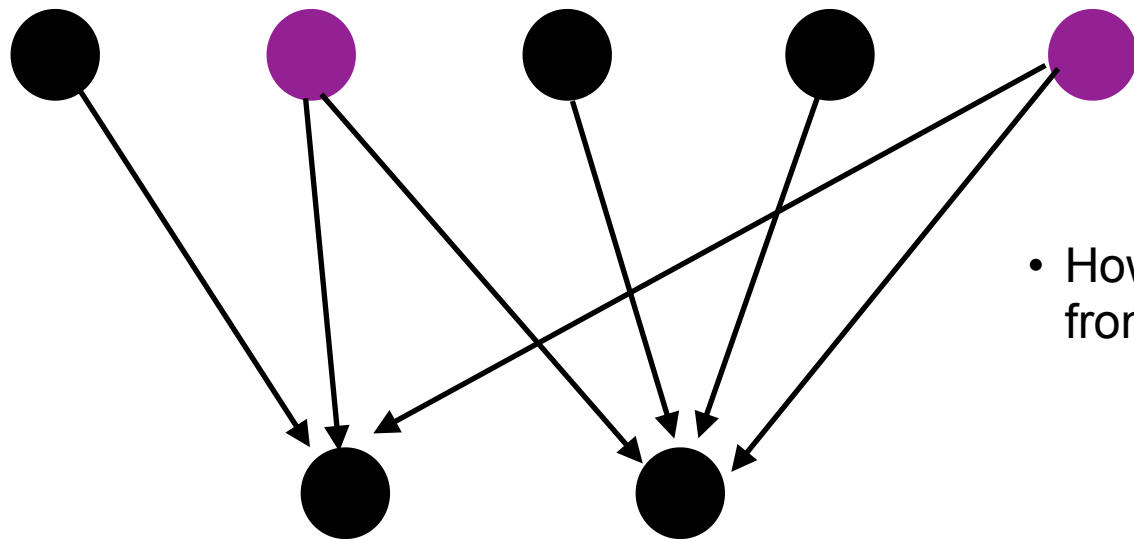
## Looking for similar profiles: Projected networks



Projected networks  
(Overlap)

$$O_{ij} = \sum_{\ell} W_{i\ell} W_{j\ell}$$

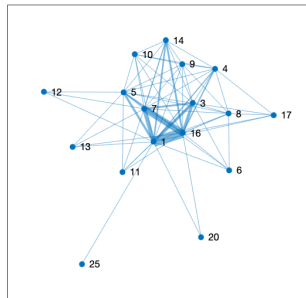
## Looking for similar profiles: Projected networks



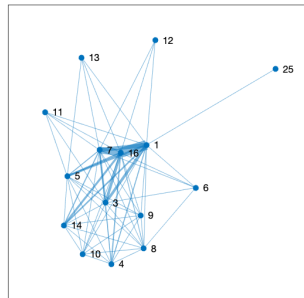
- How often do firms borrow from the same banks?

# Projected networks

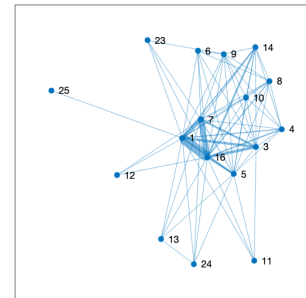
2018 Q1 ( $a = 3.40$ )



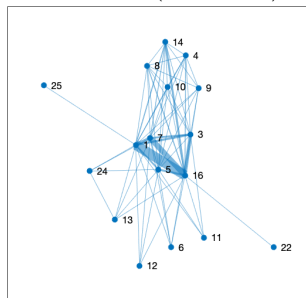
2018 Q2 ( $a = 3.35$ )



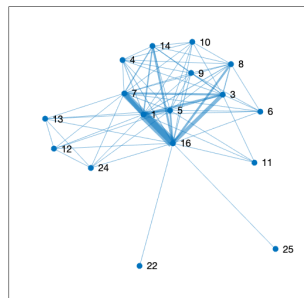
2018 Q3 ( $a = 3.30$ )



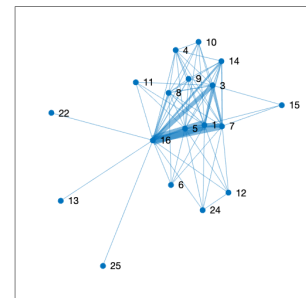
2018 Q4 ( $a = 3.30$ )



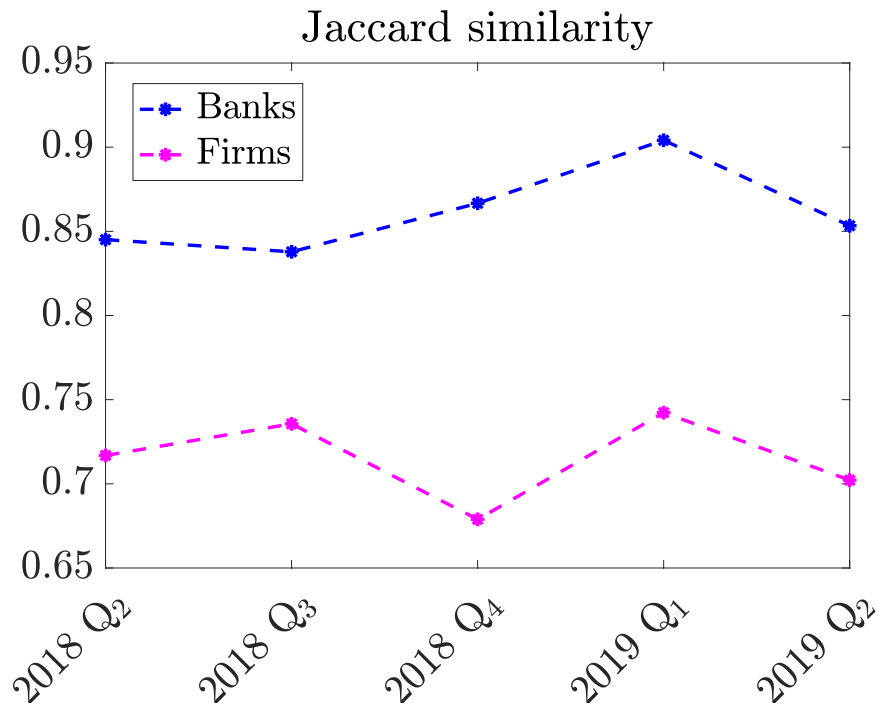
2019 Q1 ( $a = 3.30$ )



2019 Q2 ( $a = 3.32$ )



## Stability over time



- Very strong **persistence** in the overlap structure both between banks and between firms
- Very strong **persistence** in the centrality of both banks and firms
- **The same 3 banks** are the most central ones in all quarters
- **The same firm** is the most central one in all quarters (with little variation behind it)

## (Very preliminary) Conclusions

- The Pólya filter produces **very stable network backbones** over the 6 available quarters
- Such a stability is reflected both by
  1. very similar values of the maximum likelihood parameter of the filter
  2. strong link persistence in the bipartite bank-firms loan network
  3. strong link persistence in the projected overlap networks between banks and firms
- Overall, this suggests that validated links belonging to the network backbones yield a large predictive power
- **Next steps:** including information about **ratings of the loans**