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

[Graph showing trends over years for different types of loans: Commercial (Comm.), Consumer (Cons.), Housing (Hous.), Micro (Micro).]

[Graph showing real growth over years with inset for 2018 to 2019.]
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
• **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