An Integrated micro-macro firms' distress model based on payment's network

Micro Financial Stress Test

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- There are indeed examples of **network analysis applied to the interbank market** (Freixas, Parigi and Rochet, 2000; Furne, 2003; Boss, Elsinger, Summer and Thurner, 2004; Iori et al., 2006; Nier et al., 2007). In this case, however, the networks considered are very simple and easy to study because they consist of few nodes organized in canonical forms.

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The debate

How dramatic are the consequences of credit rationing on growth, productivity and unemployment?

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- Drawing on the modern literature on the monetary transmission mechanisms with capital market imperfections, this research propose a **model based upon firms reliance on bank loans** (credit channel) to sustain the production process. In this framework a shortage on short-term credit has impact on the production process and affects the entire production chain.

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- We do not investigate the financial institutions' efficiency but **we focus on the interactions among firms** embedded in production networks and the complex interactions among them.

The choice between arm's-length debt securities and relationship debt: evidence from Italian firms shows loans are the main source of capital for Italian firms.

We construct a **empirical micro-macro model** which describes the convolution of bank distress probabilities at the micro-level and the macroeconomy. There are a number of reasons to combine the micro and macro perspectives.

- In a **pure macro model**, many potentially relevant effects may be obscured due to the loss of information following data aggregation.
- A **purely micro financial model** it is difficult to interpret movements in aggregate variables: there is no straightforward economic interpretation of the macro fluctuations, for example in terms of structural shocks. Moreover it could preclude financial-macro feedback, also called second-round effects. Both are desirable features of models suited for macro stress-testing.

1. The **microeconomic** part of the model links probabilities of firm distress to both firm-specific and macroeconomic variables.
2. We then combine this model with a **macro model** describing the dynamics of the main macroeconomic variables, as well as their interaction with the financial sector.
3. Evaluate policy and structural shocks in the **combined micro-macro** model

The micro-econometric part of the model links probabilities of firm's distress to macroeconomic variables with an hazard rate model to estimate Probability of Distress (PD) using a logit function:

$$PD_{it} = \frac{e^{\beta X_{it-1} + \pi Z_{t-1}}}{1 + e^{\beta X_{it-1} + \pi Z_{t-1}}}$$

where the default probability (PD) at time t is function of firm i's characteristics X and macro environment's conditions Z.

This standard approach is improved by including the firms' i local network relations (N_{it-1}):

$$PD_{it} = \frac{e^{\beta X_{it-1} + \pi Z_{t-1} + \Psi N_{it-1}}}{1 + e^{\beta X_{it-1} + \pi Z_{t-1} + \Psi N_{it-1}}}$$

we propose three different specifications for N_{it-1}:

Network Connectivity $\quad N_{it-1} = \sum_j c_{ij}$

PD Propagation $\quad N_{it-1} = \sum_j a_{ijt-1} PD_{jt-1}$

The link with the macroeconomic is carryed out with a VAR model (Hosmer and Lemshow, 2000):

$$Z_t = \Pi^{MM} Z_{t-1} + \Pi^{MF} PD_{t-1} + \Pi^{MN} N_{t-1} + u_t$$

where $Z_t = [Y_t, P_t, R_t]'$

We expand the macro system with one equation, namely the data generating process for the aggregate probability of distressed events originating from the micro model

$$\begin{bmatrix} Y \\ P \\ R \\ PD \end{bmatrix}_t = \begin{pmatrix} \Pi^{MM} \\ \Pi^{FM} \end{pmatrix} \begin{bmatrix} Y \\ P \\ R \end{bmatrix}_{t-1} + \begin{pmatrix} \Pi^{MF} \\ \Pi^{FF} \end{pmatrix} PD_{t-1} + u$$

What is still missing:

- An explicit description of financial institutions' behaviors
- An AB simulation model linking micro-macro

Transactions

- Two transaction types: wire transfers, invoice discounting
- The sample: 80% of Italian firms and 14% of the total value of Italian financial transactions.
- Representative both at the sector level and at the geographical level even if there is a bias towards larger enterprises underestimating SME.

Network is characterized by scale-free distributions

- size of turnover per firm
- volume per transaction
- number of transactions per relation
- number of incoming relations per firm (demand side)
- number of outgoing relations per firm (supply side)

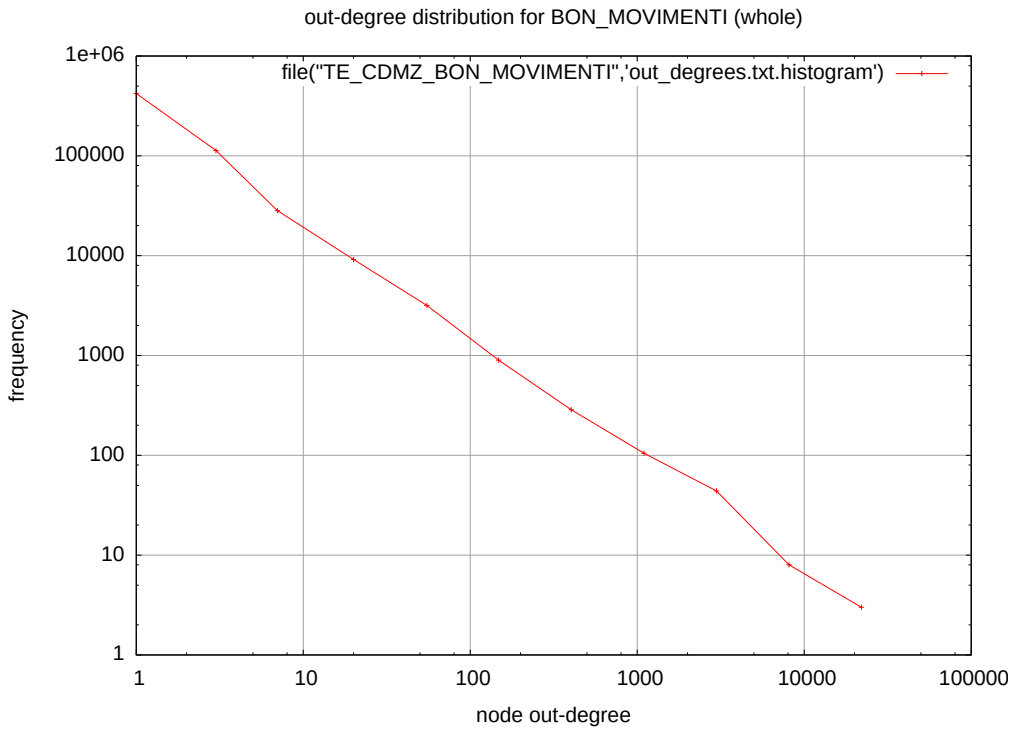

Figure: Out Degrees

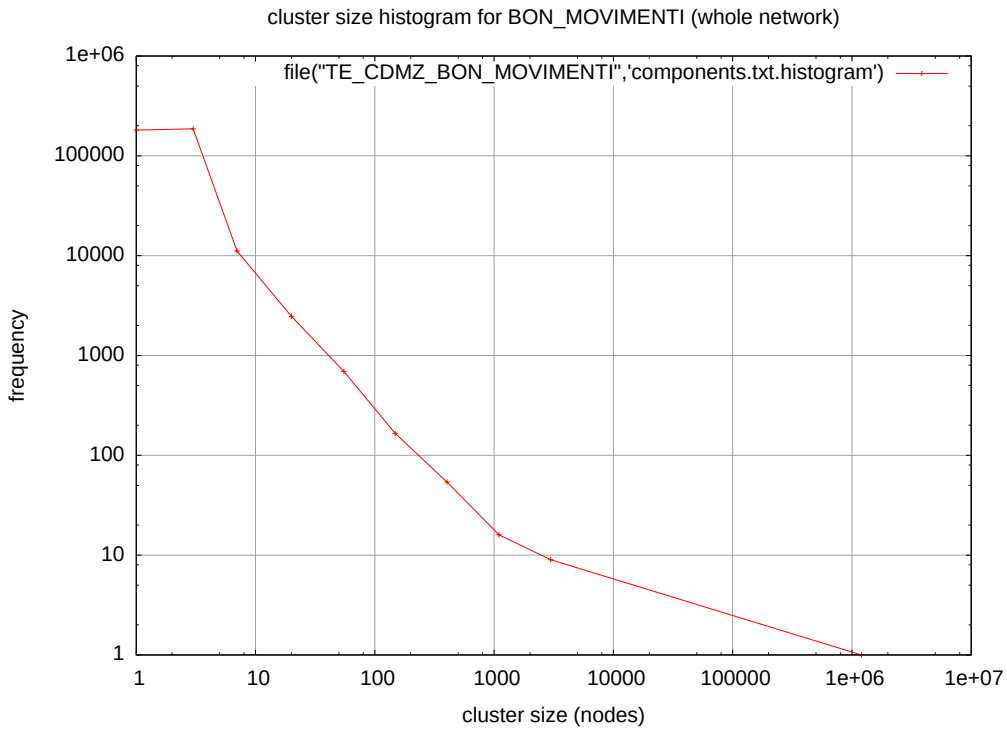

Figure: Components

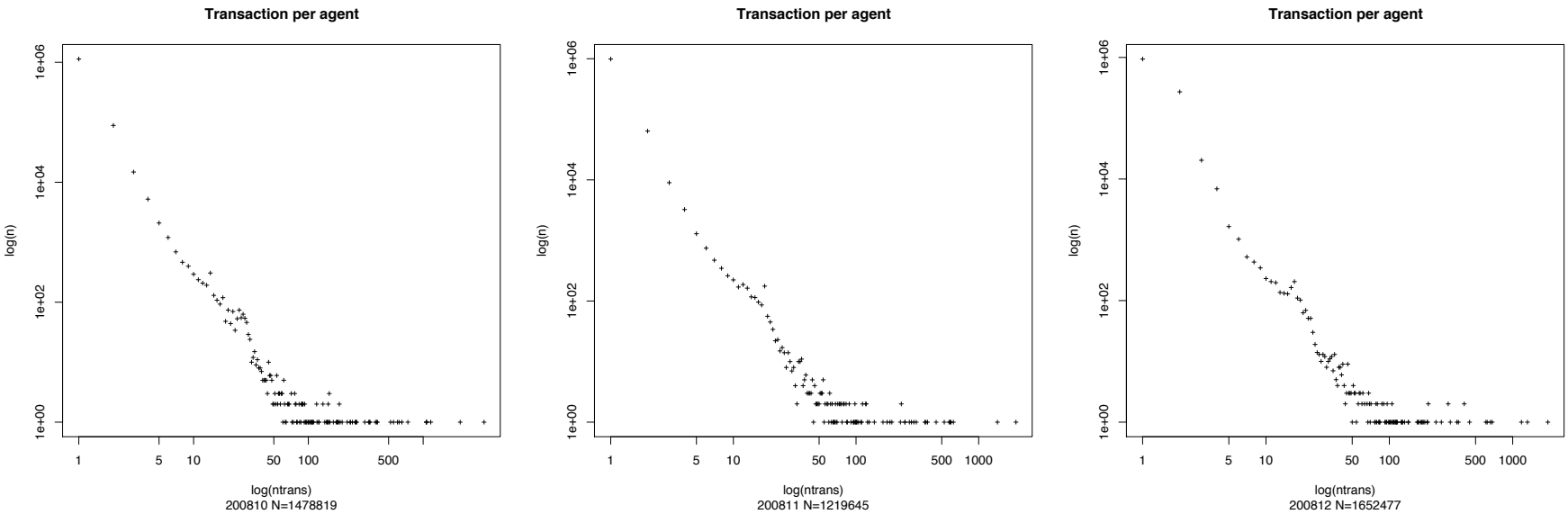

Figure: Stability over time

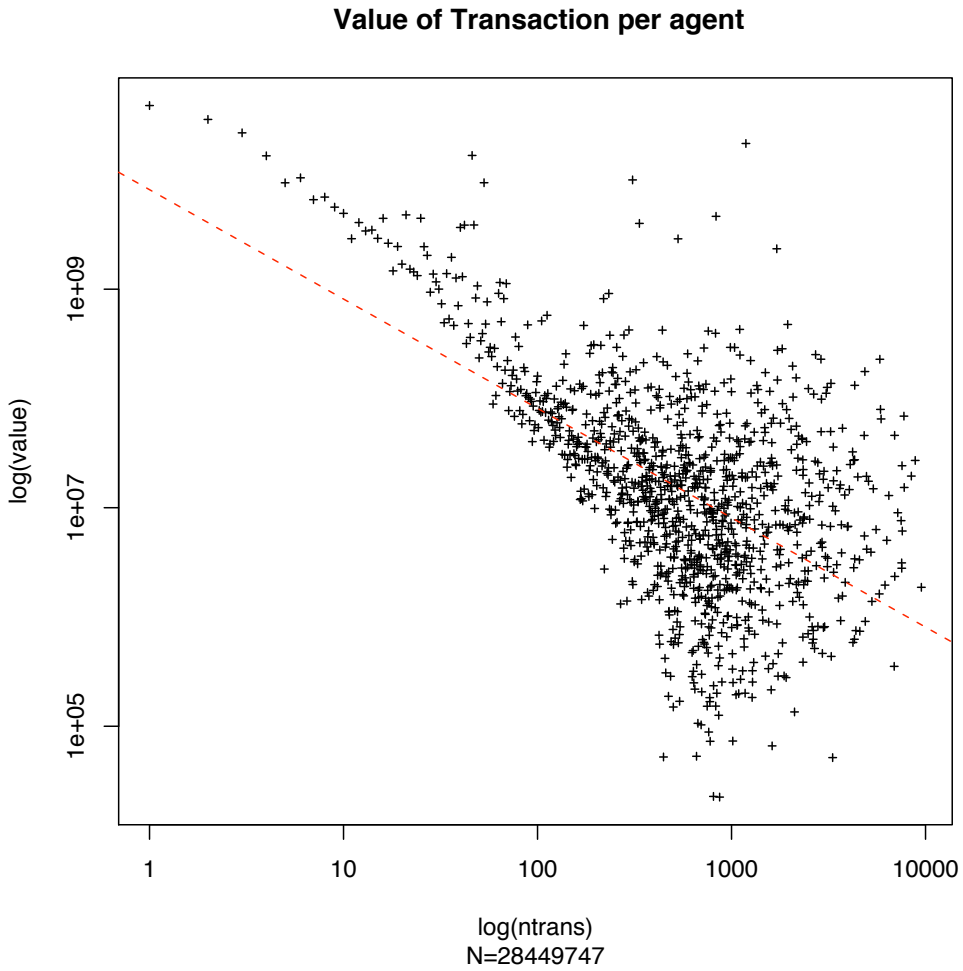

Figure: Volume