

# A multi-agent model for the maximization of the stability of the interbank and banks-firms system

Universität Bielefeld

Giuseppe Mastrangeli

Bielefeld University

EBIM – Economic Behavior and Interaction Models

## Abstract

I have created a multi-agent model to study the stability of inter-bank market and firms-bank relations. The model is inspired by Iori, Jafaray, G. Padilla [3] who investigate the interbank structure, and by Delle Gatti, Gallegati, C. Greenwald, Russo, E. Stiglitz [1] who investigate the properties of a society in which there are a financial system and two typologies of firms. The aim is to find some rules that an external institution could implement in this society to decrease the bankruptcies of firms and banks.

## 1. Introduction

The economy consists of three sectors: downstream firm sector D, an upstream firm sector U and a banking system of Z banks. D firms produce final product, U firms produce intermediate product that D needs. In every period each D firm looks for the U firm with lowest price of intermediate goods. At the same time every firm searches for the bank with the lowest interest rate. Each bank has the possibility to lend or/and borrow money using inter-bank lending contracts.

## 2. Firm system

### D firms

At the beginning of each month firms of type D search U firm from which they can buy intermediate products. The searching method is the preferred - partner choice rule. To start production U firms must have enough net worth to cover the cost of workerst and the cost of intermediate products that they are buying. If a D firm has not enough money, it search for a loan in the bank system. The searching method is the preferred - partner choice rule. During the month, D firms get intermediate products and produce the final output. At end of the month D firms sell all the output and pay the debt, with interest, to the bank, if there is one. If, at end of this operations, the net worth of D firm is negative, the firm default.

### U firms

At the beginning of each month firms of type U receive requests of intermediate products from a set of D firms. To start production firms of type U must have enough net worth to cover the cost of workers. If U firms have not enough money, they search for a loan in the bank system. The searching method is the preferred - partner choice rule. During the month, U firms produce intermediate product and deliver it to D firms. At end of the month U firms pay the debt, with interest, to the bank, if there is one. If, at end of this operations, the net worth of an U firm is negative, the firm default.

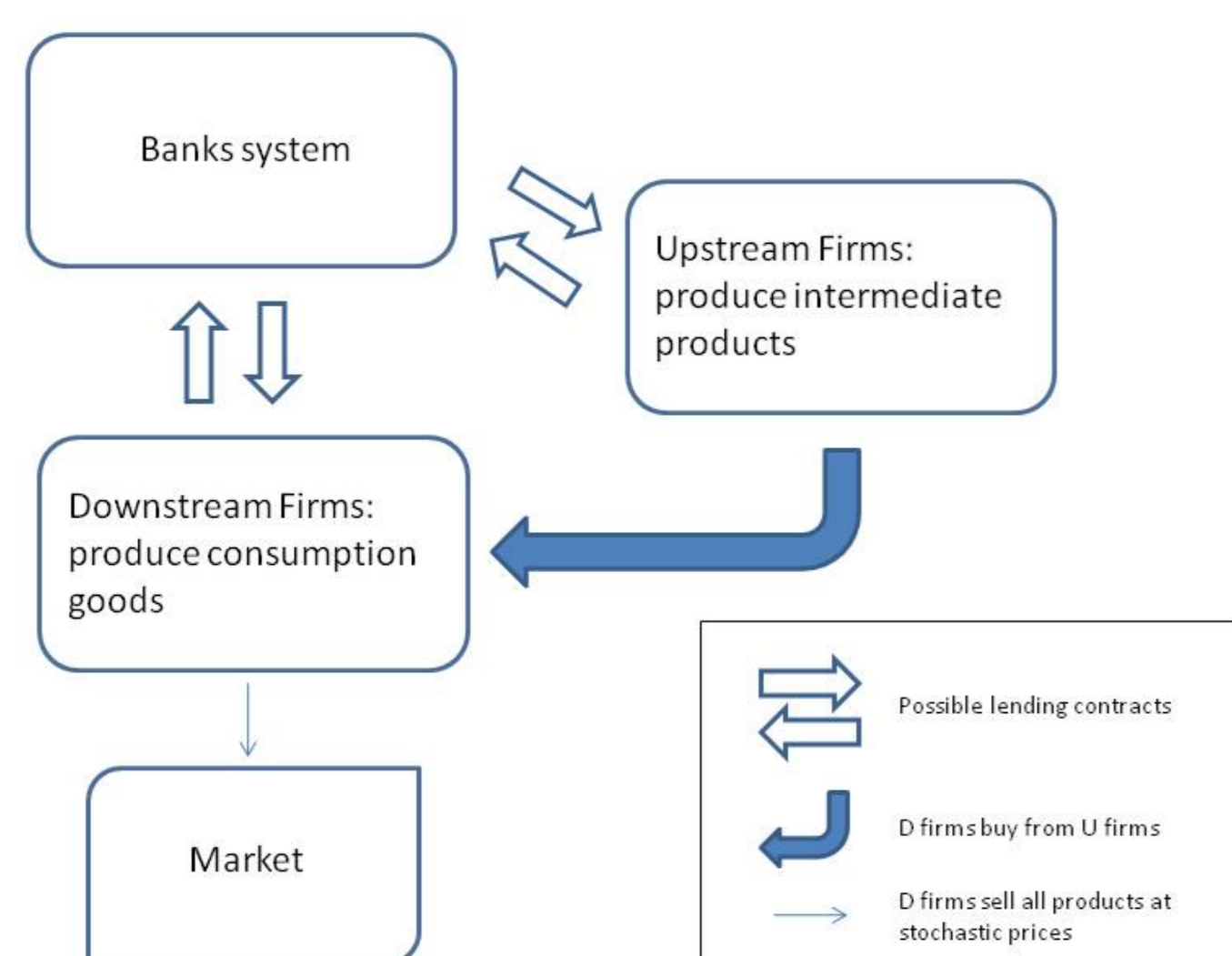


Figure 1: A schematic structure of the economic system

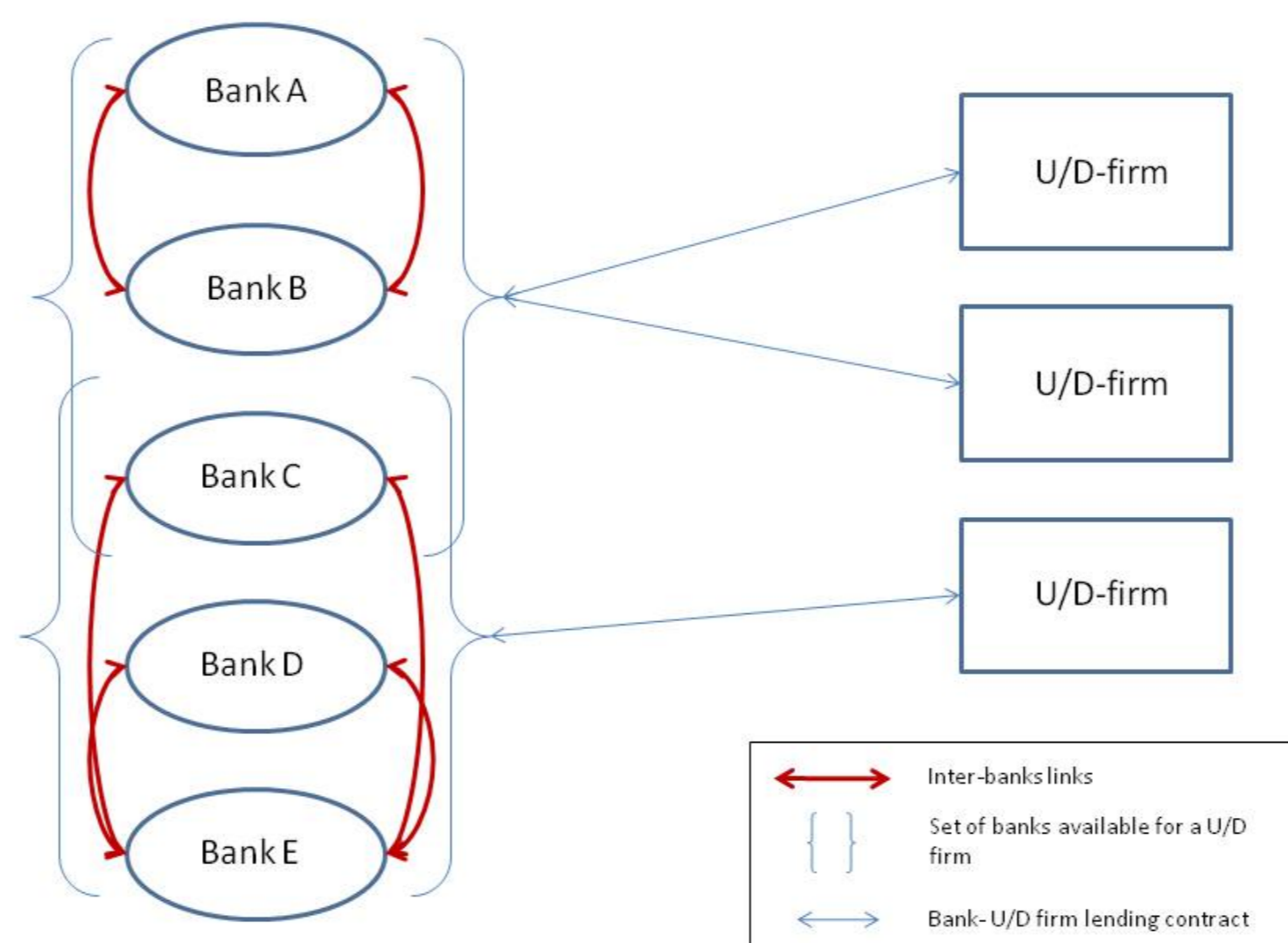


Figure 2: Schematic relation among banks and U or D firms-banks: "preferred - partner choice rule"

## 3. Bank system

### Banks

At the beginning of each month each bank receives shocks to its liquid reserves. They must pay interest to depositors and must pay their workers. After this fluctuation, if the net worth is positive, banks can give loans to U and D firms. If net worth is negative, this bank cannot lend money, and at end of this period it will try to get credits from other banks.

At end of the month each bank that has a debt contract, pays it with interest. They get also returns of the firms credits contracts, if some firm has got money from banks. If, at end of this operations, the net worth is not bigger than zero, banks can ask other banks debt contracts that they will pay at end of next month. If, after asking partner-banks, a bank has negative net worth, it defaults.

### Evolution of the net worth of banks

$$A_{z,t+1} = A_{z,t} - L_{z,t} + p_{i_{z,t}} - bd_{z,t} + ci_{z,t} + c_{z,t} - bc_{z,t}$$

Bank-firm credit contract

$$L_{z,t} = \sum_{i \in I_z} B_{i,t} + \sum_{j \in J_z} B_{j,t}$$

Theoretical return in bank-firm credit contract

$$\pi_{z,t} = \sum_{i \in I_z} (1 + r_{z,t}^i) B_{i,t} + \sum_{j \in J_z} (1 + r_{z,t}^j) B_{j,t}$$

Missed return due to bankruptcies of firms

$$bd_{z,t} = \sum_{i \in I_{z,t}^f} (1 + r_{z,t}^i) B_{i,t} + \sum_{j \in J_{z,t}^f} (1 + r_{z,t}^j) B_{j,t}$$

New interbank contracts

$$ci_{z,t} = \sum_{z \in Len_{z,t}} -b_{z,t} + \sum_{z \in Bor_{z,t}} b_{z,t}$$

Theoretical return on last period interbank contracts

$$c_{z,t} = (1 + r_b) \sum_{z \in Len_{z,t-1}} b_{z,t-1} + \sum_{z \in Bor_{z,t}} -b_{z,t-1}$$

Missed return due to bankruptcies of banks

$$bc_{z,t} = (1 + r_b) \sum_{z \in Len_{z,t-1}^b} b_{z,t-1} + \sum_{z \in Bor_{z,t}^b} -b_{z,t-1}$$

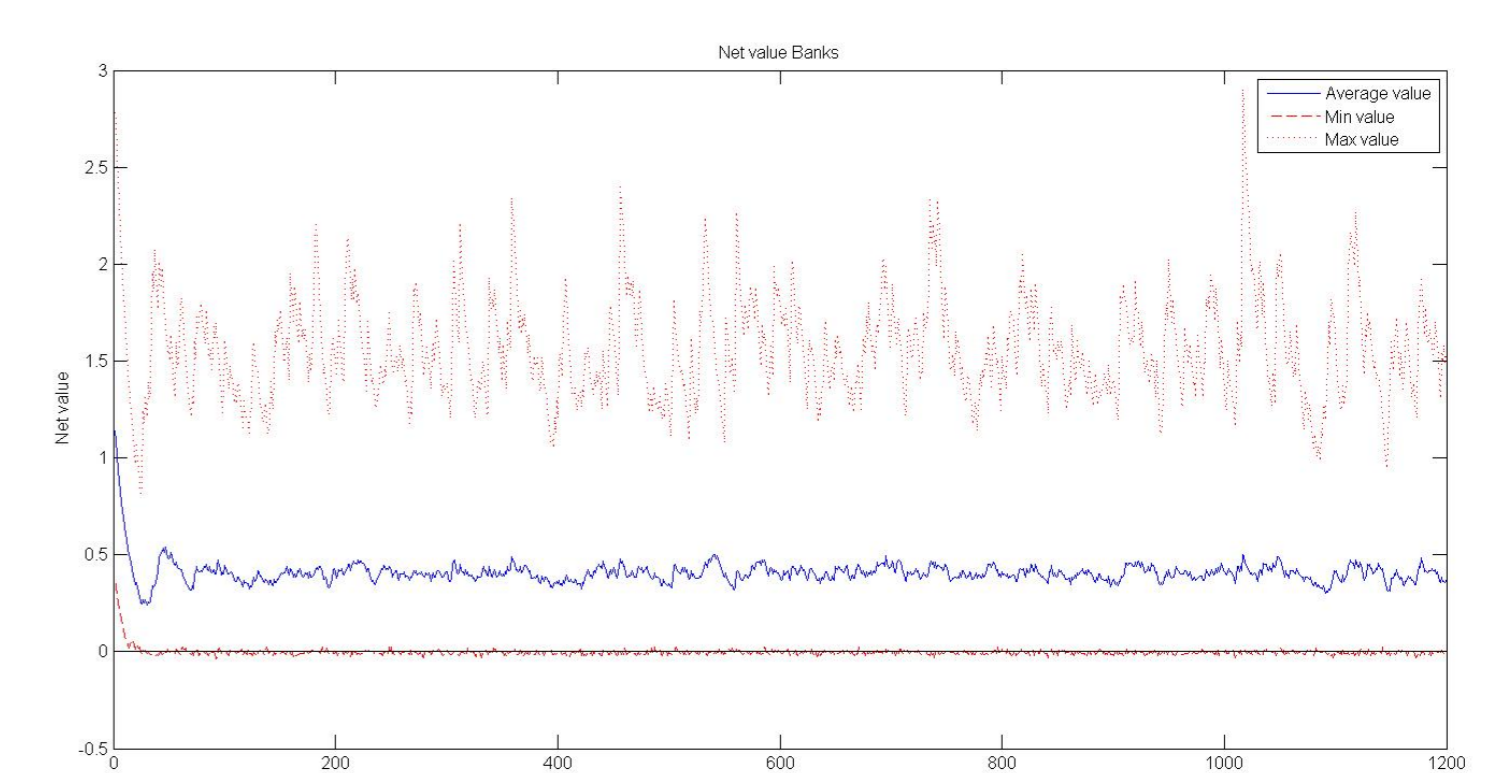


Figure 3: Average net value of the system of banks

## 4. Development

In this work I am extending the multi-agent system of Domenico Delle Gatti, Mauro Gallegati, Bruce C. Greenwald [1] that describes a society of banks and two typologies of firms, joining it with the interbank market described in Giulia Iori, Saqib Jafarey, Francisco G. Padilla [3].

With this model I try to find some rules that an external institution could implement in this society to decrease the bankruptcies event of firms and banks. In particular I answer to this two questions: How can the government or another institution like Central bank create some rules to determine the Interbanks relationship such that we have the best solution of the problem for the stability of the system? How can the government or another institution like Central bank create some rules to determine the bank-firms relationship such that we have the best solution of the problem for the stability of the system? Both questions are equivalent to solve two optimization problems in this multi-agent system.

## References

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