# A Study on the Agent-Based Simulation Method for the Firm Network Dynamics

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Despite of its tremendous complexity, there exit many attempts to analyze the firm network dynamics so far. The so-called Gibrat's law has been confirmed[1] as the stylized facts for the firm growth: the distribution of firm size can be fitted with a power-law; and in the power-law region the firm growth rate is independent of the firm size. A great number of stochastic models were proposed in order to reproduce the statistics of firm growth. Nevertheless, there are some problems in applying these models to the real business world because of the difficulty in describing the interactions among firms as well as the decision-making process of individual firms.

Based on Ikeda's study[2], a multi-agent simulation model has been constructed in this study, taking the modeling of business-to-business transactions into account. Specifically, a subset of the transaction network is generalized and firms are modeled as interacting nodes of the network. An interaction matrix describing the inter-business relationships are calculated quantitatively through the analysis of historical data. In such an agent-based model, firms on the network interact with others so as to cope flexibly with the changing business environment[3]. In the mean time, firms also periodically make decisions by using the game theory, on the capital amount of the future investment so as to maximize their net present values (NPV).

Previous studies showed that the agent-based simulation can reflect the dynamics of firm growth to a certain extent[2]. On the other hand, there are still several issues need to be refined or clarified. To this end, we point out that the assumption of the stationary mean value of revenues (MVR) of the firms can be relaxed. We take two approaches to model the MVR as a time-dependent function. One solution is to use a moving average of the past data, the other one is to use the Nash equilibrium MVR, an idea which was proposed also in one of Ikeda's studies[4]. Simulations using the two different models are carried out, and a detailed comparison is made to evaluate the different methods. In addition, we also present a comparison of two methods for

the computation of NPV, one for the genetic algorithm and the other for a game tree.

**Keywords**
agent-based simulation, firm dynamics, game theory, transaction firm network

**References**
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