

Boxed Economy Model

Fundamental Concepts and Perspectives

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Abstract

In this paper, the concept of Boxed Economy model is proposed. Boxed Economy model is an agent-based microeconomic simulation which is intended to make predictions and explanations of the real economic movements in the general economy.

We suggest the importance of reusable design with object-oriented framework in the field of agent-based economic simulation. Two frameworks at the different level are described in this paper: “Boxed Simulator Framework” and “Boxed Economy Framework”. The source code and model is going to be open to public for sharing and co-improving.

Key Words: agent-based economic simulation, multi-agent, social simulation, framework, open source

1 Introduction

“Look inside the box, and you can find another real world.....”

Boxed Economy model is constructed as a new foundation of the agent-based simulation model for the general economy¹ (Figure 1). This study is intended to produce an agent-based simulation platform to make explanations and predictions of the real economic phenomena.

Boxed Economy model is implemented by Java language: the object-oriented language which is portable and independent of the platform.

The detail model and the program code of Boxed Economy model is going to be opened to public for sharing and co-improving of the simulation models and related tools. Boxed Economy model is in-

tended to be like “Swarm” in the economic field: Swarm is an open-source simulation model that achieves success especially in the field of Artificial Life [MBLA96].

There are two frameworks that help the simulation builders to share and co-improve the simulation, those are “Box Simulator Framework” and “Boxed Economy Framework”. Box Simulator Framework provides a shared platform for the components of the simulator at the application level. Boxed Economy Framework is designed for agent-based economic models.

We may leave the concrete simulation models for the future paper [IHK⁺]. The purpose of this paper is, to focus attention on the framework design and to introduce the concept and perspective of our economic simulation.

2 Background

A large number of the social simulations using interactive agents have been reported lately. Especially the simulations studied in the area of economics are named as Agent-Based Computational Economics in some papers [Tes98].

In the area of agent-based economic simulation, there are three types of exploration. First type of

¹ The Boxed Economy model is developed by the *Boxed Economy group*, which is a branch of *In-The-Box project* held at Keio University, Japan. The group consists of the authors, Takuya Iwamura, Tomohiro Yoshikawa, and Hiroyoshi Kawakami. (Contact us: boxed-economy@novel.mag.keio.ac.jp, <http://www.novel.mag.keio.ac.jp/boxed-economy/>)

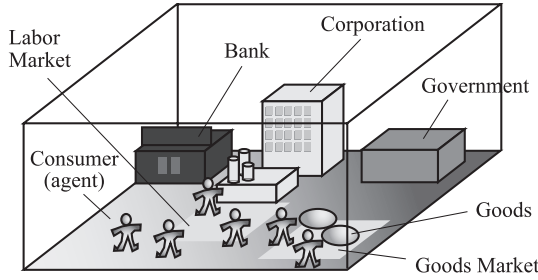


Figure 1: The abstract illustration of Boxed Economy model

explorations are handling primitive society: “sugarscape” and “mechanism of emergence and collapse of money” [EA96] [Yas95].

Another type of explorations are the models focusing on the specific markets: “stock market” and “foreign exchange market” [PAH⁺94] [ITT99] [IO96].

The last type of explorations try to simulate the whole economic society: “Agent-Based Keynesian Economics” and “ASPEN” [Bru97][N.B98].

Especially ASPEN has similar characteristics to the concept of the Boxed Economy model. They are both agent-based microeconomic simulation which is used for prediction of the real economy. Notable points for ASPEN would be, (a)it is strongly focusing on the U.S. economy, (b)it needs numerous amount of calculation during the simulation due to the minuteness (the simulation is designed to run on the massively parallel Paragon computer), (c)the program sources are not opened to public.

A lot of agent-based economic simulations are build from scratch, and they are not designed for reusing or sharing the simulation components. The enormous development time and cost is required in the development style. This is one of the reason why it is difficult for economists to use these models for practical purpose so far.

E.Bruder and M.Maier had pointed out the importance to make simulations in modules with object-oriented languages [BM97]. Although it is a key for the progress of the simulation, modularizing is not enough. To add more flexibility to the simulation model and to arrange the model as the society changes, the design of interface to connect the modules should be concerned as well.

Little attention has been given to the reusable design of agent-based economic simulation, although a large number of studies have been made in the field of software engineering. E. Gamma and et al. had suggested about the principle of reusable object-oriented design: “Program to an interface, not an implementation”[GHJV95]. From this view-

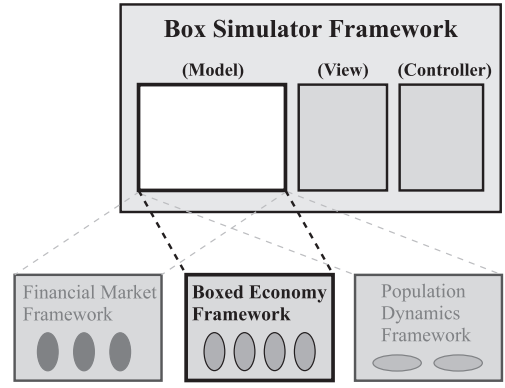


Figure 2: Two frameworks at different level

point, the past study of agent-based economic simulation can be regarded as programming to implementations, not programming to interfaces.

3 Frameworks for Agent-based Economic Simulation

On the basis of the situation, we would like to propose a foundation of the general economic simulations to share, reuse, and co-improve the components by programming to interfaces. For the purpose, the frameworks and the design patterns are needed to be applied into the field of agent-based economic simulation.

The concept and the design of frameworks for agent-based economic simulations here are named as “Boxed Economy Framework” and “Box Simulator Framework” respectively (Figure 2).

3.1 Box Simulator Framework

Box Simulator Framework provides the shared platform of the simulator components at the application level ². MVC(*Model/View/Controller*) pattern is adopted to the framework structure (Figure 3).

The simulation builders do not have to care about the existence of *View* and *Controller*, when they make the *Model*. They just have to write the following sentence, which calls the method to generate the **Parameter** object, if they want to add a new parameter.

```
addParameter( name, unit, dataType,
              value, viewable, controllable )
```

At the beginning of simulation, for example, the *View* windows and input forms on *Controller* window are generated according to the boolean value of

² You can get the latest version of Box Simulator Framework on the our WWW site.

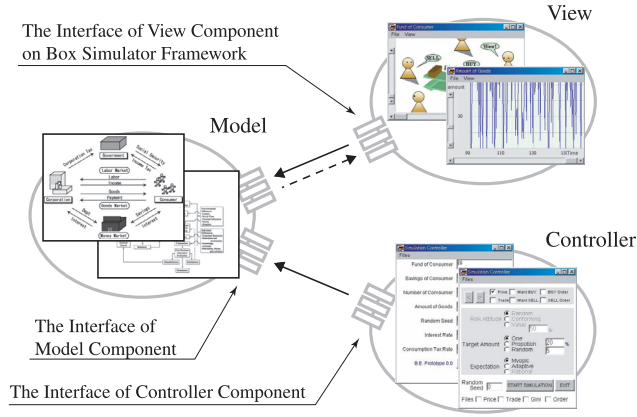


Figure 3: Box Simulator Framework

the parameter **viewable** and **controllable**. When the simulation runs, the *View* and the *Controller* will automatically reflect the status of the *Model*.

3.2 Boxed Economy Framework

Boxed Economy Framework provides the shared platform of the agent-based economic simulation model at the implementation level (Figure 4). In this framework, “**Relation**” object is introduced as the connection among the objects for the weak interdependence between the modules (objects or sets of objects)[IHI⁺99]. The simulation builders can exchange the modules which describe theories or hypotheses. It can be explained by *Strategy* pattern [IHI⁺99][GHJV95].

In the economic simulation, it will be the task to arrange or expand the model as the mechanism of the society changes, or it will not be possible to make the model realistic. Boxed Economy Framework can contribute to make a continual metabolism in the model.

3.3 Advantage of Using Framework Design

The framework is defined as a set of modules and architecture design for the specific software. The introduction of the framework to the agent-based simulations important as follows:

- Due to the nature of the object-oriented framework, a part of the model can be easily expanded or upgraded. This means that the simulation builders can make the models in parallel as long as they keep the same framework, and they can concentrate on the object related to their major: consumer, corporation, and so on. In addition, the easiness of the model arrange-

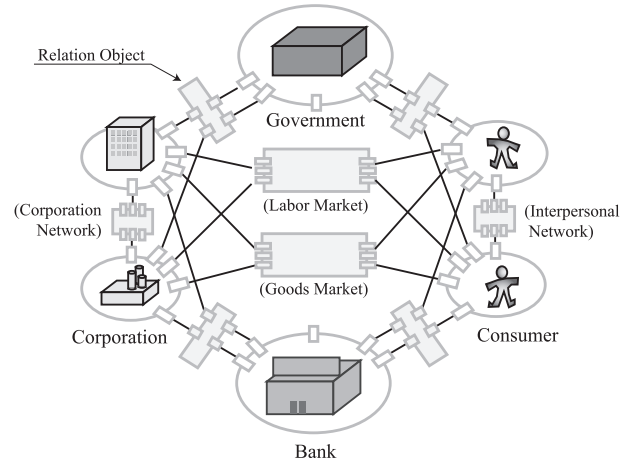


Figure 4: Boxed Economy Framework

ment is essential to synchronize the model to the dynamically changing society.

- Reusability helps the simulation builders to reduce time and costs of creating or developing the simulation model. It also helps to avoid the risk of program bugs.
- The simulation users can make comparative simulation and compare the different results between the hypothetical models that they had modularized on the same framework. In the field of social simulation, it is difficult to say which model is more reliable by experiments, so they need to compare the models by running the simulations and choose the more realistic model.
- Making the source and the model open to public provides the simulation users an easy situation to replicate the models made in the past.

4 Perspective for Prediction and Explanation

In the Boxed Economy model, the goals of our scientific inquiries are both, prediction and explanation.

The prediction will be done by following procedure (Figure 5). The instance of Boxed Economy model is inherited with the individual parameter settings, which is extracted from the real economy. Then a large number of simulation runs with different settings of unknown parameter are executed. The simulation which traces the path of real economy is chosen by comparing the trends of macroscopic status between real and artificial economy. Thus we can use the simulation settings for the prediction.

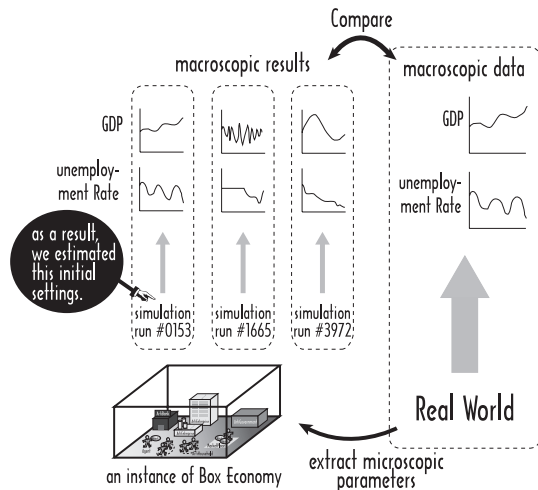


Figure 5: Prediction with Boxed Economy model

We, however, should pay attention to the trap of instrumentalism, which is taking the position that theories are considered as just instruments, and are irrelevant to the truth. For this reason, explanation is also needed as the goals of economic modeling. The model should be able to explain the internal dynamics of economy, because the real microscopic structure has been build into the model.

5 Conclusion

In this paper, the concept of Boxed Economy model is proposed as an agent-based simulation model for economic phenomena. It is also useful for the impact analysis of policy changes, and effective for the educational tools. The Boxed Economy model seems to have a great possibility to do the prediction and the explanation toward the positive economics, although we just took the first step at the present.

To make the progress in the study of the social science, using frameworks on the simulation would be necessary due to the importance of sharing, reusing and co-improving the model. The framework would be the base of making a continual metabolism in the simulation model. To make the model more reliable, we would like to suggest to form the community of researchers in the area of agent-based economic simulations.

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