

Building a Simulation Model of Foreign Exchange Market

- Reproduction of Yen Dollar Market -

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Abstract

The purpose of this study is to make a basic Foreign Exchange Market Model. It is important to make a simple basic model at first to understand the complex emergence of exchange rate which is caused by various factors. The model is a multi-agent-based model, consisting of dealer and speculator. Both agents' action relies on market trend and their personality, either trend follower/ Contrarian. In this paper, the simulation experiments are done by changing the ratio of Trend Follower and Contrarian. As a result, the complex fluctuation of exchange rate can be observed. The validity of this model is evaluated by the effect between the size of fluctuation and probability.

Keywords: Foreign Exchange Market, Artificial Market, Agent-Based Simulation, Econophysics

1 Introduction

The model to be developed in this paper is Yen-Dollar market which adopts floating exchange-rate regime. By building a model through new approach, using multi-agent modeling and computer simulation, an economic research from new point of view can be achieved [1].

It should be noted that the foreign exchange market is a special market compared to other markets. In a foreign exchange market, an amount of money that is dealt in a day is two hundred trillion yen but the actual demand does not reach 10 % of it. Most of the dealings are for speculation. However, many studies about such a special market have been reported recently. This leads to the creation of a high consisting mathematical model.

As a process of this research, we will first de-

velop the basic model, and then extend it gradually. Thus, the model described in this paper is very simple and small scaled. Changing the parameter in every phase will be possible using PlatBox Simulator¹ [2]. Therefore each factor's effect can be calculated accurately by analyzing the simulation results [3].

2 Model

2.1 Basic Structure of the Model

There are three types of agent in this model: Dealer and Speculator, as a market participant, and Market agent as a wirepuller to bring suitable dealings. The reason for selecting Dealer and Speculator as a market participants is because in real market, the purpose of most dealings are for speculation.

Dealer agent has a "Limit Order Behavior" that decides limit order and sends it to Market agent. Speculator agent has a "Market Order Behavior" that decides market order and sends it to Market agent. Market agent has a "Mediate Dealings Behavior" that brings suitable dealings between market order and limit order.

2.2 Flow of the Simulation

The flow of Yen Dollar market model will be as follows.

1. Market sends a past exchange rate information to few Dealers.

¹PlatBox Simulator is a software platform to execute and to analyze the agent-based social simulations. See our web site (<http://www.platbox.org/>) for more information.

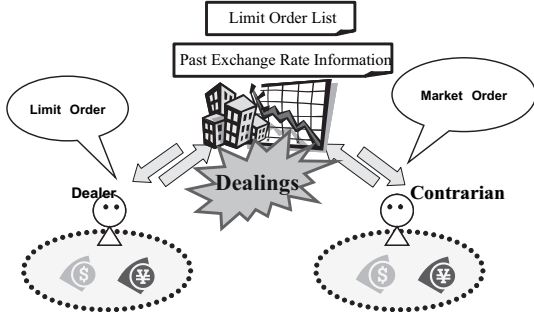


Figure 1: The world of Yen Dollar Market

2. Dealer calculates the short term regulation of an exchange rate^[4]. Based on the regulation, it decides the limit order² and sends it to the Market.
3. Market then adds the limit order to limit order list one after another. When the limit order list completes, Market will send the past exchange rate information to Speculator.
4. Speculator calculates regulation of an exchange rate. Then decides a market order³ and sends it to the Market.
5. Market refers to the limit order list and brings the most suitable dealing to fruition.
6. After dealing, Market adds new exchange rate to the past exchange rate information. Then Market receives the new limit order from Dealer that has done its dealing. Then Market brings dealings with Speculator's market order again.
7. When an exchange fluctuation goes up and down greatly, both of expectation and anxiety of market participants are increased. Therefore change the number of Dealer participating in dealings.

2.3 Decision Method of Agent's Order

The decision making of Dealer and Speculator is as follows. Among Dealer, there are Trend follower⁴ and Contrarian⁵, whose ratio is set and they decide limit order by their type and the market trend. The trend can be referenced from an

²Limit order is an order to announce the price that a dealer wants to have dealings beforehand.

³Market order is an order, which hit an order for selling or buying to limited order, and make a deal.

⁴Trend follower is market man who gives an order which follows the market trend.

⁵Contrarian is market man who gives an order that is contrary to the market trend.

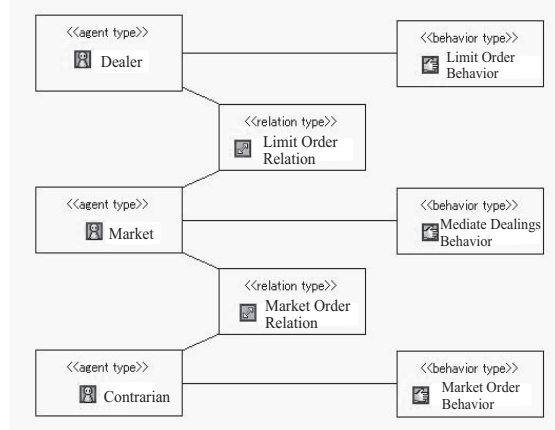


Figure 2: Class diagram of Relation and Behavior (Yen Dollar Market model)

arbitrary moving average, which is calculated from a past few periods decided by the parameter.

$$Tr = \frac{1}{P} \sum_{i=1}^P Ri - \frac{1}{P} \sum_{i=2P+1}^{3P} Ri$$

Note that Tr is an index of market trend, P is the period to refer the past exchange rate, and Ri is The Exchange rate of i -th period. If there is a sharp fluctuation, they widen the Spread. The number of sell and buy order will be the same and it is selected from 1-11 at random.

Within the speculator, there are Trend Follower and Contrarian. They decide their own market order depending on their type and the market trend. The number of order is selected from 1-11 at random.

3 Simulation Experiment

3.1 Experiment 1: Basic Settings

3.1.1 Setting

The setting of the simulation is as follows:

- Number of Dealer = 20
- Number of Speculator = 1
- Trend Follower Dealer: Contrarian Dealer = 1 : 1
- Trend Follower Speculator : Contrarian Speculator = 1 : 1
- Dealer's referring past exchange rate = 15 period
- Speculator's referring past exchange rate = 0 - 100 period

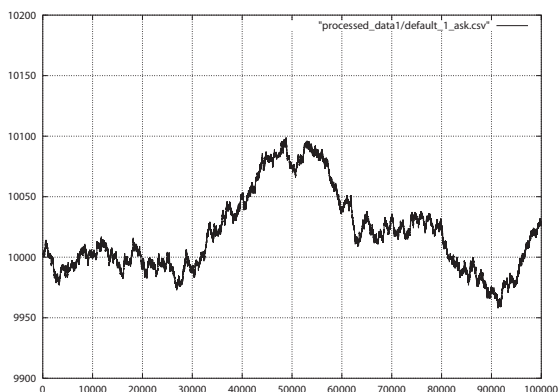


Figure 3: Transaction of market price, where it shows settled down to original exchange rate pattern.

One Speculator is enough in this model. The reason is because the continuous session is adopted in this model as a form of dealings. Either Trend Follower or Contrarian will be decided in each step. We run the simulation one hundred thousand steps changing the random seed number in 10 patterns. The time scale of one hundred thousand steps will be about 8 days.

3.1.2 Result of Experiment

There are three fluctuation types. “Settle down to original exchange rate pattern”, “Rising exchange rate pattern”, and “Falling exchange rate pattern”. Graphs of those patterns are shown in figure 3, 4, 5. The exchange rate moves little by little every step, and occasionally very big. The percentage which exchange rate moves in figure 3 was 20%. Figure 4 pattern was 50% and figure 5 pattern was 30%. In all of these results, little exchange rate fluctuations appear many times but as the range of fluctuation becomes larger, the outbreak frequency decreases.

“Settle down to original exchange rate pattern” shows that around 50 thousand steps, the rate moves up and down greatly, but eventually it settles down to its original rate. We see from “Falling exchange rate pattern” that the rate sometimes fluctuates 0.3-0.5 yen in 1500 intervals. On the other hand there are only two times that rate fluctuates 0.3-0.5 yen at figure 4. Overall, the rate fluctuation in figure 5 is more than that in figure 4.

3.1.3 Analysis

The Agent’s strategy in this model is influenced only by market trend and their personality. They do not study or be influenced from fundamentals.

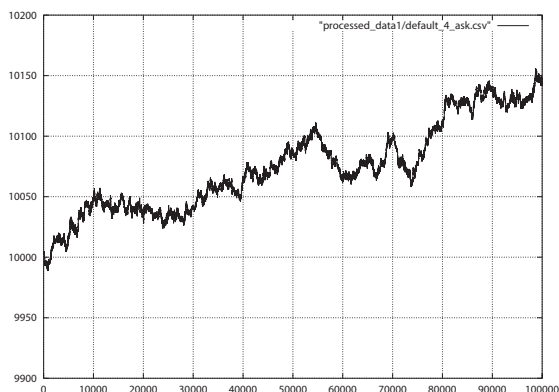


Figure 4: Transaction of market price, where it shows rising exchange rate pattern.



Figure 5: Transaction of market price, where it shows falling down exchange rate pattern.

Even in this very simple model, the exchange rate fluctuated intricately and is difficult to estimate. Also the phenomenon in real market, that there are less outbreak frequencies as fluctuation becomes larger was reproduced. These show that exchange rate fluctuates very intricately like a real market even in the simple model without the fundamentals.

3.2 Experiment 2: The Ratio of Trend Follower and Contrarian

3.2.1 Settings

The experimentation was given in two patterns, by changing the ratio of the Trend follower and Contrarian equals the ratio of (1) 3:2 and (2) 2:3. The Dealer’s ratio of Trend follower and Contrarian is as same as Speculator’s ratio.

3.2.2 Result of Experiment

As a result of the pattern Trend Follower:Contrarian = 3:2, shown in figure 6,

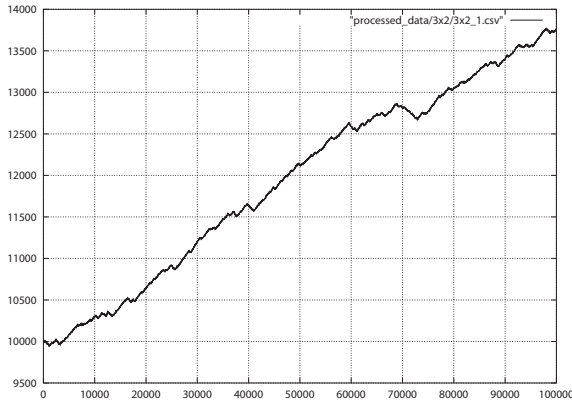


Figure 6: Transaction of market price (Trend follower : Contrarian = 3 : 2)

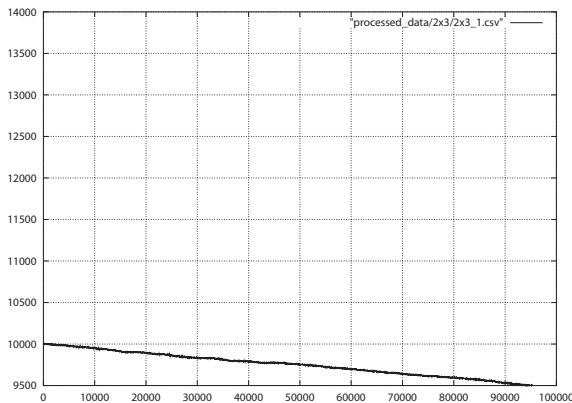


Figure 7: Transaction of market price (Trend follower : Contrarian = 2 : 3)

the rate fluctuation of becomes very big. The record of exchange rate in any random number setting had a similar result.

In the case of the pattern Trend follower: Contrarian = 2:3, shown in figure 7, the rate decreases. The record of exchange rate in any random number had a similar result.

3.2.3 Analysis

Considerable result appeared just by changing the ratio of Trend Follower and Contrarian. The rate fluctuates big when most market men is a Trend Follower. On the other hand, the rate gently fluctuates down when many Contrarians are in the market. That is to say, instead of following but by always making the order that goes against the trend, allows to the market to keeps the exchange rate stable. Data show that there are many Trend Followers in the U.S.A and exchange rate fluctuation is a bit larger.

The another interesting point is that if the ratio of Trend Follower or Contrarian increases, all re-

sult records become similar irrespective of random seed number. This is caused by the power of Trend Follower to push forward the fluctuation in one direction, or the power of Contrarian to crush the fluctuation. The result leads to our presumption that the continual change of the Trend Follower and Contrarian's ratio causes the exchange rate to be more intricate and difficult to estimate.

4 Conclusion

This research takes part in the project to research the exchange regime, and the main stress falls on Asian financial stability. Recently, introduction of Asian common currency has been becoming realistic, creating a meaning to study the characteristics of each exchange rate system.

However, further studies and experimentations are needed for higher validity and to extend other facts into this basic model. Running the simulation and analyzing the result of each parameter, such as number of dealer and the period of past exchange rate to get the trend, is important.

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