A SYSTEM DYNAMICS MODEL OF FUTURES MARKET

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ABSTRACT

Futures and options market have become increasing important in the world of finance and investments. But to many people they still are strange fields because of their nescience about the market. The purpose of this research is to use system dynamics build an interactive simulation model that will help us to understand the futures market in an easier and more intuitive way. In the model we can learn how futures works, how futures prices can be determined in a variety of different situation, and what will happen to the investors' profit under the different situations and the different policies, here we can see the notorious risk in the futures trading.

Keywords: Futures, Stock, System Dynamics, Simulation, Arbitrage, and Speculate.

INTRODUCTION

In recent years, futures and options market have become increasing important in the world of finance and investments. But to many people they still are strange fields because of their nescience about the market. Have you ever wondered whether trading in futures could make you money? Well, it can --- if you know what you are doing. But to jackaroo, futures market is not easy to understand --- maybe you will puzzle your brain to find how the futures market works from the textbooks where there are so many concepts and relations. Can we find a way to understand more efficient and intuitive?

System dynamics is considered a methodology that bridges the gap between understanding the structures and understanding the behavior. System dynamics enables most people to describe and analyze a system (here is futures market), based upon an intuitive system understanding, and more to use system dynamics promote our intuitive system understanding.

The purpose of my research is to use system dynamics build an interactive simulation model that will help us to understand the futures market in an easier and more intuitive way. In my model we will learn how futures works, how futures prices can be determined in a variety of different situation, and what will happen to the investors' profit under the different situations and the different policies, here we can see the notorious risk in the futures trading.

WHY IS SYSTEM DYNAMICS APPLICABLE

The use of system dynamics modeling that has become increasingly popular in recent years is *interactive simulation gaming*. It is a good way to understand the real system more efficiently and low-cost. Futures trading is complex and high-risk, it is almost impossible for a new hand to realize and understand futures only through the textbook – people need more practices and get the common sense in the real trading. But because of its notorious risk, to get the experience on the futures trading is quite costly. So here we can use system dynamics build a model to simulate the mechanics and internal structure of futures market. Then we can understand with the model in a more easy way.

Further more, the problems that one address from the perspective of system dynamics has at least two features in common. First, they are dynamic: they involve quantities that change over time. Our intention is to use system dynamics to promote mathematical understanding. The second feature of problems to which the system dynamics perspective applies involves the notion of feedback.

The futures market is a dynamics system from the perspective of system dynamics. In the futures market, every second, the futures price is changing, the money flows from one account to another, someone gain and someone lose, the amount of buy or sell orders increases and decrease, the information is always updating… Everything is changing so far over time.

There are many factors that interact and affect each other, the relations among the causes and results are quite complex. When we want to determine the futures price in terms of the spot prices and other observable variables, we can find some closed sequence of causes and effects. For example, as the delivery month approaches, futures price raises will cause the gap between the spot price and futures price increase. The larger the gap is, the more aggressive the sell behavior will be. In the futures market, the increase of the sell orders will lead to the futures price drop.

In short, we can implement system dynamics method to analyze the futures market and through building an interactive simulation model to help us understand the futures market more efficiently and intuitively.

SIMULATION MODEL

Determination of Futures Prices

In the futures market there are three main factors, which will affect the futures prices: Arbitrage Factor, Speculate Factor, and Effect Due to the Gap Between Spot Price and Futures Price.

Arbitrage Factor

Arbitrage Factor

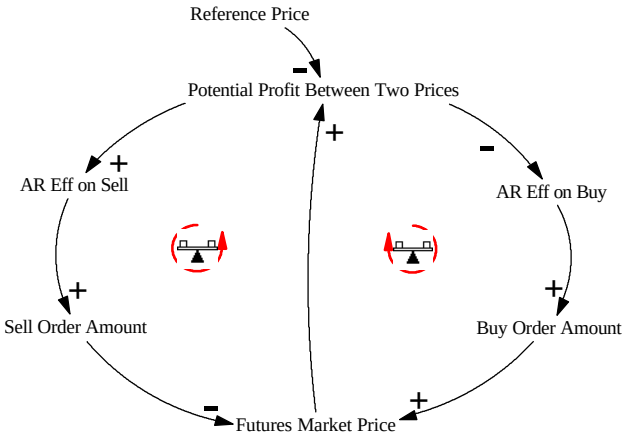

Figure 1 Arbitrage Factor CLD

Arbitrageurs are a very important group of participants in futures market. Arbitrage involves locking in a riskless profit by simultaneously entering into transaction in two or more markets. In the model, we will show how arbitrage is sometimes possible when the futures price of an asset gets out of line with its cash price (Figure 1). When the futures market price rises (drops), the gap between the futures price and the reference price (i.e. no-arbitrage-opportunity price) will be large. The larger the gap is, the more opportunities (i.e. the potential profit) the arbitrageurs will find. The generous profit will drive the arbitrageurs to sell (buy) the contracts, i.e. go short (long), in the futures market and buy (sell) the commodity in the spot market, then the arbitrageurs lock the riskless profit between two markets. But too many sell (buy) orders go into the futures market will cause the supply more (less) than the demand, the futures price drops (rises). There are two symmetrical negative feedback loops, which will force the futures price is almost equal to the reference price. So the arbitrage factor can be regarded as the 'Good' element in the futures market.

The Speculate Factor

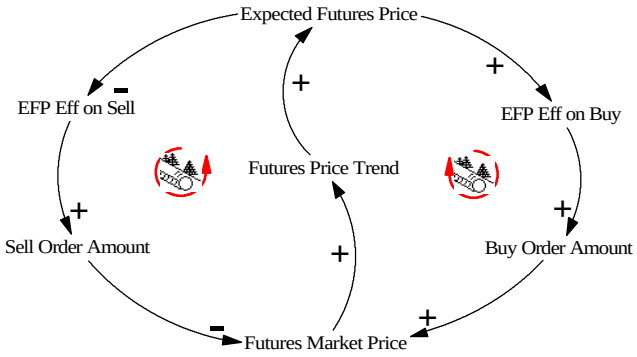

Figure 2 Speculate Factor CLD

Whereas hedgers want to avoid an exposure to adverse movements in the price of an asset, speculators wish to take a position in the market. Either they are betting that the price will go up or they are betting that it will go down. So they would like to take the risk in order to make the profit. Later we can see the speculators will make the futures market price unstable. When the futures price begins to rise, the speculator will think the trend of futures price will increase, so he will expect that tomorrow or later price will rise. So he will buy the contracts in the futures market and wait the price rise to get the profit. When the price begins to drop, the speculator will think the trend will decrease, and expects that the price will drop later, so he will sell the contracts and wait the price drop to get profit. There are two symmetrical positive feedback loops, when the futures price has a change, the speculate factor will escalate the price change and make the price unstable.

Effect Due to the Gap Between Spot Price and Futures Price

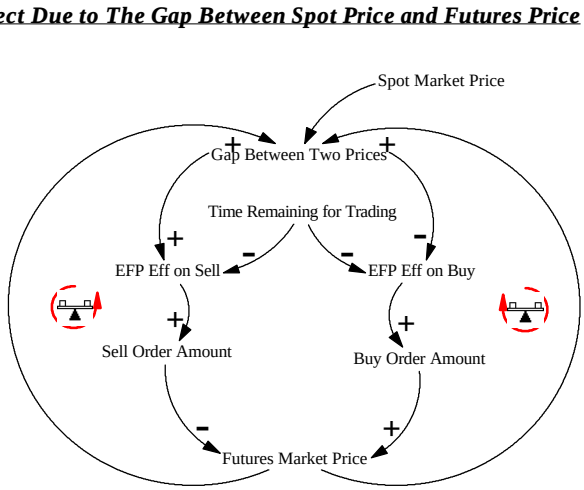

Figure 3 Effect Due to the Gap Between Spot and Futures Price CLD

Contracts that remain at the time trading ends must be honored through delivery. If the deliverable supply of a commodity is greater than the amount totaled up in all the open contracts, then prices tend to drop because supply exceeds demand. (Figure 3) The surplus of a commodity brings the buyers of contracts (the longs) under pressure to sell off (to liquidate) as many and as fast as possible. Needless to say, the selling behavior of the speculative longs becomes increasingly aggressive as the delivery month approaches because they have to liquidate (offset) or risk taking a delivery; vice versa. If the futures market price is higher than the spot market price, as the delivery time approaches, the longs, which will buy the assets in the future, will become increasingly aggressive to close out their position through selling. So the sell orders will increase, which causes the futures price drops. On the contrast, if the futures market price is lower than the spot market price, as the delivery time approaches, the shorts, which will sell the assets in the future, will become increasingly aggressive to close out their position through buying. So the buy orders will increase, which causes the futures price rises. There are two symmetrical negative feedback loops, which will force the futures price close to the spot as the delivery month approaches, known as the convergence of futures price to spot price.

Mechanics of Futures Trading

Mechanics of Net Margin

Net Margin is the margin value, which the investor is really required to keep in the margin account. The value is between the initial margin and maintenance margin. There are two factors that affect the net margin. One is the change of futures price: when the price rises, the balance in long account will increase and those in short account will decrease; vice versa. The other is the change of position: initial margin is required when a

futures position (long or short) is initiated, on the contrast when the positions offset, some money will be free.

Mechanics of Margin Account

The difference between two variables (Margin Account Balance and Net Margin) is the former is the total amount the investor owns including the margin (i.e. Net Margin) and the superabundance. Margin Account Balance is the amount of money that the investor has invested in the futures market. The futures price, the only factor, will affect its input and output. When the price rises, the balance in the long account will increase, and those in the short account will decrease; vice versa. In the model the initial value is the money the investor owns on his margin account at the beginning. (The amount of total money in the model the investor has.) We use this variable to calculate the investor's gain (or loss).

Mechanics of Long and Short Position

Long Position and Short Position are the two variables that are used to calculate the total number of long (or short) positions (the number of buy or sell orders) before cleared each day. In the model the purpose to settle these two variables is to calculate the Net Position each day. Their inputs are buying or selling orders per day, and their outputs are the contracts closed out.

SIMULATION RESULTS

In the futures market there are various kinds of investors. To the change in the futures market they have different reactions (i.e. behaviors). How to compare their behaviors? How to measure which one is more profitable. In the model I divide the total investors into two kinds: the risk-taking and the risk-averse. The risk-taking is the one who would like to undertake more risk in order to make more profits. In the futures market their typical behavior is to be very confident of their judgment on the changes of the futures price and their reactions are very drastic. And the risk-averse is on the contrast. They also want to seek profits in the futures market. But their behaviors are sensitive. When the futures price rises or drops and beyond their expected limits, they normally would like to reaction immediately and liquidate to close out their position. Here we will analyze two different kinds of investors under the different price conditions.

Futures Price Rises Overall

Two different kinds of investors' profit level were observed when the futures price rises overall. In the model we change the spot price to influence the futures price and get the expected price trend. Although the price has many oscillations during the trading time, overall the price is rising.

Based upon the model, we can get the results about the different profits two kinds of investors earn. The risk-taking will get much more profits than the risk-averse. We can say because the risk-taking would like to undertake more risk – as they consider the

price will rise, they will insist their idea. When the price has an oscillation which makes the price go to the opposite direction, not as they expected, they will still wait because they believe the price will be back and go their expected way. So as the price rises overall, which is same as their judgment, they luckily earn the much more money. Here we also can see the attractive high profit.

On the contrast the risk-averse would be more care about the price change. When the futures price rises or drops and beyond their expected limits, they normally would like to reaction immediately and liquidate to close out their position. Because they want to avoid the risk, they more concern about the price change (oscillation), and then they frequently change their positions. Of course as we see, their profit is much lower than the risk-taking.

Futures Price Drops Overall

Here we will observe the two different kinds of investors' profit level when the futures price drops overall. In the model we change the spot price to influence the futures price and get the expected price trend. Although the price has many oscillations during the trading time, overall the price is decreasing.

Based upon the model, we can get the results about the different profits two kinds of investors earn. The results are very similar as the futures price drops overall, which the risk-taking will get much more profits than the risk-averse. The reason is same.

Futures Price Changes With High Frequency and No Obvious Trend

Now we will observe the two different kinds of investors' profit level when the futures price oscillates more drastically and there is almost no trend (increase or decrease). In the model we again change the spot price to influence the futures price and get the expected price change. The price has many oscillations during the trading time, but there is no obvious trend. Based upon the model, we can get the results about the different profits two kinds of investors earn. The risk-taking lose much more money and they almost bankrupt. But the risk-averse don't lose the money; on the contrast they can earn a little money. Why?

We can say because the risk-taking would like to undertake more risk – as they consider the price will rise, they are confident and insist their idea. When the price has an oscillation which makes the price go to the opposite direction, not as they expected, they will still wait because they believe the price will be back and go their expected way. But this time they are not so lucky, the price continues to drop. When they want to change the idea, unfortunately the price begins to rise. So this time he lost a big amount of money.

On the contrast the risk-averse would be more care about the price change. When the futures price rises or drops and beyond their expected limits, they normally would like to reaction immediately and liquidate to close out their position. Because they want to avoid the risk, they more concern about the price change (oscillation), then they

frequently change their positions. So as we see the risk-averse don't lose the money, on the contrast they can earn a little money.

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