ONTOLOGIES FOR TRANSMISSION MECHANISM FROM INTEREST RATE TO EQUITY PRICE

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Abstract—After the credit crisis, nearly all the central banks have cut interest rates to stimulate economies, in recent months, we have seen central banks in many countries pursuing a strategy of raising interest rates in order to prevent an increase in inflation arising. Usually, these monetary polices will cause a drastic fluctuation in stock market, since the stock market is an important channel from monetary policy to real economy, interest rate is a universal monetary tool and is regarded as a monetary policy indicator.

It is crucial to understand how interest rate affects equity price both for central bank and investors in stock market. Adjustment of interest rate can change money supply immediately to affect equity market in short term and effect real economy which feedback to equity market in long term, so central banks need a model to simulate monetary policy transmission, by the analog central banks can assessment the effects of interest rate adjustment and carry out appropriate adjustment. Investors need a system which can calculate how the interest rate adjustment affects equities in market and give market operations promptly.

The transmission mechanism from interest rate adjustment to equity price fluctuation is complicated, it may transform from foreign exchange market, bond market, durable goods consumption market, fixed assets investment and others. In order to implement functions above, by reducing human information processing limitations and cognitive biases, an ontology based framework, for investigating the transmission mechanism from interest rate to equity market is proposed.

But these classical theories are incomplete in several important ways. Ben S. Bernanke put forward credit channel in 1995, he described two possible linkage, balance sheet channel and bank lending channel, so in this paper these linkage is analyzed by three ontologies, static ontology, dynamic ontology, and social ontology.

Static ontology describes the subjects and their attributes in the transmission mechanism, Dynamic ontology represents the dynamic aspect of how adjustment interest rates transmit to equity price step by step. The social ontology represents the knowledge about the social structure of subjects in the transmission process. The ontologies are united in the Ontology Web Language framework which is machine readable.

After the establish of ontologies, a case the adjustment of interest rate by People’s Bank of China in 2004 is offered to demonstrate the transduction mechanism proposed.

Contrasted with this case, the adjustment implemented by Federal Reserve Board in the same period is analyzed. The comparison shows how interest rate adjustment transforms in different economy systems.

The major contributions of this research is that the ontology helps understand the knowledge about interest rate adjustment transmission to equity market, helps to build models to predict equity fluctuate against monetary policy.

Keywords: interest rate; stock market; ontology; transmission mechanism

I. INTRODUCTION

Monetary policy is now at centre stage in discussions about how to promote sustainable growth and low inflation in the economy. Fiscal policy has lost its luster as a tool to stabilize the aggregate economy because of doubts about the ability to time fiscal policy actions to obtain desirable stabilization outcomes, as well as concerns about budget deficits. The result is that both economists and politicians in recent years advocate that the stabilization of output and inflation be left to monetary policy.

After the credit crisis, most central banks in the world reduced interest rate to stimulate economy, and the people's bank of China announced to keep moderately relaxed monetary policy, then the some economists believe high inflation will sweep across the world, these polices impact stock market by different way. So it’s crucial to understand how interest rate affects equity price for central bank and government, they need a model to simulate how the new interest rate police change economy. The investors need a model to help them formulate a appropriate investment strategy immediately.

In this paper, I provide an overview of the transmission mechanisms of monetary policy, then analysis the weakness of this traditional theory. Then the credit channel advanced by Bernanke is introduced.

After that I use ontologies to explain the credit channel of monetary policy transformation the ontologies can be used to build a prediction system. Static ontology, dynamic ontology and social ontology is used in this paper to
establish the model. Static ontology is used to represent the static aspect of the financial market, the social ontology shows social structures, include the relationship between firms and investors and the relationship between firms and commercial banks, dynamic ontology represent how information of adjustment interest rate transmits to stock market to effect the equity price.

At last, I choose the interest rate adjustment by People's Bank of China in March 2002 to evaluate the model.

II. RELATIVE WORK

A. Monetary Transmission Mechanisms

DDM (dividend discount model) shows that in medium and long term, the equity price is decided by real economy, if the firm is expected to earn a lot of money, the equity price of this firm will raise. (Richard O.Michaud and Paul L.Davis, 1981).

\[ EP = \sum_{i=0}^{N} \frac{D_i}{(1 + r)^i} \]

EP is the equity price, Di is the dividend in n year, r is the discount rate, and it means the price of equity equals the discounted cash flow from this stock.

B. Credit Channels

These traditional theories are readily available, central bank use their leverage over short term interest rates to influence the cost of capital and durable goods, thus change the aggregate demand affect the production. But there are several weaknesses in these theories.

One is that, in general, empirical studies interest rate sensitive components of aggregate spending have in fact had great difficulty in identifying a quantitatively important effect of the neoclassical variables; the variables usually have lag effect, so it is difficult to separate the effect of them. Thus Tobin's q formulation has generally no longer successful.

The other is that how should short term interest rate effect on long term assets in financial market. For example the federal funds rate is an overnight rate, but monetary policy should have a weak impact on long term rates.

To solve these problems, Bernanke put forward credit channel of monetary transmission. The credit channel includes two basic channels: the bank lending channel and the balance-sheet channel.

III. ONTOLOGY

Ontology is a branch of philosophy concerned with the study of what exists. In artificial intelligence, ontologies can be used to encourage standardization of the terms for representing knowledge about a domain [1]. They provide some structure for development of knowledge bases as well as a foundation for generating views of knowledge bases [2]. It is widely accepted that ontologies provide a useful means to facilitate (human or machine) access to, and reuse of knowledge in, the organization and have huge potential to improve information organization, management, and understanding [3, 4]. In addition, when ontologies are formalized in first-order logic or a subset thereof, they can support inference mechanisms [5, 6].

Noy and McGuinness (2001) describe an ontology as a formal explicit description of concepts in a domain of discourse, i.e. classes (sometimes called concepts); properties of each concept describing various features and attributes of the concept, i.e. properties; and restrictions on slots, i.e. restrictions. An ontology combined together with a set of individual instances of classes constitutes a knowledge base. In ontology, classes are the focus of most ontologies, as they describe concepts in the domain. For example, a class of security represents all securities. Stocks are instances of this class. A class can have sub-classes representing concepts that are more specific than the super-class. Properties describe features of classes and instances. All instances of a class inherit the properties of their class. In practice, developing ontologies includes defining classes in the ontology, arranging the classes in a taxonomic hierarchy, defining properties, and describing allowed values for these properties, and filling in the values for properties, for instance.

IV. ONTOLOGIES FOR CREDIT CHANNEL

A. Static ontology

Figure 1. static ontology for transmission mechanism

B. Social ontology

First, UML-RT uses UML as an architectural modelling language, which is tuned for real-time software systems and is being used for modeling software architectures [7]. It can represent the organizational architectural styles based on the
Tropos project [8, 9, and 10]. In our study, all the financial entities are looked as one multi-agent system, and then each entity is one agent. So the relationships among entities can be shown in the system architecture.

There are four principal constructs that are used for modeling structure in UML-RT: capsules, ports, protocols, and connectors [11]. Capsules are complex physical, possibly distributed architectural objects that interact with their surroundings through one or more signal-based boundary objects called ports. A port represents an interaction point between a capsule and its environment. They convey signals between the environment and the capsule. So in this research, a port specifies a distinct interaction point between the agent (one financial entity) and its environment (other financial entity). Each port of a capsule plays a particular role in a collaboration that the capsule has with other objects. To capture the complex semantics of these interactions, ports are associated with a protocol that defines the valid flow of information (signals) between connected ports of capsules. In a sense, a protocol captures the contractual obligations that exist between capsules. Connectors are abstract views of signal-based communication channels that interconnect two or more ports. The ports bound by a connection must play mutually complementary and compatible roles in a protocol.

Secondly, Relationship between institutions.

There are two important relationship introduced. One is loan relation between commercial bank and firm, this effect the production and profit of the firm. The other is the equity purchase relation between investors and firm, it forms the equity price by the trading between investors based on information afforded by firms and bond market.

C. Dynamic ontology

It mainly shows how interest rate increase money supply, then the firm can get more loans, then the firm gets a beautiful balance sheet, finally the investors will purchase equity issued by the firm, this action arise the stock price.
March 2002, People's Bank of China announced lowering prime interest rate from 3.78 to 3.24 to stimulate economy. Based on the macroeconomic date observed from National Bureau of Statistics, we can see how monetary policy affects equity price.

I choose this adjustment because there is no interest rate change since 1999, these dates can verify my model with little disturb from before interest rate adjustments.

VI. CONCLUSION

It is crucial to understand how interest rate affects equity price both for central bank and investors in stock market. The transmission mechanism from interest rate adjustment to equity price fluctuation is complicated, it may transform from foreign exchange market, bond market, durable goods consumption market, fixed assets investment and others. In order to implement functions above, by reducing human information processing limitations and cognitive biases, an ontology based framework, for investigating the transformation mechanism from interest rate to equity market is proposed.

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