SiSMar: Social Multi-agent Based Simulation of Stock Market

(Extended Abstract)

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ABSTRACT

In this paper, we introduce a new model of the stock market. This model describes the behavioral and cognitive attitudes of the investor at the micro level and explains their effects on his decision making. A multi-agent based simulation is used to validate our model and to study the emergence of certain stock market phenomena at the macro level. The modelling and implementation details of our simulator will appear in the full version of the paper.

Categories and Subject Descriptors

J.4 [**Computer Applications**]: Social and Behavioral Sciences—*Economics, Psychology, Sociology*; I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Intelligent agents, Multiagent systems*

General Terms

Economics, Experimentation, Human Factors

Keywords

Multi-agent based simulation, Cognitive and behavioral modeling, Stock market, Volatility.

1. INTRODUCTION

The complexity of the financial rules governing the stock market and their confrontation with investors' activities make the interpretation and the explication of observed global behavior very difficult to understand.

Previous researches, such as in [3], used numerical approach. However, recently, emerged evidences show that stock markets could not be only studied with a rational paradigm such as in [4]. In the last decade, we use the behavioral multi-agent based simulation in order to complete the description of theoretical phenomena by many aspects based on the individual's behavior and their interactions [2]. This evolution shows that the multi-agent based simulation is a promising approach to study the stock market dynamics.

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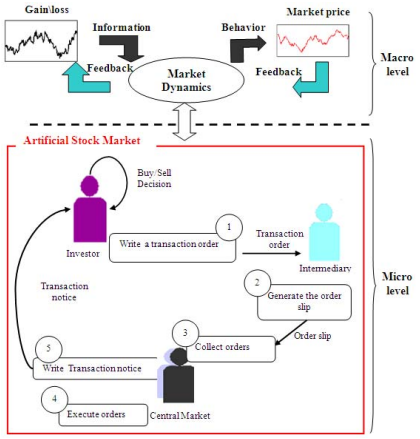

Figure 1: Stock Market dynamics.

We introduce in this paper a new conceptual model representing the stock market. This model, which is essentially based on cognitive behavior of the investors, is used for the construction of a multi-agent based simulation: SiSMar (**Si**mulation **S**tock **Mar**ket).

2. STOCK MARKET MODEL

We consider the stock market as an institution where we introduce a set of social relations that link the actors and a number of rules that govern the whole system. In this paper, we identify mainly three kinds of actors: novice investors, expert investors and market intermediary.

Our model includes two granularity levels: the micro and the macro level. At the micro level, it describes the cognitive behavior of investors. In addition, it represents actors' interactions. These interactions participate in the emergence of socio-economic phenomena observed at the macro level which influence reciprocally behavior and individual interactions. Figure 1 shows the global stock market dynamics integrating micro and macro levels. It specifies at the micro level the five sequential steps for the transaction realization.

2.1 Hypothesis

We introduce mainly two hypothesis for the constructing of our model. First, we assume that the stock market

is represented by a social network where information circulates randomly among heterogenous set of investors. This information concerning stocks and indexes is available permanently for all investors. Their interactions described in figure 1 form the stock price. Second, we admit that the buying and selling are accomplished immediately and closed out the same day.

2.2 Model description

Our artificial stock market is composed of : (1) a set of agents corresponding to the considered three types of actors: ExpertInvestor agents, NoviceInvestor agents and Intermediary agent, (2) a CentralMarket agent responsible of conducting transactions and controlling the stock market dynamics. The cognitive behavior model of the investor describes his perceptual, informational and decisional processes. It includes the behavioral attitudes and the social profile which influence these processes.

2.2.1 Rational analysis

For our modelling, we adapt two complementary approaches necessary to accomplish the rational analysis: (1) fundamental analysis and (2) chart analysis. The first approach is based on the analysis of the past and the present, exploring the companies' accounts in order to foresee the future. The second approach is based on the hypothesis that the past development of a financial asset provides better information about its own future. The trend of our artificial stock market is determined by the CentralMarket agent from trends calculated by all expert investors.

2.2.2 Irrational analysis

- *Behavioral attitudes*

  We introduce in our model three pairs of behavioral attitudes: *optimism/pessimism*, *speculation/caution* and *imitation/leadership*. These attitudes play the role of reactive modulators that filter and weight the effect of external stimuli. For their representation, we adopt the generic approach introduced in [1]. This approach is based on the specification of a set of inhibitor and triggering thresholds.

- *Socio-demographic profile*

  We define the components of socio-demographic profile (or social profile) of an investor which adjust its rational analysis. These components influence his behavior and represent a moderator of the decision-making process. Moreover, our model takes into account two socio-demographic characteristics: age and wealth. Each of these components has implications on opinions and advices diffuse.

2.2.3 Investor objective

We assume that the investor targets a single goal during a trading day. The objectives taken into account by our model are the security of the capital, profitability and speculating and finally liquidity and availability. The objective influences all processes of the model and determines the schedule for the investor, like the period during which it remains inactive on our artificial stock market.

3. SISMAR: THE ARTIFICIAL STOCK MARKET

SiSMar (**Si**mulation **S**tock **Mar**ket) generates randomly a population of investor agents. In order to observe the behavior and decisions during the simulation steps, we assume that our agents exchange many stocks with different characteristics. At each simulation step, every investor agent may behave in several ways, depending on his state. He may be inactive if the number of simulation steps is not a multiple of its periodicity, however, he remains to listen to his environment by recording all messages received. Once active, investor agents interact on the market.

Our two types of investors have several features in common, we propose a generalization: the Investor agent. Each agent A_i is characterized by his social profile (age_i and $wealth_i$), his objective ($objective_i$), his behavioral attitudes ($pessimism_i$, $optimism_i$, $speculation_i$, $caution_i$, $imitation_i$ and $leadership_i$), his state ($portfolio_i$, $periodicity_i$), his cognitive threshold ($T_{iAcceptance}$ and $T_{iTransaction}$) and finally the network of his trusted neighbors ($trustNet_i$). In our simulation, the neighborhood is not physical but it is a neighborly relationship (trust, privacy, etc.). An investor can receive advice or opinion from his neighbors. However, the agent takes into account the message received if it is filtered through the filter of privacy and the filter of confidence.

Through SiSMar, we observe the magnitude of changes in stock prices. In a bull market, we notice that the upward movements are longer than those of downward. This reflects a resistance to downtrend pressure on the bull market. In addition, changes in the prices of the studied stocks is very considerable which shows that a large number of transactions were executed. Contrarily, we observe some positive stock price fluctuations however dominated by a global downtrend when SiSMar announces a bear market. We can conclude from these two observations that there is resistance to the increase in the bear market. These two results are in line with what happens in reality on a stock market and coincide with the principles of Dow Theory.

4. CONCLUSION

In this paper, we proposed a new model of stock market dynamics. This model enabled us to develop an artificial stock market. Our research focuses on the modeling and the simulation of the stock market and particularly the investor behavior and his decision making.

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