Cloud-Computing Based Mobile Algorithmic Trading Services

Junwei Ma
Southwestern University of Finance and Economics
heilongshen@163.com

Chaoran Zhou
Southwestern University of Finance and Economics
287448195@qq.com

Zhangxi Lin
Texas Tech University
zhangxi.lin@ttu.edu

Abstract

Average investors tend to make poor invest decisions because of their bounded rationality and limited access to market information while information overload is getting worse in these years because of the advancement of information technology. To help investors analyze massive market data and implement optimization trading strategies timely, we propose a trading support scheme namely Mobile Algorithmic Trading Services (MATS) which incorporates real time data collection, analytics and automated trading modules based on algorithmic trading, cloud computing technologies and mobile security trading. Now we have a conceptual design for MATS and identified the theoretical research problems in implementing a feasible system. A prototype MATS is being developed for conducting experiments to study the research problems.

Keywords: Algorithmic Trading, Mobile Financial Services, Cloud Computing，Rationality, Information Overload.

1. Introduction

The rapid advancement of mobile computing technologies and the fast growing number of mobile computing users have reinforced the era of mobile commerce (m-commerce), defined as “e-commerce for users on the move” (Kalakota and Robinson 2001). The significant value of mobile computing is rooted in the convenience of the ubiquity of communications, variously selectable applications, and increasing computing capability. One of the most important applications in m-commerce is mobile stock trading services (MSTS), facilitating stock trading with various utilities, such as stock search, market analysis, order submission, and portfolio management. So far, there has been many popular MSTS applications, such as Yahoo Stock APP, ScotTrade Mobile, CNBC Real-Time, mobile E*Trade, Interactive Brokers, etc. MSTS allow users to access real-time security product information almost ubiquitously, submit trading orders to order management system instantly, and receive the trading results conveniently. Therefore, it has been widely accepted by investors.

However, there are three major weaknesses in existing MSTS. First, the convenience of MSTS tends to promote frequent impulsive trading. Evidences from the option market suggest that unsophisticated option market investors tend to overreact to obsolete news on underlying stocks, and be misled by impending scheduled news releases regarding actually mispriced stocks (Mahani and Poteshman 2007). How to overcome inconsistent trading strategies has long been a critical issue for the profitability of MSTS. Secondly, *information overload* may significantly deteriorate stock investors' irrational decisions (Blair 2011). The Internet makes it easy to access security market information but also responsible to the information explosion. Rich information, owing to the constantly innovated information technology, may lead to high information overload, resulting in worse subject state of consumers towards decisions (Chen et al 2008). Particularly, since security markets respond promptly to new information and excess returns decrease over a short period of time, investors may miss important trading opportunities or take a wrong movement due to their misuse or misprocessing of the massive information (Muntermann 2009). Thirdly, as *algorithmic trading* (AT), also called *automated trading*, has been widely adopted by the commercial financial institutions (Coggins et al 2006), which applies computer algorithms to optimize security trading operations in real-time, it is hard for individual investors to compete these computers with MSTS in speed and accuracy. It is estimated that in 2009 AT is responsible for 73% of trading volume in the equity market in the U.S. (Hendershott et al 2011). Therefore, the AT-enabled security market has become much more volatile and riskier to many investors. For example, the 2010 Flash Crash, which happened on May 6, 2010 at 2:45p, was a United States stock market crash in which the Dow Jones Industrial Average plunged about 900 points in a short moment (Lauricella 2010). Obviously, to cope with the impact of the AT on the market is beyond the capability of manual operations of mobile trading.

To resolve the above problems, we are proposing a scheme, namely Mobile Algorithmic Trading Services (MATS), by incorporating algorithmic trading and cloud computing technologies into mobile security trading. We claim that MATS can effectively overcome the abovementioned three weaknesses of MSTS, by means of the back-end AT systems in conjunction with cloud computing. The major difference between AT and traditional individual order-based trading is that AT works at the level of trading strategies, including: trend following, pair trading, delta neutral strategies, arbitrage, mean reversion and scalping, etc. Guided by a carefully configured strategy, the back-end AT system can help the investor to sell or purchase securities or stocks systematically in multiple markets, and handle emerging market risks timely in accordance with dynamics of security markets (Giddings 2008). This is because that AT allows investors to work at the strategic level of decision making to avoid irrational behaviors at the more detailed technical level. Meanwhile, cloud computing reinforces the power of AT, by enabling investors to access and digest massive information better in a timely manner. As Agopyan et al (2010) indicate, well developed cloud computing application utilities for AT can provide versatile information services in data collection, analytics, trading, and risk management, particularly in a high frequency trading platform.

There are several viable research problems in implementing MATS. How could MATS overcome the weaknesses of MSTS and provide less risky yet profitable mobile investment services? What are the most wanted mobile algorithmic trading features for MATS? How could cloud computing underpin investors' mobile decision making with MATS? At this primitive stage, we are to discuss the principles of MATS, present a design of MATS, and conceive the scheme how to implement a prototype MATS and conduct experiments for further theoretical research.

2. The Fundamentals of Mobile Algorithmic Trading Services (MATS)

2.1 Bounded Rationality and Stock Investment Profitability

The ideal of MATS is mainly motivated by the theory of bounded rationality. Initially proposed by Herbert A. Simon (1991) in 1950s, bounded rationality is referred to as the situation in which rationality of decision makers is limited by the available information, their capability of handling the information, and the available time for they to make a decision. Financial decisions and investor behaviors in the financial market are affected by a variety of factors: physiological endogenous steroids (Coates and Herbert 2008), emotional responses and feelings (Lo and Repin 2001; Shu 2010). Kamstra et al (2003) find that changes in mood drive changes in investor risk aversion and cause seasonal patterns in aggregate stock returns around the world. Wu et al (2012) report the similar results that the subjects tended to sell high-priced stocks in short periods with a holding day because of its great price fluctuation even if its price was rising during the study period. Changes in mood resulting from seasonal affective disorder drive changes in investor risk aversion and cause seasonal patterns in aggregate stock returns (Kamstra et al 2003). Even though some experienced investors are able to make much better decisions, they may miss significant trading opportunities due to their biased strategies in information research (Muntermann 2009). These studies indicate that it is difficult for investors to make profits and even lose money in the financial market, because of their inconsistent decisions and behaviors, as a result of their bounded rationality. Therefore, MATS must be able to facilitate investors in rational strategy decision making and consistent trading operation (Giddings 2008). In this way, the AT strategy services by MATS could be a versatile resolution to these problems.

2.2 Principles of MATS implementation

There are several principles available to MATS implementation, but the following should be the most important ones distinguishable from those used by MSTS.

1) <u>AT strategy selection and configuration.</u> Decision making at the strategic level to avoid emotional actions at the individual order level is critically important to maintain the consistency of trading strategy.

2) <u>Risk and return estimate, real-time risk warning, and timely decision-making support.</u> Unexpected market volatilities may put a series of orders based on a seemingly robust AT strategy into risk. In this way, investors' instantaneous responses to AT system's alerts are critical to reduce upcoming possible losses. This makes mobility and ubiquity of MATS valuable, and so as to the just-in-time information services by cloud computing.

3) <u>Post-trading strategy effectiveness auditing.</u> Evaluating the performance of a customized strategy will help investors refine their parameters configured for the strategy.

3. Design of MATS

Figure 1 shows a basic structure of MATS, consisting of two parts: (1) *Mobile Client System* (MCS) facilitating trading strategy decision making, (2) *Back-End AT Cloud* (BEAC), composed of three subsystems: *Automatic Trading Decision Subsystem* automatically makes decisions and generates instructions; *Algorithmic Trading Subsystem* executes orders according to the customized strategies by investors; *Portfolio Recommender Subsystem* processes massive information to provide real-time trading decision support.

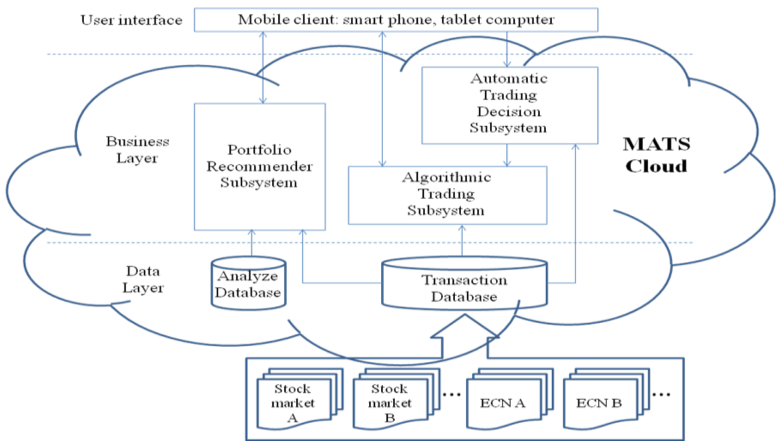

Figure 1. The Structure of MATS

Investors can access the back-end of MATS by mobile devices and make use of the utilities provided by BEAC. When receiving a consultation instruction, Portfolio Recommender Subsystem will extract relevant information from two databases, Analyze Database and Transaction Database. Analyze Database contains recent macroeconomic data, industry analysis, and the financial data of list companies created by analysts. The consultation instruments may include investment preferences, such as the expected duration of this investment, risk tolerance degree, targeted market, and so on. Then the Portfolio Recommender Subsystem will match these requirements with the investor's trading records and the required analysis data. Finally, an optimized investment recommendation, including the composition of investment portfolios, holding interval, expected return, and volatility, is feedback to the mobile device. Algorithmic Trading Subsystem plays a central role in MATS, all trading instructions, from either Automatic Trading Decision Subsystem or the investor, are executed by this subsystem. Since security trading is sensitive to time delay, the primary improvement of MATS is fast transaction of orders, compared to the ordinary MSTS. Algorithmic trading subsystem can connect the quotation system of the security market or the Electronic Communications Network by the Direct Market Access technology to access liquidity pools, and deliver and execute orders instantly.

To facilitate rapid and massive data storage, computation and transaction, a computer cloud will be employed by MATS to perform major computational tasks in a concurrent manner. With SaaS (software as a service) model, MATS is provided to MATS users as a collection of cloud services. Although major time-critical features of MATS must be performed in the servers co-located at security market sites to minimize the latency, some functions of Portfolio Recommender Subsystem, Automatic Trading Decision Subsystem, Algorithmic Trading Subsystem, and databases of MATS could be running on the cloud servers. These servers access the data sources in different security markets via the Internet, process macro-orders, and monitor news about the markets on the Internet. These servers receive instructions from the mobile client users and send operation results back to users via mobile communication networks anytime and anywhere.

4. Further Research Plan

Based on current primitive research work, there are two follow-up projects to be accomplished: A prototype MATS, and the experiments based on the prototype for investigating the research problems defined in Section 1.

4.1 Prototyping MATS for Experimentation

This version of MATS prototype is for experiment purpose only, but all its features and utilities must match the needs of a real system. To facilitate the experiment for the comparison between MATS and MSTS, this prototype must be able to provide the basic functions of MSTS. Following the structure of the MATS system in Figure 1, the major tasks in the prototype MATS system are described as follows:

1) MATS back-end algorithmic trading system is implemented as a simulation system. There are several tasks

    - Implement main functional modules of the system in Figure 1. Specifically, we only need to implement those features needed for the experiment, such as security price quoting, transaction log, performance analysis, strategy interpreting and implementation, and so on. In addition, some functions of MSTS will be included.

    - Conceive a security market simulation system for reproducing a specific portion of security market from either historical trading time series or the time series generated by the Monte Carlo method. Proper data interface will be designed to accept different types of time series. These series must come with other relevant information, such as news releases, market indexes, posting of popular BBS, etc. The structure of the information will be carefully designed to meet the needs of experiment.

2) MATS Cloud services will be implemented in the Linux-based cloud computing testbed in Southwestern University of Finance and Economics. The main services to be available for experiment: real-time sentiment analysis, real-time market trend analysis, user customized strategy evaluation, and market risk warning

3) MATS client MCS provides three main functions: *Portfolio Management*, for configuring preferences of portfolio; *Algorithmic Trading Strategy Configuration*, where the mobile client users can configure security pricing model, trading strategy, and trading algorithm; and *Risk Warning and Control* for emergent market event processing. MCS will be implemented on iPhone in Object C programming language on the iOS platform (Figure 2).

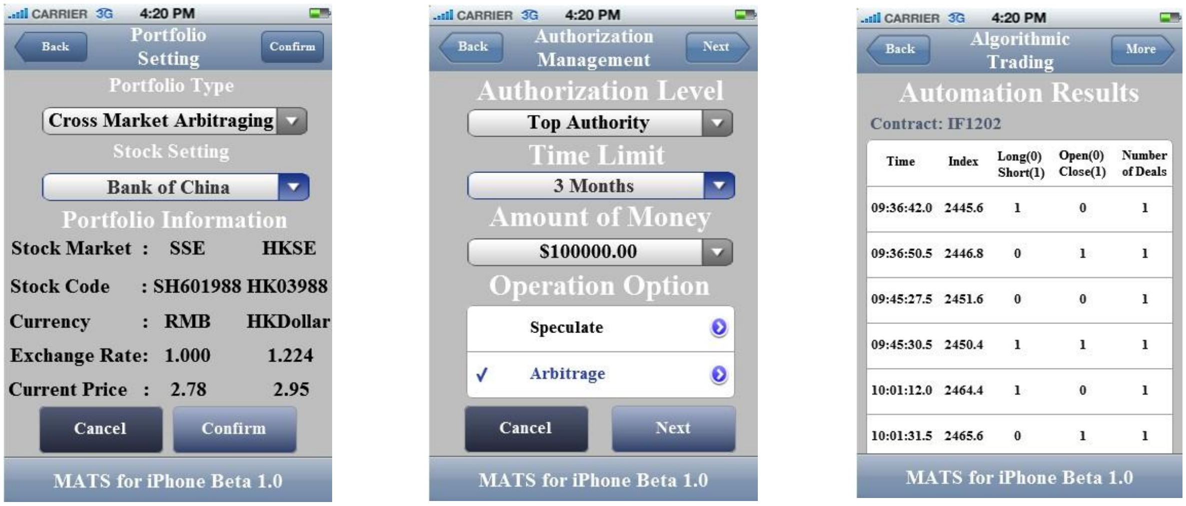

Figure 2. MATS client in development

4.2 Experiment Design (The first stage)

1) Objectives: (1) To compare the performance between MATS and MSTS investors; and (2) to study the behaviors of investors in using different mobile security trading systems.

2) Theoretical model and hypotheses: To be further developed.

3) Experiment setup: The experiment is similar to the "Turtle traders experiment". Experiment subjects will be divided into two groups with similar stock market trading experience, trade the same set of stocks, and endowed with the same amount of fund. The first group will invest with MATS and the second group will manage their stock account by MSTS. The virtual market will be configured in two aspects: (1) different patterns of market volatilities, in particular, the market extreme condition model with Levy process which indicates market sharp fluctuation; and (2) with/without some kinds of information services, such as market sentiment information.

4) Questions to be answered: (1) Could MATS better prevent investors from emotional trading? (2) How does MATS help investors monitoring market fluctuation unperturbedly and minimize irrational operations accordingly?

5) The evaluation of MATS can be measured by various indicators, such as volume-weighted average price, Sharp Ratio, and Alpha with the indexes of the whole stock market.

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References:

[1]. Agopyan, A., Sener, E., & Beklen, A. (2011). Financial Business Cloud for High-Frequency Trading A Research on Financial Trading Operations with Cloud Computing. International Journal on Advances in Intelligent Systems. 4:203-217.

[2]. Blair, A. (2011, March 14). Information overload's 2300-year-old history. Harvard Business Review. Retrieved from http://blogs.hbr.org/cs/2011/03/information_overloads_2300-yea.html

[3]. Chen, Y., Shang, R., & Kao, C. (2008). The effects of information overload on consumers' subjective state towards buying decision in the internet shopping environment. Electronic Commerce Research and Applications. 8: 48-58.

[4]. Coggins, R., Lim, M., & Lo, K. (2006). Algorithmic Trade Execution and Market Impact. IWIF 1, Melbourne Page 518-547.

[5]. Giddings, G. (2008). Humans versus computers: Differences in their ability to absorb and process information for business decision purposes – and the implications for the future. Business Information Review. 25: 32-39.

[6]. Hendershott, T., Jones, C., & Menkveld, A. (2011). Does Algorithmic Trading Improve Liquidity? The Journal of Finance. 66: 1-33.

[7]. Kalakota, R. and Robinson, M. (2001). M-Business: The Race to Mobility. McGraw-Hill, New York.

[8]. Kamstra, M., Kramer, L., & Levi, M. (2003). Winter blues: a SAD stock market cycle. The American Economic Review. 93: 324–343.

[9]. Lauricella, T. (2010). Market Plunge Baffles Wall Street -- Trading Glitch Suspected in "Mayhem" as Dow Falls Nearly 1,000, Then Bounces. The Wall Street Journal: May 7, 2010 p. 1.

[10]. Lo, A. & Repin, D. (2002). The Psychophysiology of Real-Time Financial Risk Processing. Journal of Cognitive Neuroscience. 14: 323- 339.

[11]. Coates, J. & Herbert, J. (2008). Endogenous steroids and financial risk taking on a London trading floor. Proceedings of the National Academy of Sciences. 105: 6167-6172.

[12]. Wu, H., Tseng, C., Chan, P., Huang, S., Chu, W., & Chen, Y. (2012). Evaluation of stock trading performance of students using a web-based virtual stock trading system. Computers and Mathematics with Applications. 64: 1495-1505.

[13]. Mahani, R. & Poteshman, A. (2007). Overreaction to stock market news and misevaluation of stock prices by unsophisticated investors: Evidence from the option market. Journal of Empirical Finance. 15: 635–655.

[14]. Muntermann, J (2009). Towards ubiquitous information supply for individual investors: A decision support system design. Decision Support Systems. 47: 82–92.

[15]. Shu, H. (2010). Investor mood and financial markets. Journal of Economic Behavior & Organization. 76: 267–282.

[16]. Simon, H. (1991). Bounded Rationality and Organizational Learning. Organization Science. 2: 125–134.