Article

A Mixed Approach for Determining Stock Prices

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Abstract

This paper examines the movement of stock prices. When analyzing stock price movements, both fundamental and chartist analysis need to be considered. This paper employs the bounded rational expectation model. This approach depends on behavioral financial economics. This paper shows that this bounded rational- fundamentalist-chartist mixed model can account for the movement of stock prices. Simulated stock price movements are very similar to those experienced in reality. Market participants rely on a fundamental approach when stock prices differ from the simulations; on the other hand, they use a chartist approach when the departure is small. Standard deviation of the simulated stock prices is smaller than that of exchange rates in reality.

Key words

Chartist Model, Exchange Rates, Fundamental Model, Stock Prices

Ⅰ. INTRODUCTION

The 1970s marked the development of rational expectation theory in macroeconomic theory. Numerous papers have addressed this topic. The situation has not changed in recent times. We cannot deny the fact that the theory of rational expectations has contributed to the development of economics in many fields in macro- and microeconomics as well as in finance and monetary fields and others.

However, some problems have been encountered recently with this approach. Above all, many economists feel that economic information is extremely varied and complex such that no single economic agent can fully understand it. Storing and processing information is also difficult and sometimes impossible in reality. Rational expectation theory has contributed much, especially to economic theory. However, it seems natural to think that agents form expectations using different forecasting methods and approaches. Also, the rational expectation approach does not perform well for empirical work (De Grauwe and Grimaldi, 2006). When analyzing stock prices or exchange rates, the hypothesis of perfect rational expectation is impossible and we have to look for another approach in reality. Too much dependence on the rational expectation model is dangerous and invalid.

Traditionally, stock prices have been determined by enterprise dividends, expectations, and other factors, such as firms' future prospects, which is the most important factor in determining stock prices. Macroeconomic variables are important factors in determining stock prices (Kurihara and Nezu, 2006). Most economists in academic fields rely on this approach. However, in the real world, the chartist approach seems to contribute to market forecasts. In reality, most traders sell/buy stocks, currencies, and other financial commodities based on this chartist approach. When analyzing stock prices, such aspects should not be disregarded. It is important to draw upon the findings of both methods when examining stock prices. Depending too much on one of the two approaches is dangerous.

Behavioral economics has been developing rapidly. Although this approach has been used in many fields, few papers on this topic have been presented in the monetary and financial fields. This paper introduces its use for economics. Although stock sales agents do not understand the complete economic situation, they are not fools. People can store and process the information that is relevant to them, even if it may be a tiny fraction of the total realm of information. Moreover, agents tend to change their behavior easily and promptly. However, people are not perfectly rational but rather bounded rational. It seems appropriate to think that agents use a rule to help them understand the economic situation and make decisions, and the rule must be a simple one in reality.

This paper is structured as follows. After introducing a theoretical model for stock price determination, a mixed model of fundamentalist and chartist calculation is developed in section 2. Section 3 uses this model to perform empirical analysis. Finally this paper ends with a brief summary.

Ⅱ. THEORETICAL MODEL

As explained above, this paper presents a bounded rational model. Agents cannot fully acquire and process all pertinent information, but they use as much information as possible and act based on a bounded rational rule. Agents act as follows: they check the profitability of the rule and compare it to other available rules. If they find that the rule is less profitable, they consider switching to the better rule. If they find otherwise, they stick to the initial rule. They are not perfectly rational, but they act in a bounded rational manner.

In general, economic agents emphasize chartist analysis in the real world, whereas academic economists prefer fundamental over chartist elements. This paper also assumes that agents use both of these two fundamental and chartist models to forecast stock prices. Economists in academic fields have not completely evaluated the chartist model, but evidence suggests that many agents use it as a basis for forecasts. No strong theoretical reason suggests that we should disregard the chartist rule. It is important to bridge both academic and business worlds.

The fundamentalist model here assumes that agents know fundamental stock prices. They compare the present market stock price with the fundamental one, and they forecast the future stock price to move toward the fundamental stock price. This leads us to specify the following rule as equation (1):

$$E_t = (\Delta s_{t+1}) = - \alpha(s_t - s^*_t) \tag{1}$$

where E_t is the forecast made in period t by the fundamentalists using information up to time, s_t is the stock price in period t, Δs_{t+1} is the change in the stock price between period t to t + 1, s^*_t is the fundamental stock price in period t, and $\alpha > 0$ measures the speed with which the fundamentalists expect the stock price to return to the fundamental stock price. This is a typical fundamental approach.

On the other hand, chartists are assumed to follow a feedback rule. This paper assumes that chartists use the previous period's stock price information to predict the future. This assumption seems to be very realistic. Most chartists do not extrapolate information from past periods but extrapolate only the most recent period's information. However, chartists are not perfectly rational but in fact bounded rational. In the real world, this assumption seems to be very realistic and adequate. The chartists' forecast rule is specified as follows:

$$E_t = (\Delta s_{t+1}) = \beta(\Delta s_t) \tag{2}$$

where E_t is the forecast made in period t by the chartists using information up to t, and β is the coefficient

measuring the degree with which chartists extrapolate the past change in the stock price. This paper assumes that $0 < \beta < 1$.[1)]

The general idea is that agents seem to follow one of the two rules: either the fundamental rule or the chartist rule. Agents are assumed to use of one the two rules, compare their profitability, and decide whether to keep the rule or to switch to the other one. This means that the fraction of the total population of agents using chartists and fundamentalist rules is a function of the relative (risk-adjusted) profitability of these rules. The following procedures in equations (3) and (4) are specified.[2)]

$$W_f = E_t(\pi_f) / (E_t(\pi_f) + E_t(\pi_c)) \tag{3}$$

$$W_c = E_t(\pi_c) / (E_t(\pi_f) + E_t(\pi_c)) \tag{4}$$

where W_f and W_c are the fractions of the population that use fundamental and chartist rules. Of course $W_f + W_c = 1$. The variables π_f and π_c are the risk-adjusted profits realized by the use of chartist and fundamental forecasting rules in period t. Each variable is profits made in forecasting minus $\mu\sigma^2$. μ is the coefficient of risk aversion. σ^2 is the variance of the forecast error, $\sigma^2 = [E_{t-1}(s_t) - s_t]^2$

Equations (3) and (4) can be interpreted as follows. When the risk-adjusted profits of the chartist rule increase relative to the risk-adjusted profits of the fundamentalist rule, the share of agents who use chartist trader rules increases, and vice versa. The switch seems to be easy for the agents.

Profits in the stock markets are defined as the one-period earnings of investing stocks. More formally,

$$\pi_{i,t} = [s_t - s_{t-1}] \text{ PLUSMINUS } [E_{t-1}(s_t) - s_{t-1}] \tag{5}$$

where i = f (fundamentalist) or c (chartist). PLUSMINUS [x] = 1 (for $x > 0$), 0 (for $x = 0$), or -1 (for $x < 0$).

Finally, it is assumed that agents aggregate these forecasts to obtain market forecasts. The market forecast of stock price changes can be written as a weighted average of the expectation of fundamentalists and chartists.

$$E_t(\Delta s_{t+1}) = - W_f \alpha(s_t - s^*_t) + W_c \beta(\Delta s_t) \tag{6}$$

The realized change in the stock price in period t + 1 equals the market forecast made at time t plus white noise errors, ε_{t+1}, occurring in period t + 1. The ε_t is assumed to be normally distributed with

means equal to 0. Equation (6) can be written as follows:

$$\Delta s_{t+1} = - W_f \alpha(s_t - s^*_t) + W_c \beta(\Delta s_t) + \varepsilon_{t+1} \quad (7)$$

Section 3 provides empirical analysis that mainly checks whether or not the new rule is appropriate and which rule is adopted. When stock prices move largely or frequently, checking which rule is used in the market is important not only for market agents but also for policymakers. Analyzing the deterministic rule in stock markets is an important issue not only for stock traders but also for policymakers. Stock prices impact the economy and affect not only enterprises but also broad macroeconomic activities.

Ⅲ. EMPIRICAL ANALYSIS

As mentioned above, economists in academic fields have not emphasized chartist analysis. Chartists do not emphasize extrapolation from past information but tend to employ recent information. However, much empirical evidence indicates that chartist analysis or technical analysis is appropriate and agents make forecasts based on this approach in reality. Taylor and Allen (1992), Menkhoff (1997, 1998), and Cheung and Chinn (2001) provide examples. Too much dependence on fundamental analysis seems to be dangerous when analyzing stock prices. Stock traders watch prices on a daily or sometimes hourly or minute/second basis. Every minute and second, they carefully watch stock prices as a factor in sell/buy decisions. In such cases, chartist analysis seems to be used much more. Bridging the business world and the academic world is important.

For empirical analysis, fundamental stock prices should be determined. The Hodrick-Prescott Filter method is used to calculate the fundamental prices.[3] μ is set to one. The sample periods are from 1986 to 2006. The data are daily. Three cases, U.S., U.K., and Japanese stock index prices, are used for calculation.

Next, α and β should be computed. The estimated equations (1) and (2) are as follows. The method is OLS.

$$E_t = (\Delta s_{t+1}) = - 0.1904 \ (s_t - s^*_t) \quad (1)$$
$$(-28.567)$$

adj.R^2: 0.090; D.W.: 1.850

$$E_t = (\Delta s_{t+1}) = 0.010 \ (\Delta s_t) \quad (2)$$
$$(26.375)$$

adj.R^2: 0.023; D.W.: 1.998

Figure 1 is the Dow Jones. The upper part shows the simulated stock price obtained in the simulation run and the stock price rate in reality. Figure 2 is the Dow Jones (U.K.), and Figure 3 is the TOPIX (representative indexed stock price index in Japan).

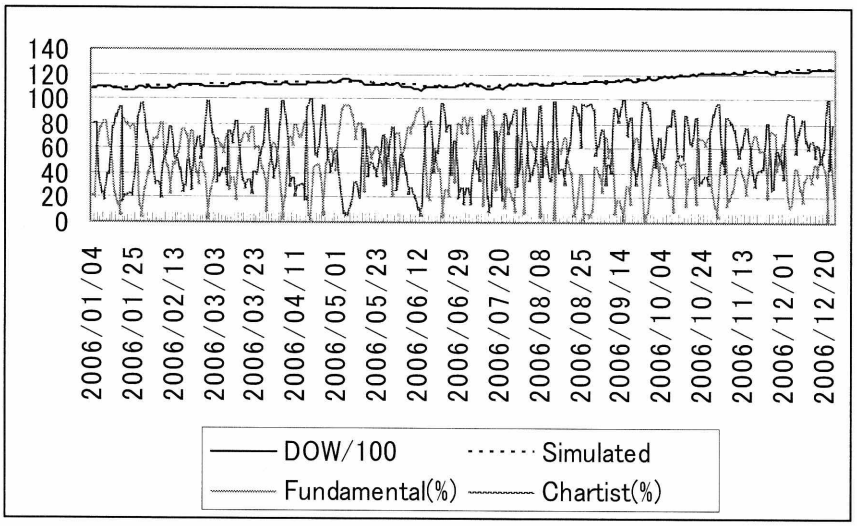

Figure 1. Simulated stock price and the stock price in the real market (DOW: U.S.).

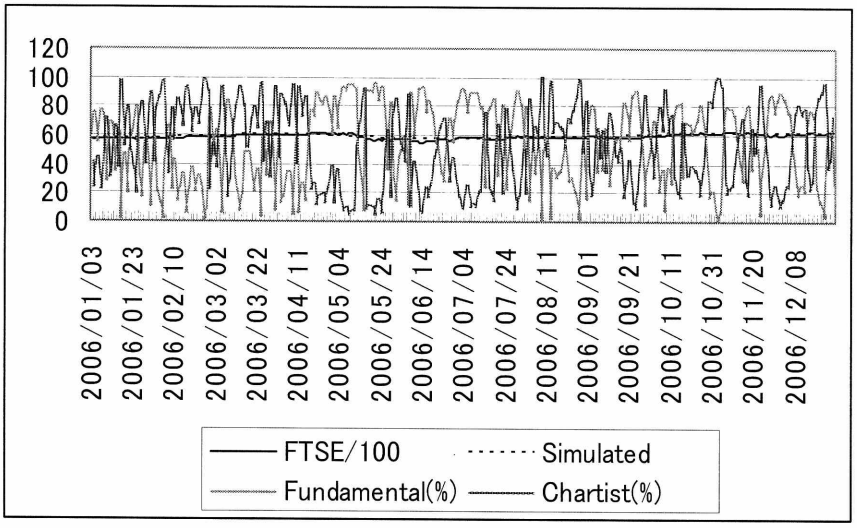

Figure 2. Simulated stock price and the stock price in the real market (FTSE: U.K.).

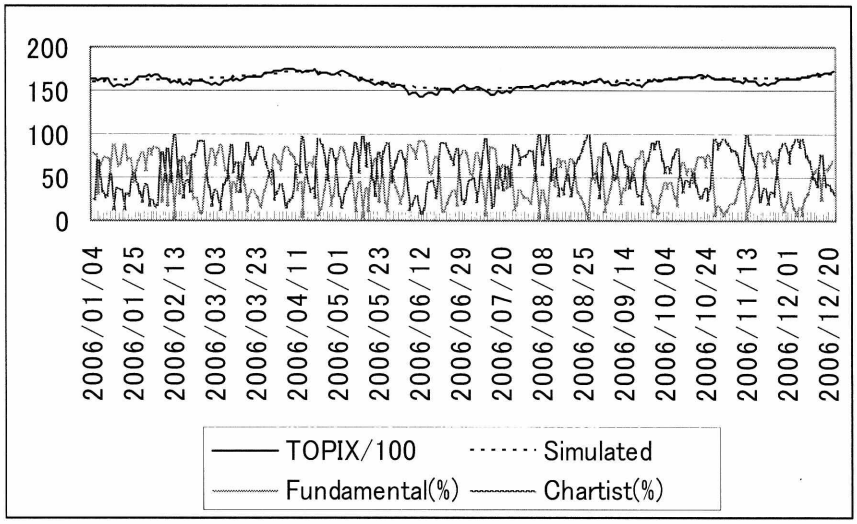

Figure 3. Simulated stock price and the stock price in the real market (TOPIX: Japan).

The most interesting features of these simulations are as follows. First, it appears that the movement of the simulated stock price is similar to the reality. However, simulated stock price is very often different from the stock price in reality. Second, nonfundamental periods are characterized by situations in which the chartists' weights are low and fluctuate significantly. Third, there is not much difference between the three cases. It can be said that this bounded rational- fundamentalist-chartist mixture model is suitable for analyzing stock prices and the results seem to be as expected.

Finally, the standard deviation of simulated stock price and the stock price in the real market are calculated. Table 1 shows the results.

Table 1. Standard Deviation of Stock Prices

		1990-1999	2000-2006
DOW	Simulated	2654.89	925.48
	Real	2657.34	2567.37
FTSE	Simulated	1330.55	826.42
	Real	1334.14	833.04
TOPIX	Simulated	4623.08	2970.13
	Real	4658.28	2993.79

The results are not very clear. However, we can say that simulated results have achieved good performance in general.

Ⅳ. CONCLUSIONS

This paper analyzed the deterministic elements of stock prices from a realistic point of view including some important and new ideas. When analyzing stock price movements, both fundamental and chartist analyses need to be considered. Taking into account only one of them is inadequate. This paper also uses the bounded rational expectation model, which depends on behavioral financial economics. It shows that this bounded rational, fundamentalist-chartist mixed model can account for stock price movements. The movements of stock price in reality and as simulated are very similar. Also, agents rely on the fundamental approach when stock prices vary from the simulated ones; on the other hand, agents rely on the chartist approach when the departures are small. Furthermore, standard deviation of simulated stock prices is smaller than that of exchange rates in reality. The simulated stock prices show good economic performance for stability.

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ENDNOTES

1) This ensures dynamic stability.
2) One of the objections to this switching rule could be that when one of the two rules is more profitable, all agents will use that rule. However, some psychological literature says that there is a status quo bias in decision-making. Agents need time to change a decision rule that has been used for some time.
3) AR (1) was applied, but the results are not so different from those shown below.

REFERENCES

Cheung, Y.W. and Chinn, M., "Currency traders and exchange rate dynamics: A survey of the U.S. market", Journal of International Money and Finance, Vol. 20, March 2001, pp. 439-472.

De Grauwe, P. and Grimaldi, M., The exchange rate in a behavioral finance framework (Princeton University Press, 2006).

Kurihara, Y. and Nezu, E., "Recent stock price relationships between Japanese and US stock markets", Studies in Economics and Finance, Vol. 23, No. 3, October 2006, pp. 211-226.

Menhoff, L., "Examining the use of technical currency analysis", International Journal of Finance & Economics, Vol. 2, June 1997, pp. 307-318.

Taylor, M. and Allen, H. "The use of technical analysis in the foreign exchange market", Journal of International Money and Finance, Vol. 11, December 1992, pp. 304-314.