Modeling the dynamics of institutional, foreign, and individual investors through price consensus

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1. Introduction

The dynamics and relation among the trades of institutional, foreign, and individual investors and a comparison among their performances have been topics of debate in academic research. For instance, Grinblatt, Titman, and Wermers (1995) and Wermers (1999) analyze characteristics of mutual funds, while Barber and Odean (2000) observe individual traders through household account data. Cohen, Compers, and Vuolteenaho (2002) capture the reaction of individual and institutional investors to cash-flow news, and Choe, Kho, and Stulz (1999, 2000) study investment behavior of foreign investors in the Korean market. Moreover, there are also studies that compare the performance of various types of traders (Bae, Yamada, & Ito, 2006; Grinblatt & Keloharju, 2000; Karolyi, 2002; Kamesaka, Nofsinger, & Kawakita, 2005). Most of the previous studies focus on net transaction amount for comparing the characteristics of each market player. However, to compare the market participants more inclusively, we believe that the price which they trade is also important. An investor could buy (sell) a stock not only because he or she evaluates the value of the stock to be high (low), but also because the stock price is temporarily lower (higher) than the investor’s price consensus. For this reason, considering only transaction amounts could lead to uncomprehensive observations. Therefore, in this paper, we suggest a price consensus measure which incorporates stock price, stock volatility, and risk aversion of investors, in addition to net transaction amount. The basic idea of the proposed measure is that if an investor purchases shares of a stock, it could be inferred that the estimated value of the stock by the investor is higher than the executed price. Furthermore, if an investor is more risk averse, the gap between the estimated value and executed price is expected to be larger. Through a price consensus measure, we are able to inversely approximate market participants’ expected stock price. The measure allows considering not only net purchase amounts of market participants, but also the price that they trade at, when analyzing the dynamics of market participants.

A similar model was first proposed by Grossman and Stiglitz (1980), which is a noisy rational expectation model with a single asset where informed, uninformed, and noisy traders exist. The main contribution of our research is applying the model of Grossman and Stiglitz in order to incorporate price consensus and applying the theoretic model to analyze empirical data for providing more comprehensive implications on the behavior of different investors. In contrast to their work, we assume all traders are informed traders with their own views on the value of a stock, while the quality of the views may differ. Thus, the model of Grossman and Stiglitz (1980) could be extended to a multiple-asset case (Admati, 1985), but this paper focuses on the single-asset case to study the dynamics among institutional, foreign, and individual investors in a basic setting.
uninformed traders in Grossman and Stiglitz (1980) are also considered to be informed to a degree, who trade with disperse and uncertain information. In addition, daily closing prices are thought as the price that reach the equilibrium after intraday trades of institutional, foreign, and individual investors based on their views. For the empirical analysis, we focus on investors in the Korean stock market since our proposed measure can be easily calculated for KOSPI (Korea Composite Stock Price Index) stocks from publicly available data of the Korea Exchange, such as data on historical stock prices and net purchase amounts of various investor types. We include analyses for 2008 and 2014, which can be considered as crash and normal market periods, respectively. Note that studying the behaviors of different types of investors is particularly important in emerging markets including Korea, because these markets are known to be vulnerable to the trades of foreign investors (see Choe et al., 1999, 2005). Nonetheless, our method can be also applied to other markets when net transaction data of different types of investors are available.

The remainder of the paper is organized as follows. The price consensus measure and its theoretic justification are presented in Section 2. In Section 3, empirical behavior of institutional, foreign, and individual investors is analyzed with the proposed price consensus measure. Section 4 concludes.

2. Price consensus measure

In this section, we present a measure that represents a price consensus of an investment group. We follow the rational expectations model of Grossman and Stiglitz (1980). We begin by introducing the market model in general form, and then explain how the model is extended for measuring price consensus, including a discussion on parameter estimation.

2.1. The general model

There are three types of agents in the market: institutional, foreign, and individual investors. The number of agents at time $t$ in each type are denoted as $N_{Ins}$, $N_{For}$, and $N_{Ind}$, respectively. All agents are risk averse and their utility function is defined as CARA (constant absolute risk aversion) utility function with positive risk aversion represented by $\gamma_{Ins}$, $\gamma_{For}$, and $\gamma_{Ind}$ for each agent type, respectively. Agents invest in a risky asset, such as stocks, and a risk-free asset. The risk-free asset has a risk-free rate of return $r_f$, and the price of the risky asset, denoted as $S$, is composed of two parts,

$$S = \mu + \epsilon$$

where $\mu$ is the value of the risky asset which is unknown to all agents, and $\epsilon$ represents noise. The noise term is normally distributed with a mean of zero and variance $\sigma^2$ while the variance is assumed to be known to all agents. Agents are assumed to have daily views or price consensus about $\mu$ and trade depend on the views. Their views may be formed based on cash flow information of the company or may reflect sentimental subjective views on the price of the risky asset. The price consensus on the value of the risky asset at time $t$ for institutional, foreign, and individual investors are denoted as $\mu_{Ins}$, $\mu_{For}$, and $\mu_{Ind}$, respectively. Furthermore, we assume the economy as an open system, and this assumption allows us to disregard the stock position of an agent prior to a specific trade.

At time $t$, an agent of type $i$ will trade to maximize the expected utility,

$$\max E \left[ -\gamma_i (d^i S + (W_i - d^i p^i) (1 + r_f)) \right]$$

$$= \max -\gamma_i (d^i S + (W_i - d^i p^i) (1 + r_f)) + 3\gamma_i d^i Var(S)$$

where $d^i$ denotes the demand for the risky asset of the agent $i$, $W_i$ is wealth of the agent $i$, and $p^i$ is the price of the risky asset at time $t$. The optimal demand $d^i_t$ of agent $i$ at time $t$ can be expressed as

$$d^i_t = \frac{E[S_i] - (1 + r_f)p^i}{\gamma_i Var(S)} = \frac{\mu^i - (1 + r_f)p^i}{\gamma_i \sigma^2}$$

(1)

where $E[S_i]$ is the conditional expectation based on the investors’ price consensus. Thus, the demand of agent $i$ at time $t$ is proportional to the difference between the price consensus of the risky asset and the total return of investing the market value of the risky asset at the risk-free rate. On the other hand, the demand of the agent is reciprocal to the risk aversion and the risk level of the risky asset. The equilibrium price of the risky asset is settled to satisfy the market clearing condition: market clears when the demands of buying and selling offset each other,

$$\sum_i d^i_t = \sum_i N_i d^i_t = \sum_i \frac{\mu^i - (1 + r_f)p^i}{\gamma_i \sigma^2} = 0$$

(2)

where $D^i_t$ represents the total demand of all investors of agent type $i$. By rearranging the formulation given by Eq. (2), we can show that price is settled as a discounted convex combination of agents’ belief on the price as follows

$$p^i = \frac{1}{1 + r_f} \left( \frac{N_{Ins}}{N_{Ins} \gamma_{Ins} \sigma^2} + \frac{N_{For}}{N_{For} \gamma_{For} \sigma^2} + \frac{N_{Ind}}{N_{Ind} \gamma_{Ind} \sigma^2} \right)$$

(3)

In addition, it can be noticed that larger the number of agents and lower the risk aversion, the price impact of the belief becomes stronger. In Section 3.2, with price and demand data, we show how to decompose price into information of three types of agents.

2.2. Parameter estimation from data

With some assumptions, the general formulation explained in the previous section can be modeled using data that only contains demand of each agent, represented by net purchase amounts and price of the risky asset. The variance of the risky asset denoted as $\sigma^2$ that is known to all market players is estimated as the sample variance of price of the risky asset. Moreover, the distribution of $\mu^i$ is modeled as an independent normal distribution $N(\theta_i, \sigma^2)$ with a fixed variance $\sigma^2$, and the daily risk-free rate is set to zero.

With these assumptions, the likelihood function of the model can be written as

$$\text{Likelihood} = \prod_i \prod N \left( D^i_t | \theta_i - p^i - N^i \frac{\mu^i}{\gamma_i \sigma^2} \right)$$

$$= \prod_i \prod N \left( D^i_t | \theta_i - \gamma_i \sigma^2 \frac{\mu^i}{\gamma_i \sigma^2} \right)$$

(4)

where $\gamma_i$ substitutes $\gamma_i / N$ for simplicity. Our aim is to find $\theta_i$ and $\gamma_i$ that maximize the likelihood function. The following proposition illustrates how the log of the likelihood function can be maximized.

Proposition 1. For agent $i$, based on the likelihood function given by Eq. (4)

(a) the optimal $\theta_i$ that maximizes the likelihood function given $\gamma_i$ is

$$\theta_i = \bar{p} + D^i_t \gamma_i \sigma^2$$.
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