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The Influence of Investor Sentiment on Scale Effect of the A-share Market: An Empirical Analysis of Principal Components

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Abstract: Scale effect in the stock market refers to the negative correlation between company size and expected return, which is a common anomaly in the financial market. Investor sentiment is the opinion that investors create based on their expectations of the potential future cash flow from their assets and the inherent dangers of making investments. The initial goals of this paper were to develop an investor sentiment index system and investigate how it relates to the market scale impact. In this paper, principal component analysis and the CICSI index, which can better measure Chinese investor sentiment, are combined to construct investors More than 3000 sample stocks are grouped by size, the average return rate of each group is calculated, and the scale effect is tested. Through the verification of the scale effect under the optimistic, neutral, and pessimistic sentiment index, the applicability of generated sentiment index to the scale effect is confirmed.

Keywords: investor sentiment, scale effect, principal component analysis, CICSI index

1. Introduction

Behavioral finance suggests that cognitive irrationality, decision irrationality, trading behavior bias, and the limited nature of market arbitrage can expose investors to certain emotional influences that affect capital market performance, stock prices, and returns [1]. Investor sentiment refers to the opinion that investors have about the potential returns and investment risks of a certain asset based on their expectations. Through the study of investor sentiment, we can reveal how limited rational investors affect the market. Domestic and foreign scholars have tried to construct measures of investor sentiment from different dimensions such as subjective and direct indicators, public market statistics, and economic fundamentals factors. On this basis, the effects of investor sentiment on investment behavior decisions, market volatility, excess returns, market size effect, liquidity premium, portfolio, and risk diversification strategies in the market have been studied from different perspectives. Investor sentiment and the financial market size effect have some mutual influence in terms of the Chinese stock market. Scholars have used different methods to construct single or composite indicators of investor sentiment and have argued from different perspectives the scale effect exhibited by China's Shenzhen and Shanghai markets in some periods, and the interaction between investor sentiment and scale effect. However, relatively few studies on such relationships have been conducted in recent years, and the indicator construction is basically based on the CICSI

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index of Chinese investor sentiment and the corresponding indirect indicator adjustment. The next section presents some of the existing literature and the methods of constructing indicators.

Investors only display a limited degree of reason while making investments. In the context of behavioral finance theory, investor sentiment is the term used to describe how investors' expectations of the future are consistently biased. The study of investor sentiment has become an important topic. According to various research philosophies, there are two main groups in the subject of behavioral finance for study on investor behavior. The first category, headed by Kahneman, concentrates on psychological research, modelling relevant analytical approaches to analyze human decision-making behavior [2,3]. The second category is investor behavior research, which is centered on the real-world applications of investor psychology. Market-specific sentiment indicators and stock-specific sentiment indicators are two categories of investor sentiment measurements. It is also divided into single and composite indices. Single sentiment indices include direct survey data, indirect market variables and textual information mining variables. Research methods for composite investment indices include principal components, Kalman filter and Laplace feature mapping. Sentiment indicators commonly used abroad to study the impact of individual and institutional investor sentiment on stock returns include the American Association of Individual Investors Index, Chartcraft's Investor Intelligence Index, the Haddaday (HADADY) Company Friendly Index, the Investor Confidence Index (UBS/GALLUP) Index, the Stock Market Dynamic Analysis Magazine's " Good Light Index" and other direct indicators. In China, there are survey-based CCTV Watch Index, China Securities Analyst Index, and indirect indexes such as closed-end fund discount rate, entrepreneurial sentiment index, derivatives trading index, and consumer confidence index.

He et al. attempted to screen out unreasonable indicators through a combination of indices and indicators, so as to screen out proxy variables suitable for characterizing investor sentiment and obtain the final selected proxy variables of investor sentiment LPM (Shenwan Microcap Index), CAI (New Wealth Best Analyst Index), NAFA (number of new fund accounts per week), HPBI (Shenwan High P/E Index), HPEI (Shenwan High P/E Index), NIPO (number of IPOs per week) [4]. In order to construct an integrated investor sentiment index (CICSI), Lu chose six single sentiment indicators, and then measured the correlation between the integrated investor sentiment index and extreme market volatility and discovered that the closed-end fund discount rate and the number of stock forum postings were the two factors that had the strongest correlation [5]. The most famous foreign sentiment index is the BW index proposed by Baker & Wurgler. They synthesized the BW sentiment index using six market variables and confirmed that sentiment can inversely predict the returns of stocks with small market capitalization, new listings, high volatility, poor predictability, no dividends, high growth, and high probability of bankruptcy, based on principal component analysis. Much of the subsequent research on sentiment in the U.S. market has been based on their findings or has used the BW Index as a benchmark for comparative studies [6]. Cai & Lai used three different data dimensionality reduction methods - principal component, Kalman filter, and Laplace feature mapping (LE) - to select four sentiment source indicators suitable for the Chinese context - urban residents' investment intention, IPO First-day return, log account opening ratio and market capitalization-weighted turnover ratio, were selected to build three monthly composite indices to measure investor sentiment in the Chinese stock market. The validity of the three sentiment indices was tested using the AH stock premium index, and it was found that the sentiment index based on the Kalman filter method was the most effective. The sentiment index based on the principal component method was the second most effective, and the sentiment index based on the LE method did not meet the validity requirements of the empirical study [7]. Meanwhile, on the basis of improving the construction method of the BW index, Yi et al. selected six individual indicators suitable for measuring domestic stock investors' sentiment and used the principal component analysis method to

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construct a composite index suitable for measuring investors' sentiment in the domestic stock market [8].

The size effect is a common financial market anomaly, also known as the small firm effect, which is a negative correlation between firm size and expected returns. The average return of the smallest portfolio was found to be significantly higher than the average return of the largest portfolio, and this phenomenon remained significant even after risk adjustment [9]. Zhao investigates the relationship between stock returns and firms in China using cross-sectional regressions and finds that both the size of listed firms in terms of shares outstanding and total market capitalization are negatively correlated with stock returns, and that firm size is still negatively and statistically significantly correlated with abnormal returns after excluding risk factors. There is a small firm effect in the Chinese stock market [10]. Xie et al. used Amivest ratio and turnover ratio to measure the liquidity of the Shanghai stock market. They found that there is a significant liquidity premium phenomenon in the Shanghai stock market, and there are also value effects and scale effects [11]. Jin & Zhang empirically tested the asymmetric effect of the liquidity premium in the Shanghai stock market through a panel threshold model. It is found that the liquidity premium of small-scale stocks in the Shanghai stock market is higher than that of large-scale stocks, verifying that there is a significant scale effect on the liquidity phenomenon [12]. Regarding the relationship between investor sentiment and scale effect in China, Chi & Zhuang examined the characteristics of economies of scale in asset portfolios by grouping stocks according to their outstanding market capitalization and found that investor sentiment is affected by firm size. Stocks of tiny businesses typically have the lowest levels of investor sentiment, and as a company's size increases, the level of fluctuation becomes less pronounced. Additionally, investor sentiment towards stock returns changes depending on the size of the asset, with consumers being least sensitive to returns on smaller-capitalization stocks and most sensitive to returns on stocks with a medium asset size [13]. Li & Wang point out that there is a negative relationship between expected returns and liquidity for small-scale stocks and a positive relationship between expected returns and liquidity for large-scale stocks in Shanghai, while the opposite is true in Shenzhen, and that expected returns for illiquid stocks in China's stock market are positively correlated with liquidity, while highly liquid stocks are negatively correlated [14]. Meng et al. used a two-stage conditional asset pricing model with conditional beta parameters changing with investor sentiment and firm characteristics for empirical analysis, and the results showed that the scale effect of pricing A and H stocks became insignificant and the value effect of pricing A stocks decreased significantly after adding the conditional pricing model with investor sentiment. This leads to the conclusion that investor sentiment can help pricing models capture stock pricing anomalies [15].

This paper uses principal component analysis to study the investor sentiment index, which generally consists of the following four steps: First, descriptive statistics were performed on the data to eliminate the undesirable effects caused by different data units between variables. Second, correlations among the variables were determined to verify whether the selected variables were suitable for principal component analysis. Third, the number of principal components is determined based on the eigenvalues or their cumulative variance contribution requirements, combined with the data decay status. Fourth, the weighted average of each principal component is calculated and the composite sentiment index is constructed using the corresponding variance contributions of each principal component as weights.

2. The Construction of Investor Sentiment Indicators

2.1. Variable Selection

Referring to the investor sentiment index (BW index) was constructed by Baker and Wurgler, this paper uses eight variables, namely, the discount rate of fund (DCEF), trading volume (TURN),

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number of IPOs (IPON), IPO first-day return (IPOR), number of new investor accounts (NIA), consumer confidence index (CCI), the total number of shares traded in the market (Mnshrtrdtl) and the total amount traded in the market (Mnvaltrdtl), are selected as proxies for investor sentiment, and the consumer price index (CPI), the Ex-factory Industrial Price Index (PPI) and Macroeconomic Sentiment Index (MBCI) as proxy variables for economic fundamentals to construct the investor sentiment index, with data from CSMAR and Wind database. The sample range selected in this paper is the monthly individual stock data and market data of A-share SSE and SZSE indices from January 2013 to December 2022.

2.1.1. DCEF

Closed-end fund discount rate is a composite discount rate of quoted funds weighted by fund shares, which is used to measure market investor sentiment and is a more common indicator used by scholars studying investor sentiment at home and abroad, reflecting investors' expectations of listed companies' earnings in the coming period, and it is generally believed that DCEF is negatively correlated with market sentiment.

2.1.2. TURN

Trading volume uses the ratio of monthly trading volume to the average of monthly market capitalization outstanding. Higher trading volume for the stock market indicates more active market buying and selling, stronger investor confidence, and higher market participation.

2.1.3. IPON

Under the approval system, the number of IPOs is affected by policy changes in issuance review and review efficiency. This study hypothesizes that the number of IPOs is not only related to the number of approved firms, but more importantly, the timing of the IPO chosen by the firm within six months after obtaining the approval, without considering the effects of relevant policy changes and changes in the efficiency and degree of review and approval of the issuing and reviewing departments. If the timing is right, it represents a more positive view of the market environment and development by companies and investors, which is related to the change in investor sentiment.

2.1.4. IPOR

The first-day yield of an IPO is the ratio of the difference between the first-day closing price and the issue price to the issue price. There are many factors influencing the first-day yield, some of which are considered to be the IPO price suppression caused by information asymmetry, irrational behavior of investors, excessive trading by noise traders, agency conflicts between underwriters and issuers, etc., the unique retail investment structure of the Chinese market, the inability to short the market, the lack of IPO supply and the single investment channel for investors, but all of these factors are related to the two-way interaction of investor sentiment in the secondary market [16].

2.1.5. NIA

This indicator is a direct reflection of changes in the number and size of new investors due to market sentiment, again with feedback from investors on the positive impact of market sentiment.

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2.1.6. CCI

Due to the large number of retail stockholders in China, consumer confidence represents the emotional condition of the consumer group and is also a demonstration of the short-term market sentiment of the investor group, which is the consumer group's view and evaluation of the state of economic development and recent trends by means of consumption, and its expectations of future market price fluctuations are greatly based on the expected outcomes of this current market environment and level of economic development, thus forming effective response mechanism to the market sentiment.

2.1.7. Mnshrtrdtl

It is the aggregate of all individual shares traded during the month. It represents the overall monthly condition of market activity and, at the same time, is a general response to the basic trading condition of the entire stock market. Without considering changes in specific influencing factors such as policy changes and market hotspots, the total number of shares traded in the market is also a response to the overall market sentiment.

2.1.8. Mnvaltrdtl

It is the aggregate of all individual stock trading amounts during the month. The total monthly market transaction amount is the overall liquidity and size change of the market trading funds. On the one hand, the increase or decrease in the total market transaction amount is an expression of investors' bullishness or bearishness on stock market hot spots; on the other hand, it is also a vote of investors' stability and confidence in the market with the scale of capital flows.

2.2. Descriptive Statistics

The descriptive statistical analysis of these eight proxy variables is shown in Table 1. As can be seen, the magnitudes of the variables chosen have a significant impact on their mean and standard deviation. For this reason, this study employs the coefficient of variation as a measure of how far apart the variables are distributed. After removing the influence of the magnitudes, it is found that the coefficient of variation of IPOR is greater than 1, which indicates that the dispersion of IPOR is greater and the first-day IPO returns fluctuate more each month. The coefficient of variation of IPOR is greater than 1, indicating that the dispersion of IPOR is larger and the first-day IPO returns fluctuate more each month; the coefficient of variation of NIA and CCI is less than 0.1 and is more stable. All eight variables' skewness is not zero, meaning that their distributions are all asymptotically skewed. Of these, the closed-end fund discount rate, the number of new investor accounts opened in the previous month, and the consumer confidence index have left-skewing skewness, while the remaining variables have right-skewing skewness. The normal distribution's kurtosis is 3. When a sample's kurtosis value is more than 3, it typically means that the distribution in the sample is spiky and steeper than the normal distribution. Compared to the remaining 7 variables, which all have kurtosis values below 3, the IPO first-day return has a higher kurtosis and a flatter distribution.

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Table 1: Descriptive statistical analysis of investor sentiment proxy variables.

Var.	Mean	S.D.	β	Median	Skewness	Kurtosis	Obs.
DCEF	-1.946	1.740	-0.894	-1.559	-0.973	0.731	120
TURN	0.247	0.112	0.454	0.209	1.601	2.414	120
IPON	21.176	18.176	0.858	16.000	0.784	0.082	120
IPOR	6.756	8.054	1.192	4.668	2.373	6.295	120
NIA	13.912	0.606	0.044	13.960	-0.204	0.256	120
CCI	113.098	9.036	0.080	113.350	-0.081	-1.503	120
Mnshrtrdtl	8377.056	4258.379	0.508	7353.315	0.959	0.189	120
Mnvaltrdtl	97687.832	60634.477	0.621	82457.545	1.386	2.071	120

2.3. Principal Component Analysis

Due to the fact that changes in macroeconomic cycles have an impact on investor sentiment in addition to their psychology and behavior. For example, when the overall economic performance of the society is better, investors expect more opportunities in the future market and their sentiment is higher, so in order to make the measure of investor sentiment more accurate, the macroeconomic components of the sentiment proxy variables need to be removed before doing the principal component analysis. Combining the eight sentiment proxies, $TURN_t$, $IPON_t$, $IPOR_t$, NIA_t, CCI_t, $Mnshrtrdtl_t$, $Mnvaltrdtl_t$ with 3 macroeconomic variables, CPI_t, PPI_t, $MBCI_t$, were regressed separately using a multivariate linear model, excluding the influence of macroeconomic factors on sentiment. First, the residual series generated after the regression are processed to calculate the mean and standard deviation of the residuals and standardized. The calculation formula is:

$$e_i^* = \frac{e_i - \bar{e}}{s_e} \quad (1)$$

Where e_i denotes the residual of the i^{th} observation, and $\bar{e}$ represents the mean of the residuals of all n observations, the s_e represents the standard deviation of the residuals of all n observations, and e_i^* is the standardized residual of the i^{th} observation.

The correlation coefficient and partial correlation coefficient of the starting variables are related by the KMO value, which runs from 0 to 1. The variables are evaluated for substantial correlation using Bartlett's spherical test. If it is not significant then it is not suitable for principal component analysis. Its null hypothesis is that the correlation between all variables is 0. The residuals after standardization are tested separately, and the results show that the KMO value is 0.69 and the p-value of Bartlett's spherical test is much less than 0.05, which satisfies the principal component analysis conditions.

Third, the total number of primary components is calculated based on the data decay status, the eigenvalues, or the cumulative variance contribution criteria. Eight normalized residual series were subjected to principal component analysis; the first two principal components' eigenvalues were larger than 1, and the cumulative variance contribution was greater than 70%, which could account for the majority of the data (see Table 2).

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Table 2: Loadings matrix of the first two principal components.

Variables	Main component 1	Principal component 2
DCEF	0.1640	0.8614
TURN	0.7800	0.3744
IPON	0.7090	-0.0713
IPOR	0.5114	-0.3177
NIA	0.8478	0.0388
CCI	0.2854	-0.8681
Mnshrtrdtl	0.9155	-0.0751
Mnvaltrdtl	0.9377	0.0674

Fourth, the weighted average of each principal component was calculated and the composite sentiment index was constructed using the corresponding variance contribution of each principal component as weights, and the results were as follows:

$$Sent_t = 0.489DCEF_t + 0.219TURN_t + 0.114IPON_t + 0.077IPOR_t + 0.054NIA_t + 0.028CCI_t + 0.015Mnshrtrdtl_t + 0.004Mnvaltrdtl_t \quad (2)$$

3. The Scale Effect Analysis

3.1. Data Sources and Processing

In this paper, stocks from January 2013 to December 2022 are selected as the sample, and the remaining three thousand stocks in A-shares after excluding ST stocks and stocks listed for less than three months are used as the study sample. Calculate the return of the stock in month t based on monthly data of the closing price of the individual stock:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \quad (3)$$

Where $P_{i,t}$ refers to the closing price of stock i on the last trading day of month t, and $P_{i,t-1}$ refers to the closing price of stock i on the last trading day of month t-1. The portfolio average return is the average return weighted by market capitalization outstanding and is calculated as:

$$R_k = \frac{1}{n}\sum_{t=1}^{n}\left[\frac{S_{it}}{\sum_{i=1}^{m} S_{it}} R_{it}\right] \quad (4)$$

Where n is the number of sample study periods in the portfolio, with a total period of 116 months, and using the $Sent_t$ indicator to calculate the sentiment values for each month yields 38 months in optimistic sentiment and 39 months in neutral and pessimistic sentiment; m is the number of sample stocks in the portfolio; S_{it} and R_{it} denote the outstanding market capitalization and return of stock i in portfolio k in period t, respectively; $\frac{S_{it}}{\sum_{i=1}^{m} S_{it}} R_{it}$ denotes the market capitalization-weighted average return of portfolio k in period t.

3.2. Scale Effect Existence Test

The scale effect of the stock market was tested by using portfolio analysis, in which the total market capitalization of listed companies was sorted separately in each month and divided into 10 groups equally in the order from smallest to largest, and the average market capitalization of each group in

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each month was calculated as a representative of the average scale, and then the equal-weighted and market capitalization-weighted average returns were calculated separately, and the existence of the scale effect was judged by comparing the magnitude of the returns between the portfolios. The results are shown in Table 3. As can be seen from Table 3, the smallest portfolio equal-weighted return and the total market capitalization weighted average return are 2.573% and 2.462%, respectively, while the largest portfolio equal-weighted return and the total market capitalization weighted average return are 0.769% and 0.722%, respectively, and the regression results show that the values of the t-statistics are 2.828 and 2.318, which are significant at the 5% and 10% level, which means that there is a significant scale effect in the Chinese stock market, i.e., smaller companies have higher stock returns and larger companies have lower stock returns.

Table 3: Empirical results of scale effect.

Combination	Equal weighted		Value weighted		
	Equal-weighted average return (%)	Equal-weighted average return (%)	Average size (billion yuan)	Average size (billion yuan)	Average size (billion yuan)
Low	2.573	0.009	21.208	2.462	0.009
2	2.027	0.009	28.843	1.884	0.008
3	1.681	0.009	35.526	1.542	0.009
4	1.313	0.008	43.079	1.196	0.008
5	1.239	0.008	52.373	1.138	0.008
6	1.099	0.008	64.636	1.057	0.008
7	0.953	0.008	82.951	0.91	0.008
8	0.948	0.008	114.873	0.869	0.008
9	0.86	0.007	181.283	0.816	0.007
High	0.769	0.006	694.794	0.722	0.006
H-L	1.803	0.006		1.74	0.008

4. The Impact of Current Investor Sentiment on the Scale Effect

First, the stocks for the month are still divided equally into 10 shares by size and the weighted average return for each portfolio is calculated. Second, the investor sentiment for each month is ranked by the previously calculated $Sent_t$ value size from lowest to highest, and divide the 116 months of data into 38 months under the optimistic sentiment and 39 months under neutral and pessimistic sentiment; then calculate the average return of all months under different sentiment states to obtain the company's investment return under different sizes and different sentiments (see Table 4).

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Table 4: Current investor sentiment on scale effect.

Yield (%)	Current period optimism	Current period neutral	Current period pessimism
Small-cap stocks 1	6.115	0.989	1.591
2	5.187	0.822	0.751
3	4.786	0.416	0.403
4	4.255	0.281	0.096
5	4.234	0.154	-0.034
6	3.881	0.207	-0.043
7	4.122	-0.086	-0.338
8	3.667	0.212	-0.245
9	3.473	0.294	-0.279
Large cap stocks 10	3.006	0.572	-0.377
T-statistic	-3.56	-2.59	-2.20
Sig. level	1%	5%	10%

From Table 4, we can see that the scale effect is significant at the 10% level when the current sentiment is pessimistic; the scale effect is significant at the 5% level when the current sentiment is neutral; and the scale effect is significant at the 1% level when the current sentiment is optimistic. Thus, it can be seen that the significance of the scale effect gradually increases from pessimistic to optimistic, and the returns of small-cap stocks in different sentiment states are significantly. The returns of small-cap stocks are significantly higher than those of large-cap stocks in different sentiment states, which can also verify the effectiveness of the scale effect. Moreover, when comparing the effect of sentiment on current period returns, it finds that the stock returns under optimistic sentiment are significantly higher than the rates of the other two sentiments. Additionally, it can determine that investor sentiment is positively correlated with stock returns over the same time period, better reflecting market law that states that higher investor sentiment translates into higher stock returns, demonstrating the high effectiveness of the sentiment indicator developed in this paper.

5. Conclusion

In this paper, eight variables of monthly individual stock data and market data of A-share SSE index and SZSE index from January 2013 to December 2022 were selected as proxies for investor sentiment, and three proxies for economic fundamentals to construct an investor sentiment index. After multiple linear regression, the residual series were processed, and based on the results of KMO test and Bartlett's spherical test, the standardized 8 residual series were subjected to principal component analysis, and then the scale effect of the stock market was tested by portfolio analysis. The results show that there is a significant scale effect in the Chinese stock market, and the significance of the scale effect gradually increases from pessimism to optimism, with small-cap stocks having significantly higher returns than large-cap stocks in different sentiment states. When comparing the effect of sentiment on current period returns, it is found that stock returns under optimistic sentiment are significantly higher than the rates of the other two sentiments, proving that investors' sentiment is positively correlated with stock returns during the same period. The above study shows that there is an interaction between the size effect and the investor sentiment index in the Chinese stock market. The more optimistic investor sentiment is, the more pronounced is the impact on the average return of small-cap stocks than large-cap stocks. This situation leads to small-cap stocks being more likely to react more strongly to favorable news, market concept-driven, and policy-driven, and more

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susceptible to influence and even manipulation. This phenomenon also leads to small-cap stocks being more prone to irrational premium bubbles and exposing stocks and funds that invest in small-cap stocks, etc., to greater investment risk.

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