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## Rational or irrational investor sentiment: Evidence from China

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### ABSTRACT

In this paper, we make a doubt to the currently widely used sentiment index construction method proposed by Baker and Wurgler (2006). After analyzing its prerequisites, we put forward a new methodology for distinguishing between rational and irrational sentiment based on the idea of extracting common factors. In contrast to previous studies, we redefine the concept of "rationality" from the perspective of investors' pursuit for wealth maximization instead of associating it with fundamentals. Thus, rational sentiment reflects "smart money", while irrational sentiment reflects "dumb money". Finally, we conduct a comparative analysis of 15 commonly used single sentiment proxies. The empirical results support our predictions.

### KEYWORDS

Sentiment index; Rational and irrational sentiment; Predictability of asset returns.



## INTRODUCTION

Measuring investor sentiment is the basis of financial market research. Dozens of sentiment indexes can be found in existing literatures. While enriching our understanding of the characteristics of investor sentiment, it also complicates the establishment of a unified and representative measurement. Principal component analysis (PCA), originated with the work of<sup>[1]</sup> and<sup>[2]</sup>, is commonly thought of as a statistical technique for dimension reduction. It reduces the number of variables in an analysis by describing a series of uncorrelated linear combinations of the variables that contain most of the variance. Also, PCA can be used to filter out idiosyncratic non-sentiment-related components of sentiment proxies to obtain a "purer" measure of investor sentiment<sup>[3]</sup>. applied PCA to construct composite investor sentiment index, and since then, PCA has gradually become the mainstream method in the construction of investor sentiment index<sup>[3-9]</sup>.<sup>[3]</sup> mentioned that, considering every sentiment proxy involves a common sentiment factor and an idiosyncratic non-sentiment part, PCA is adopted to filter out idiosyncratic noise and capture the common sentiment component. However, existing studies all ignored the prerequisites of using PCA to construct investor sentiment index, merely using the first principal component to proxy for common sentiment part. In many cases, these studies come to seemingly correct conclusions while using the wrong approach. As far as our knowledge, we are the first to explicitly propose the prerequisites of using PCA to construct composite investor sentiment index, that is, the index must incorporate single sentiment proxies for which investor sentiment is of the greatest influence. However, in reality, because selected proxies are different, this is not always guaranteed. We provide a counter example in our empirical analysis to demonstrate that the use of the first principal component to proxy for common sentiment component is not appropriate and a careful examination is needed.

In order to control for the influence of fundamentals<sup>[3,10]</sup>, use regressions of a series of macroeconomic variables on sentiment proxy to purify single sentiment proxies<sup>[11]</sup>. use this method to distinguish between rational and irrational sentiment. That is, the part explained by fundamentals is referred as rational sentiment, while the remaining part is referred as irrational sentiment. However, we believe that this definition is biased. we propose a new means of distinguishing between rational and irrational sentiment. Our method takes into account not only the forward-looking nature of rational sentiment but also the relationship between investor sentiment and fundamentals. Our empirical results demonstrate that although rational sentiment does not reflect current fundamentals, it will be subject to the impacts of past fundamentals. Moreover, irrational sentiment is associated with previous returns and thus cannot be explained by fundamentals.

It has always been controversial to judge whether a proxy of investor sentiment is representative and how it is compared as "good" or "bad". Basing on the 12 most commonly used measurements of investor sentiment and the single proxies summarized by<sup>[7]</sup>, we conduct a comparative analysis of 15 single proxies of sentiment commonly used in mainland China, including turnover, closed-end fund discount, consumer confidence index, the number of new investor accounts, and so forth. The results show that there does not exist a perfect single sentiment proxy, most single proxies can reflect investor sentiment only partially.

The rest of this paper is organized as follows: Section I reviews related literature; Section II discusses the theoretical relationship between dimension reduction and information extraction; Section III constructs rational and irrational sentiment indexes and conducts a comparative analysis of 15 commonly used single sentiment proxies. Section IV concludes.

## LITERATURE REVIEW

Generally, sentiment indexes can be divided into three categories: direct indexes, indirect indexes, and composite indexes. Direct and indirect measures may not be perfect proxies of investor sentiment because they contain, in addition to sentiment component, idiosyncratic non-sentiment-related components. If we can identify and eliminate the influence of these idiosyncratic components through data processing, then we can obtain a "pure" measure of investor sentiment. However, in reality, it is

often difficult to identify these idiosyncratic components, and even if we can identify some of these components, they are often difficult to measure. It is obvious that all single proxies are not perfectly representative<sup>[3]</sup>. proposed to construct composite index using PCA to extract the pure sentiment part among various sentiment proxies. Generally, each proxy contains three kinds of information, namely: fundamentals, a common sentiment factor, and an idiosyncratic part. So, after controlling for the influence of fundamentals, the extracted common component (the first principal component) should only proxy for investor sentiment. This is exact the idea of<sup>[3]</sup>.

The<sup>[3]</sup> approach is questionable for at least two reasons. Firstly, assume that, after excluding fundamentals, each proxy includes only sentiment and idiosyncratic components. For the first principal component to be a sentiment index, the proportion of information from the common component in the original variables (often indicated by variance) must be the largest. Secondly, in addition to fundamentals and sentiment component, there are other common components among the proxies. Therefore, as previous studies use the first principal component to construct composite sentiment index without carefully examining each principal component, they reach seemingly correct conclusions in the wrong way, although the results are not necessarily wrong.

There are multiple dimensions in sentiment proxies, and the number of dimensions is related to the definition of investor sentiment. Broadly speaking, investor sentiment can be defined as any factor that affects investor's trading decisions. In this way, the fundamentals in a proxy of investor sentiment can be considered as one dimension. In addition, the part that unrelated to the current fundamentals but is related to the correct prediction of future returns can be regarded as one dimension. Furthermore, the part of investor sentiment that is unrelated to the current fundamentals but related to the incorrect prediction of future returns can be regarded as another dimension.

We define the part of investor sentiment that correctly predicts future returns and reflects "smart money" as rational sentiment. There should be three characteristics of rational sentiment: firstly, to be a subject worthy of our study, it must have systematic impacts on asset prices. Secondly, rational sentiment can correctly predict future returns<sup>[12]</sup>. Thirdly, fundamentals are still important determinants of the long-term asset returns rational sentiment should be subject to the impacts of previous fundamentals.

We define the part of investor sentiment that is not that "smart" with respect to the prediction of future returns as irrational sentiment. The characteristics of irrational sentiment should be as follows: firstly, similar to rational sentiment, irrational sentiment must have systematic impacts on asset prices. Secondly, in the long term, it is a contrarian indicator of future returns. But in the short term, irrational sentiment has positive impacts on asset returns.

## EMPIRICAL ANALYSIS

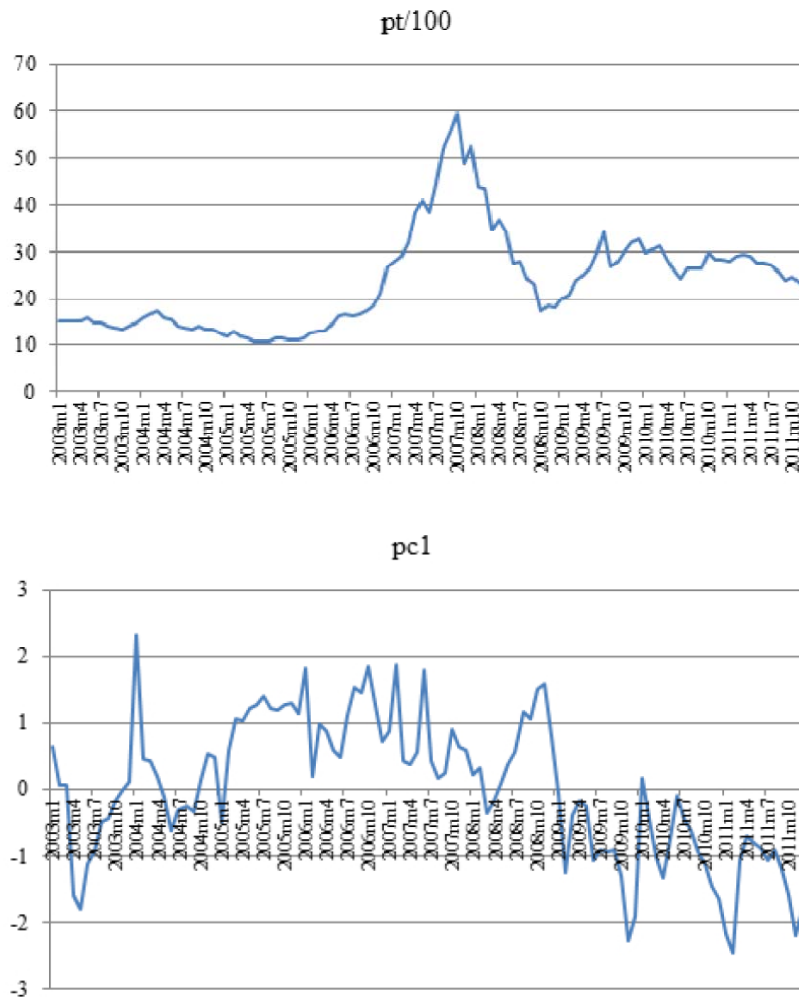
### Preliminary analysis

All the data in this study are from mainland China. According to data availability and representativeness, the proxies of investor sentiment are selected to construct composite index based on PCA. These proxies are turnover (turn), closed-end fund discount (cefd), the number of new investor accounts (open), and consumer confidence index (cci). The data span is from January 2003 to December 2011. All variables are normalized. Prior to PCA, the lead-lag relationship of each proxy is determined according to<sup>[3]</sup>. The results suggest that one-period lagged data should be used for the closed-end fund discount and the number of new investor accounts, while current data should be used for turnover and consumer confidence index. To eliminate the impacts of fundamentals, following<sup>[3]</sup>, the sentiment proxies and macroeconomic variables are submitted to a regression analysis, and the corresponding residuals are used as variables for PCA. The selected macroeconomic variables are the consumer price index (cpi), the macroeconomic climate index (mci), and the industrial added value growth ratio (iavr). The PCA results are shown in TABLE 1.

TABLE 1: The results of PCA

Component	Eigenvalue	Proportion	Cumulative	turn	L.cefd	cci	L.open
pc1	1.5400	0.3850	0.3850	-0.1152	0.6836	0.7056	0.1469
pc2	1.2840	0.3210	0.7060	0.7019	-0.0714	0.0364	0.7078
pc3	0.7185	0.1796	0.8856	0.6809	0.3522	-0.0980	-0.6346
pc4	0.4576	0.1144	1.0000	-0.1746	0.6352	-0.7009	0.2734

TABLE 1 shows that the explanation ratios are 38.5% and 32.1% for the first and second principal components, respectively. There is not much difference. It is unconvincing if we use the first principal component as the composite sentiment index just because of the 6.4% difference in explanation ratio. Counterintuitively, for the first principal component, the coefficient of turnover is negative, while the coefficient of the closed-end fund discount is positive. However, for the second principal component, the coefficient signs of all variables are in line with intuition. compared with the first principal component, the second is more consistent with the characteristics of irrational sentiment, suggesting that the simple use of explanation ratio is not reliable.



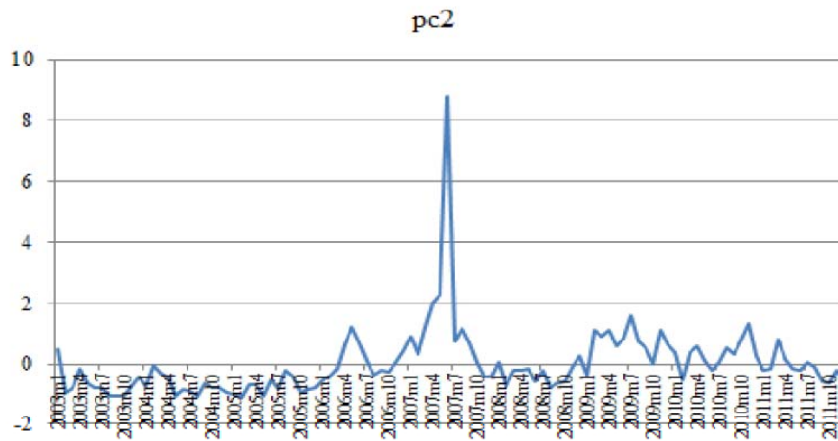


Figure 1: Time series of the SCI (pt), the first principal component (pc1), and the second principal component (pc2)

TABLE 2 provides the descriptive statistics of the first and the second principal components. Although based on PCA, the explanation ratio of the first principal component is higher than that of the second. However, the variance of the second principal component is larger than that of the first. The first principal component is skewed slightly to the left, while the second is severely skewed to the right. The kurtosis of the second principal component is as high as 35.8263, which implies a fat tail.

TABLE 2: Descriptive statistics

	mean	variance	skew	kurt	Jarque-Bera	ADF
pc1	0.0000	1.0671	-0.1902	2.3653	2.4640	-3.077**
pc2	0.0000	1.1226	4.6221	35.8263	5233.61***	-5.838***

Superscripts \*\*\*, \*\* and \* indicates that the statistics are significantly different from zero at the 1%, 5% and 10% level of significance, respectively.

**Regression analysis**

To further examine whether there are undiscovered common factors in the third and fourth principal components, we run a regression analysis of these two principal components on the SCI return. TABLE 3 shows the results. We can see that the third and fourth principal components have almost no impacts on the SCI return. In other words, both components are largely white noise rather than common factors we may have ignored. Therefore, we retain only the first two principal components and exclude the third and fourth principal components for subsequent analyses.

TABLE 3: Impacts of the third and the fourth principal components on returns

lags	pc3		pc4	
	(1)	(2)	(3)	(4)
L1	0.0082 (0.74)	0.0024 (0.19)	0.0008 (0.05)	-0.0098 (-0.49)
L2		-0.0064 (-0.48)		0.0230 (1.06)
L3		0.0194 (1.47)		0.0007 (0.03)
L4		0.0177 (1.43)		-0.0203 (-1.06)
adj. R-sq	-0.0043	0.0282	-0.0095	-0.0149

Superscripts \*\*\*, \*\* and \* indicates that the statistics are significantly different from zero at the 1%, 5% and 10% level of significance, respectively. In the parentheses we report the *t*-statistics

To examine whether rational sentiment (pc1) and irrational sentiment (pc2) are consistent with some of the characteristics defined above, we perform a regression analysis of current rational and irrational sentiment indexes on the future 1-18 month SCI return<sup>[13]</sup>. The results are shown in TABLE 4.

**TABLE 4: Regression analysis of sentiment indexes and the prediction of future returns**

forwards	pc1	adj. R-sq	pc2	adj. R-sq	pc1 (adj.)	adj. R-sq	pc2 (adj.)	adj. R-sq
1	0.0155* (1.81)	0.021	0.0239*** (3.05)	0.073	0.0153* (1.83)	0.062	0.0239*** (3.12)	0.116
2	0.0267*** (3.12)	0.077	0.0177** (2.21)	0.036	0.0264*** (3.19)	0.137	0.0177** (2.27)	0.096
3	0.0186** (2.09)	0.031	0.0153* (1.89)	0.024	0.0187** (2.15)	0.081	0.0153* (1.94)	0.073
4	0.0193** (2.15)	0.034	0.0084 (1.02)	0.000	0.0194** (2.19)	0.069	0.0085 (1.04)	0.035
5	0.0221** (2.45)	0.047	-0.0107 (-1.29)	0.007	0.0220** (2.45)	0.057	-0.0107 (-1.30)	0.016
6	0.0336*** (3.85)	0.121	0.0049 (0.58)	-0.007	0.0326*** (3.80)	0.156	0.0047 (0.57)	0.034
7	0.0226** (2.47)	0.049	-0.0036 (-0.43)	-0.008	0.0222** (2.44)	0.065	-0.0037 (-0.45)	0.009
8	0.0171* (1.83)	0.023	0.0022 (0.26)	-0.009	0.0165* (1.80)	0.081	0.0021 (0.26)	0.050
9	0.0139 (1.47)	0.012	-0.0177** (-2.14)	0.035	0.0144 (1.53)	0.037	-0.0176** (-2.16)	0.060
10	0.0191** (2.02)	0.031	-0.0065 (-0.77)	-0.004	0.0202** (2.12)	0.039	-0.0064 (-0.75)	-0.002
11	0.0183* (1.85)	0.025	-0.0116 (-1.37)	0.009	0.0205** (2.02)	0.009	-0.0115 (-1.34)	-0.015
12	0.0176* (1.72)	0.020	-0.0248*** (-3.02)	0.079	0.0193* (1.82)	-0.006	-0.0248*** (-2.97)	0.050
13	0.0232** (2.24)	0.041	-0.0159* (-1.87)	0.026	0.0260** (2.39)	0.023	-0.0158* (-1.84)	-0.001
14	0.0128 (1.19)	0.004	-0.0237*** (-2.83)	0.070	0.0186 (1.65)	0.010	-0.0237*** (-2.82)	0.063
15	0.0125 (1.15)	0.003	-0.0145* (-1.67)	0.019	0.0158 (1.35)	-0.008	-0.0145 (-1.66)	0.002
16	0.0069 (0.62)	-0.007	-0.0290*** (-3.51)	0.111	0.0136 (1.14)	-0.006	-0.0292*** (-3.53)	0.106
17	0.0145 (1.31)	0.008	-0.0069 (-0.78)	-0.004	0.0217* (1.80)	0.012	-0.0070 (-0.79)	-0.018
18	0.0103 (0.92)	-0.002	-0.0084 (-0.96)	-0.001	0.0191 (1.58)	0.015	-0.0087 (-0.99)	-0.002

Superscripts \*\*\*, \*\* and \* indicates that the statistics are significantly different from zero at the 1%, 5% and 10% level of significance, respectively. In the parentheses we report the *t*-statistics

Column 2 and Column 4 of TABLE 4 provide the results that do not include macroeconomic variables. Column 6 and Column 8 provide the results that include macroeconomic variables mic, cpi, and iavr as controllers. To save space, the coefficients of these macroeconomic variables are not reported. The value following each coefficient estimate is the adjusted R-square obtained from the

corresponding regression. The results demonstrate that the first and second principal components have significant impacts on the SCI return and are systematic factors worthy of our research. Regardless of whether macroeconomic variables are controlled or not, the coefficients of the first principal component (pc1) in all regressions are positive, although the coefficients are no longer significant in the future 14-18 months. At a minimum, it suggests that the prediction of the first principal component on future returns is not wrong (negative). This is quite strong evidence that the first principal component is a rational sentiment index that can correctly predict market returns and guide investors toward profits. Regardless of whether macroeconomic variables are controlled or not, the significant positive predictability of the second principal component is only limited to the future 1-3 months with its coefficients and significance decreasing. After a non-significant period of five months (future 4-8 months), the predictability of the second principal component on future returns becomes negative, consistent with the second characteristics of irrational sentiment defined above. From the comparison of the two principal components, it can be revealed that the period in which the second principal component positively predicts future returns is shorter than that of the first, with its significance diminishing. If these two indexes were used as a guideline for making trading decisions, investors following the first principal component would react more quickly, again confirming that the first principal component reflects the rational sentiment of "smart money", while the second reflects the irrational sentiment of "dumb money".

A careful examination of the coefficient values and significance of 1-2 months ahead of the two indexes shows that, for the first month ahead, regardless of whether macroeconomic variables are controlled or not, the coefficient of the first principal component is only significant at the 10% level, while that of the second principal component is significant at the 1% level. For the second month ahead, the coefficient of the first principal component is significant at the 1% level, with a higher value. For the second principal component, the coefficient value is decreased, and is significant at the 5% level in the second month ahead and at the 10% level in the third month ahead. This suggests that, compared with the first principal component, the second principal component has a more significant price pressure effect on future returns. Since the first principal component predicts the market sooner than the second, the "smart money" has more market timing opportunities.

### Comparative analysis

According to the above results, with the representativeness of the composite sentiment indexes constructed, we use them as benchmark to compare and analyze the representativeness of the 15 widely used single sentiment proxies (including 4 proxies used to construct the composite indexes and 11 other widely used single sentiment proxies). The coefficient significance and the adjusted R-squares of the single proxies are examined. First, we analyze the relationship between the composite indexes and the 4 single sentiment proxies used for the construction of composite sentiment indexes. The results are shown in TABLE 5.

Turnover and the number of new investor accounts mainly reflect irrational sentiment. The adjusted R-square from the regression of turnover on irrational sentiment is 61.6%, suggesting that turnover can serve as a good proxy of irrational sentiment and contains less idiosyncratic noise. The closed-end fund discount and consumer confidence index mainly reflect rational sentiment, with adjusted R-square of 50.4% and 52.5%, respectively. A deeper closed-end fund discount is associated with higher rational sentiment, suggesting that the truly rational "smart money" correctly recognizes that there is a mean-reversion process of asset prices. Malkiel also recommended investing in closed-end funds with a deeper discount in his book *A Random Walk Down Wall Street*. Our results demonstrate that the closed-end fund discount is a typical proxy of rational sentiment. So, inevitably, there will be problems if we use it as a proxy of irrational sentiment. This may be the reason why closed-end fund discount as an irrational sentiment proxy is controversial. Although the number of new investor accounts reflects irrational sentiment, its adjusted R-square, 7.2%, is not high, suggesting that, in addition to irrational sentiment, the number of new investor accounts is subject to other non-sentiment factors. Because of the methodology we use to construct the composite indexes, the macroeconomic variables

are completely unrelated to rational and irrational sentiment. However, we do not involve risk-free interest rate (rf) in the process of excluding the impacts of fundamentals, so it won't have the same problems faced by other macroeconomic variables if we regress it on rational and irrational sentiment. TABLE 5 shows that the risk-free interest rate is completely unrelated to sentiment, suggesting once again that the rational and irrational sentiment indexes constructed in our study do not include information from current fundamentals. They are "pure" proxies of investor sentiment, even though rational sentiment can be explained by past fundamentals.

**TABLE 5: Comparative results of the proxies used to construct composite indexes and macroeconomic variables**

	pc1		pc2		adj. R-sq
turn	-1.1076	(-1.56)	5.5296***	(13.15)	0.013
cefd	7.8158***	(10.47)	-0.9657	(-0.96)	0.504
cci	2.7837***	(10.91)	0.1219	(0.35)	-0.001
open	0.0018	(0.80)	0.0062***	(3.04)	-0.004
mci	-0.0000	(-0.00)	0.0000	(0.00)	-0.009
cpi	0.0000	(0.00)	-0.0000	(-0.00)	-0.009
iavr	0.0000	(0.00)	0.0000	(0.00)	-0.009
rf	-0.0000	(-0.22)	-0.0000	(-0.76)	-0.009
					-0.004

Superscripts \*\*\*, \*\* and \* indicates that the statistics are significantly different from zero at the 1%, 5% and 10% level of significance, respectively. In the parentheses we report the *t*-statistics

Based on the availability of data, the remaining 11 single sentiment proxies include the Hao-dan index, IPO first-day returns (iport), IPO amount (iponm), insider trading (insidetrd), dividend premium (divprm), individual investor activity (indtrd), stock-oriented fund shareholding (stkshare), bond-oriented fund shareholding (bndshare), stock-oriented fund cash flows (stkflow), bond-oriented fund cash flows (bndflow), and the difference of cash flow between stock-oriented fund and bond-oriented fund (flowdiff). The results of our analysis are shown in TABLE 6.

As shown in TABLE 6, the Hao-dan index (hd) reflects both rational and irrational sentiment. The adjusted R-square for rational sentiment and irrational sentiment is 33.3% and 9.3%, respectively. So, the Hao-dan index mainly reflects rational sentiment. IPO first-day returns (iport) reflect irrational sentiment, with an adjusted R-square of 10.5%. Compared with IPO first-day returns, The IPO amount reflects both irrational and rational sentiment. Insider trading (insidetrd) reflects rational sentiment. Since the block trading discount is used to construct insider trading indexes, a deeper block trading discount is associated with lower rational sentiment and more pessimistic prediction of "smart money" on future returns.

Dividend premium (divprm) reflects rational sentiment. A higher price of high dividend-paying stocks is associated with lower rational sentiment, similar to the closed-end fund discount. This relationship suggests that "smart money" in the market fully realizes that there is a mean-reversion process of dividend payment. Individual investors' activity (indtrd) reflects irrational sentiment, with an adjusted R-square of 33.7%. More active trading of individual investors reflects stronger irrational sentiment, suggesting that the individual investor is "dumb money". Since open-end funds in the market are institutional investors, they should demonstrate more rational characteristics as predicted by some



theories. However, because of the impacts of the purchase and redemption of individual investors and regulations about asset allocation, the trading behavior of the funds will inevitably show some irrational characteristics. This is especially evident for stock-oriented fund shareholding (stkshare). The adjusted R-square of the reflected rational and irrational sentiment is 8.9% and 3.0%, respectively. The open-end funds show more irrational characteristics in asset allocation. While bond-oriented fund shareholding (bndshare) reflects only rational sentiment, its adjusted R-square is 17.7%. Regardless of the fund type, rational sentiment is lower when shareholding is high, suggesting that investment behaviors of open-end funds do not show any rational characteristics. Instead, they seem to be contrarian indicator of "smart money". When the shareholding of open-end funds reaches a high point, the upward trend of the market is often unsustainable.

**TABLE 6: Comparative results of the single proxies of sentiment that are not involved in the construction of the composite indexes**

	pc1		pc2		obs.	adj. R-sq
hd	7.2953***	(5.43)			58	0.333
			3.1558**	(2.61)	58	0.093
iport	8.7954	(1.49)			108	0.011
			19.5749***	(3.67)	108	0.105
iponm	-45.2066**	(-2.28)			108	0.038
			42.5512**	(2.26)	108	0.037
insidetrd	-0.0454***	(-3.63)			106	0.104
			-0.0156	(-1.24)	106	0.005
divprm	-0.0177***	(-2.79)			84	0.076
			0.0063	(1.01)	84	0.000
indtrd	-0.1246	(-1.22)			66	0.007
			0.4391***	(5.83)	66	0.337
stkshare	-1.1789***	(-2.27)			69	0.089
			0.7036*	(1.76)	69	0.030
bndshare	-1.0560***	(-3.95)			69	0.177
			0.0843	(0.31)	69	-0.013
stkflow	0.2945**	(2.52)			69	0.073
			0.3346***	(2.91)	69	0.099
bndflow	0.4144***	(3.73)			69	0.159
			0.0095	(0.08)	69	-0.014
flowdiff	0.2378**	(2.00)			69	0.042
			0.3443***	(3.00)	69	0.105

Superscripts \*\*\*, \*\* and \* indicates that the statistics are significantly different from zero at the 1%, 5% and 10% level of significance, respectively. In the parentheses we report the *t*-statistics

Compared with shareholding, fund cash flows more reflect the behavior of individual investors. TABLE 6 shows that for stock-oriented fund cash flows (stkflow), the adjusted R-square of rational and irrational sentiment is 7.3% and 9.9%, respectively. However, bond-oriented fund cash flows (bndflow) reflect only rational sentiment. Compared with irrational investors, rational investors are more willing to contribute to bond-oriented funds to avoid risk. The difference between stock-oriented fund cash flows and bond-oriented fund cash flows (flowdiff) more directly reflects the relative flow of individual investors' funds in between the two funds. TABLE 6 shows that the relative cash flows reflect irrational sentiment better.

The discussion in this section shows that there is no "pure" rational or irrational single investor sentiment proxies. All single proxies may be contaminated as a result of idiosyncratic noise or contain information about rational and irrational sentiment simultaneously.

## CONCLUSION

In this paper we doubt the use of PCA for constructing composite investor sentiment index, which has been widely used since Baker and Wurgler (2006). We propose prerequisites for the use of PCA, clarify the relationship between dimension reduction and information extraction. From the perspective of investors' pursuit for wealth maximization, we redefine rational and irrational sentiment and propose a new idea (through PCA or factor analysis) to distinguish them. In addition, we conduct a comprehensive comparison of the representativeness of available single sentiment proxies.

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