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## FINANCIAL ECONOMICS | RESEARCH ARTICLE

# Analysis of industry risk premium with MVS three dimensions vector factor model

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**Abstract:** It is very important to identify deviation mechanism of price volatility of an industry asset and the affecting factors, and it is important to give the reasonable explanation and measurement to the abnormality of price volatility of the industry asset. This paper adopts heterogeneous panel and exploratory factor analysis methods, measuring industry risk by industry risk premium index, and constructs an industry MVS three dimensions vector factor model to analyze the factors consistent and affecting extent to industry risk. Furthermore, this paper analyzes simultaneously the linkage effect and working mechanism of multi-industries risks and gives an empirical research to determinants mechanism affecting industry risk.

**Subjects:** Quantitative Finance; Statistics for Business, Finance & Economics; Investment & Securities

**Keywords:** industry risk; noise investor irrational sentiment; industry MVS model

### 1. Introduction

The reasonable allocation among the resources of different industries, and the realization of cooperative developments and structure optimization among different industries, are useful to deepen and promote the industrial structure and to make it more effective. After a period of operation of an industry asset, its value maybe occur some changes. In normal condition, price volatility of the industry asset should keep the same pace with this value volatility of industry asset. But the real fact is that price volatility of the industry asset often greatly deviates from this value volatility, and this

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### PUBLIC INTEREST STATEMENT

It is very important to identify deviation mechanism of price volatility of an industry asset and the affecting factors, and it is important to give the reasonable explanation and measurement to the abnormality of price volatility of the industry asset. This paper constructs an industry MVS three dimensions vector factor model to analyze above questions and gives an empirical research to determinants mechanism affecting industry risk. Investors can use industry MVS model to give empirical data analysis for industry risk. Investors can identify separately the affecting extent to every industry's risk for macroeconomic dimension, industry value dimension and noise investor irrational sentiment dimension, and give comparison and analysis among multi industries for further investment decision. An investor can select industries with suitable risk levels and risk affecting factors according to his/her own preferred investment principle.

will lead to many abnormalities in the operation of financial market, such as January effect and over reaction (Banz, 1981; Basu, 1977; De Bondt & Thaler, 1985; Froot & Dabora, 1999; Mehra & Prescott, 1985). It is very important to identify this deviation mechanism of price volatility of an industry asset and the affecting factors causing this deviation. And it is also very important to give the reasonable explanation and measurement to the abnormality of price volatility of the industry asset.

Industry risk expresses price volatility of an industry asset, that is, the asset price is sometime up or sometime down. The range and frequency of up or down usually change in different time. The reason leading to this up or down range and frequency of industry asset price includes many factors. The abnormal price volatility of the industry asset can be accurately measured and explained only if the consistent system and affecting extent of these factors have been disclosed.

Many factors can affect the levels and volatility ranges of industry risk, among which the market environments the enterprises surviving in and macroeconomic conditions affect significantly. Alves (2005) and Castrén and Kavonius (2009) analyze the relationship and dynamic character of industry risk and emphasize the cross-sectional dynamics among industries. They think macroeconomic variables significantly affect industry risk. Saldías (2013a) finds that macroeconomic variables are common factors to induce strong cross-section dependence. The macroeconomic variables affecting industry risk include many sides, some of which can promote or restrain growth to all industries, whereas others can only promote or restrain growth to an industry or some industries. For example, Francis, Hasan, and Hunter (2008) find that currency risk variable greatly affects the expected returns of all 36 US industries.

Industry value (also called industry fair value) can also affect levels and volatility ranges of industry risk, which is mainly measured by industry finance indexes. Industry profit gaining indexes reflect the ability of acquiring value growth in an industry. Industry debt repaying indexes reflect the ability of repaying debt with current asset. Industry operating indexes reflect the efficiency of managing and operating current asset in an industry. Hand and Green (2011) find that annual accruals, annual change in earnings, and annual asset growth variables have effects on general long-run return. Fodor, Krieger, Mauck, and Stevenson (2013) find that size and age variables are negatively related to the probability of extreme price movements.

The character of this paper is analyzing the factors consistent and affecting extent for many different industries risks from the industry angle. Besides above observed variables, there are other variables unobserved directly which also affect levels and variations of industry risk. Saldías (2013b) finds that unobserved factors have effects on industry risk.

About unobserved variables affecting industry risk, this paper indicates by means of data analysis that noise investor irrational sentiment variables are the unobserved variables, which are significantly correlative with industry risk and are the decisive factors affecting industry risk. Ignoring the important influence of noise investor irrational sentiment variables will lead to incomplete industry risk analysis. Chou, Ho, and Ko (2012) find that rational finance theory and behavioral finance theory must be considered together to explain industry returns.

Noise investor irrational sentiment is that because investors' personal knowledge, asset investment experience, risk preference, psychology change, and others are different, they have cognition deviations and heterogeneous beliefs to asset pricing. These irrational investors who have cognition deviations are called noise traders (investors), and Black (1986) first proposes concept of noise. These noise traders invest with rational traders together in capital market (Baker & Wurgler, 2006; De Long, Shleifer, Summers, & Waldmann, 1990; Shefrin & Statman, 1994). There are massive noise traders in the market, and their irrational investment behaviors make stock prices deviate rational intervals and create unusual market phenomenon that stock prices volatilize drastically and deviate from normal condition in capital market (Das, Markowitz, Scheid, & Statman, 2010; Dumas, Kurshev, & Uppal, 2009; Escobar, Ferrando, & Rubtsov, 2015; Illeditsch, 2011). Unlike macroeconomic

variables and industry value variables which can be directly observed, noise investor irrational sentiment variables belong to psychology variables which are difficult to be observed directly and can be measured only by indirect ways. The number of opening an account found by Shiller (2005) and trading volume found by Baker and Stein (2004) can be chosen as indirect representation variables of noise investor irrational sentiment.

This paper adopts heterogeneous panel and exploratory factor analysis methods, measuring industry risk by industry risk premium index, and constructs an industry MVS three dimensions vector factor model to analyze the factors consistent and affecting extent to industry risk. Furthermore, this paper analyzes simultaneously the linkage effect and working mechanism of multi-industries risks and gives an empirical research to determinants mechanism affecting industry risk to test MVS three dimensions vector factor model.

## 2. MVS three dimensions vector factor model

### 2.1. Definition of industry risk premium

Assume that there are  $M$  industries in market and No.  $i$  industry includes  $K_i$  kinds of enterprise stocks.  $T_\alpha$  is time variable. The stock price at  $t_{\alpha\eta}$  period is  $P_{it_{\alpha\eta}}^J$  for No.  $J$  enterprise stock in No.  $i$  industry, and the stock price at last period is  $P_{it_{\alpha(\eta-1)}}^J$ . Its weighted coefficient in the industry is  $\gamma_{it_{\alpha\eta}}^J$ . Industry risk premium is defined as industry stocks weighted return rate minus risk-free rate of return, and its mathematical equation is:

$$IRP_{it_{\alpha\eta}} = \sum_{J=1}^{K_i} \frac{P_{it_{\alpha\eta}}^J - P_{it_{\alpha(\eta-1)}}^J}{P_{it_{\alpha(\eta-1)}}^J} * \gamma_{it_{\alpha\eta}}^J - RF_{it_{\alpha\eta}} \quad (i = 1, 2, \dots, M; J = 1, 2, \dots, K_i; \eta = 1, 2, \dots, N; \quad (1)$$

$$t_{\alpha\eta} = T_\alpha / N; \alpha = 1, 2, \dots).$$

Industry risk premium in  $T_\alpha$  year (or other time period which is satisfied with the following assumptions) is defined as follows:

$$IRP_{iT_\alpha} = \overline{IRP_{it_{\alpha\eta}}} * N \quad (i = 1, 2, \dots, M; \eta = 1, 2, \dots, N; \alpha = 1, 2, \dots). \quad (2)$$

According to capital asset pricing model (CAPM), the return rate of an asset can be divided into risk-free rate of return (RF) and return rate produced by risk factors. This paper adopts industry risk premium (IRP) rejecting risk-free rate of return to analyze industry risk. The advantage is only considering return rate produced by risk factors, and in contrast to return rate computed by stock price, it can measure levels and volatility ranges of industry risk more accurately.

### 2.2. MVS three dimensions vector model

The factors affecting industry risk not only include observed macroeconomic variables and industry value variables, but also include unobserved noise investor irrational sentiment variables, that is, including macroeconomic dimension, industry value dimension, and noise investor irrational sentiment dimension simultaneously.

Order that  $X$  vector represents macroeconomic dimension variables,  $X = (X_1, X_2, \dots, X_{n1})^T$ ;  $Y$  vector represents industry value dimension variables,  $Y = (Y_1, Y_2, \dots, Y_{n2})^T$ ;  $Z$  vector represents noise investor irrational sentiment dimension variables,  $Z = (Z_1, Z_2, \dots, Z_{n3})^T$ ;  $\alpha$  represents constant vector;  $B, \Psi, \Theta$  represent coefficient vector;  $\varepsilon$  represents random error vector,  $\varepsilon \sim i.i.dN(0, \delta_T^2)$ . Measure industry risk by volatility of IRP and construct MVS three dimensions vector model ( $M$  represents macroeconomic dimension;  $V$  represents industry value dimension;  $S$  represents noise investor irrational sentiment dimension):

$$IRP_{T_\alpha} - IRP_{T_{\alpha-1}} = \alpha + B(X_{T_\alpha} - X_{T_{\alpha-1}}) + \Psi(Y_{T_\alpha} - Y_{T_{\alpha-1}}) + \Theta(Z_{T_\alpha} - Z_{T_{\alpha-1}}) + \varepsilon_{T_\alpha}$$

$$B = (\beta_1, \beta_2, \dots, \beta_{n1}), \Psi = (\Psi_1, \Psi_2, \dots, \Psi_{n2}), \Theta = (\Theta_1, \Theta_2, \dots, \Theta_{n3}). \quad (3)$$

That is

$$\Delta IRP_{T_\alpha} = \alpha + B\Delta X_{T_\alpha} + \Psi\Delta Y_{T_\alpha} + \Theta\Delta Z_{T_\alpha} + \varepsilon_{T_\alpha}. \quad (4)$$

M industries' risks can be represented as follows:

$$\Delta IRP_{iT_\alpha} = \alpha_i + \sum_{X_k=1}^{n1} \beta_{iX_k} \Delta X_{X_k iT_\alpha} + \sum_{Y_k=1}^{n2} \psi_{iY_k} \Delta Y_{Y_k iT_\alpha} + \sum_{Z_k=1}^{n3} \theta_{iZ_k} \Delta Z_{Z_k iT_\alpha} + \varepsilon_{iT_\alpha} \quad i = 1, 2, \dots, M. \quad (5)$$

### 2.3. Implicit factor analysis and MVS three dimensions vector factor model

Because MVS model includes vectors of three dimensions and every dimension vector includes some variables, MVS model will estimate massive variable parameters, which will make the model lose massive degrees of free. The total estimation number of variable parameters equals to product of individual number and variable number in the model. Accompanying with increasing of individual number or variable number, the estimation number of parameters will increase in geometric level, which will make parameters estimation of the model be difficult even unable to solve.

In the case that many individuals and variables lead to lose massive degrees of free and be difficult to solve the model, the variables need to be reduced in dimensions. Because previous variables information of MVS three dimensions should be separately kept as far as possible to give a further explanation, this paper adopts exploratory factor analysis method to extract common implicit factors from MVS three dimensions, which will solve the question of variable parameters estimation of MVS model. The idea of exploratory factor analysis is first proposed by Spearman (1904). Common factors are extracted separately from MVS three dimension, and  $v$  represents mean vector while  $f$  represents factor vector.  $\varepsilon$  is the random error vector,  $\varepsilon \sim i.i.dN(0, \delta^2)$ .  $\zeta$  is the coefficient vector.  $I$  is the unit matrix.

$$\begin{aligned} \Delta X_{T_\alpha} &= v_{XT_\alpha} + \zeta_{XT_\alpha} f_{XT_\alpha} + \varepsilon_{XT_\alpha}; \\ \Delta Y_{T_\alpha} &= v_{YT_\alpha} + \zeta_{YT_\alpha} f_{YT_\alpha} + \varepsilon_{YT_\alpha}; \\ \Delta Z_{T_\alpha} &= v_{ZT_\alpha} + \zeta_{ZT_\alpha} f_{ZT_\alpha} + \varepsilon_{ZT_\alpha}. \end{aligned} \quad (6)$$

Equation (6) extracts factor vector separately from MVS three dimensions. Equation (7) is mathematical expression for factor vectors.

$$f_{XT_\alpha} = (f_{X_1 T_\alpha}, f_{X_2 T_\alpha}, \dots, f_{X_{g1} T_\alpha})^T; f_{YT_\alpha} = (f_{Y_1 T_\alpha}, f_{Y_2 T_\alpha}, \dots, f_{Y_{g2} T_\alpha})^T; f_{ZT_\alpha} = (f_{Z_1 T_\alpha}, f_{Z_2 T_\alpha}, \dots, f_{Z_{g3} T_\alpha})^T \quad (g1 < n1; g2 < n2; g3 < n3). \quad (7)$$

Assume that:

$$E(f_{XT_\alpha}) = 0; V(f_{XT_\alpha}) = I; E(f_{YT_\alpha}) = 0. \quad (8)$$

$$V(f_{YT_\alpha}) = I; E(f_{ZT_\alpha}) = 0; V(f_{ZT_\alpha}) = I. \quad (9)$$

$$\text{Cov}(f_{XT_\alpha}, \varepsilon_{XT_\alpha}) = 0; \text{Cov}(f_{YT_\alpha}, \varepsilon_{YT_\alpha}) = 0; \text{Cov}(f_{ZT_\alpha}, \varepsilon_{ZT_\alpha}) = 0. \quad (10)$$

$$\text{Cov}(f_{XT_\alpha}, f_{YT_\alpha}) = 0; \text{Cov}(f_{XT_\alpha}, f_{ZT_\alpha}) = 0; \text{Cov}(f_{YT_\alpha}, f_{ZT_\alpha}) = 0. \quad (11)$$

(6) is substituted into (4), then

$$\Delta IRP_{T_a} = \alpha + B(v_{X_{T_a}} + \zeta_{X_{T_a}} f_{X_{T_a}} + \varepsilon_{X_{T_a}}) + \Psi(v_{Y_{T_a}} + \zeta_{Y_{T_a}} f_{Y_{T_a}} + \varepsilon_{Y_{T_a}}) + \Theta(v_{Z_{T_a}} + \zeta_{Z_{T_a}} f_{Z_{T_a}} + \varepsilon_{Z_{T_a}}) + \varepsilon_{T_a} \cdot \quad (12)$$

Order that:

$$\alpha^* = \alpha + Bv_{X_{T_a}} + \Psi v_{Y_{T_a}} + \Theta v_{Z_{T_a}}. \quad (13)$$

$$B^* = B\zeta_{X_{T_a}}; \Psi^* = \Psi\zeta_{Y_{T_a}}; \Theta^* = \Theta\zeta_{Z_{T_a}}. \quad (14)$$

$$\varepsilon_{T_a}^* = B\varepsilon_{X_{T_a}} + \Psi\varepsilon_{Y_{T_a}} + \Theta\varepsilon_{Z_{T_a}} + \varepsilon_{T_a}. \quad (15)$$

MVS model converts to MVS three dimensions vector factor model:

$$\begin{aligned} \Delta IRP_{T_a} &= \alpha^* + B^* f_{X_{T_a}} + \Psi^* f_{Y_{T_a}} + \Theta^* f_{Z_{T_a}} + \varepsilon_{T_a}^* \\ &= \alpha^* + \sum_{l=1}^{g1} \beta_l^* f_{X_l T_a} + \sum_{c=1}^{g2} \psi_c^* f_{Y_c T_a} + \sum_{d=1}^{g3} \theta_d^* f_{Z_d T_a} + \varepsilon_{T_a}^*. \end{aligned} \quad (16)$$

Only after above mathematics testimony, it is feasible to give empirical analysis for industry risk.

### 3. Data and variables choosing

To test MVS three dimensions vector factor model affecting industry risk, this paper gives an empirical research and selects A shares data of China's capital market from 2001 to 2015 to analyze. Because starting time of China's capital market is late, data analysis indicates that noise investor irrational sentiment variables are significantly correlative to industry risk and obviously express the decisive factors affecting industry risk. This paper adopts Wind second industries classification standard totally including 23 industries, whose character is comprehensive reference to authoritative international industries classification standard GICS (Global Industries Classification Standard). The data include 360 panel data, among which there are 24 individuals, including industry average and 15 years data. Besides dependent variable  $\Delta IRP$ , there are 16 independent variables. The data involve with 2,904 listed companies and use 24,600 original observations, and the source is from Wind information database.

The variables affecting  $\Delta IRP$  include macroeconomic dimension, industry value dimension, and noise investor irrational sentiment dimension variables. In each dimension, a few representative variables are chosen to measure  $\Delta IRP$ . Macroeconomic dimension includes five variables. Industry value dimension includes eight variables. Noise investor irrational sentiment dimension includes three variables. Data analysis results show that these variables are representative and can well explain and measure  $\Delta IRP$ .

After choosing variables, MVS three dimensions vector model converts to the following form:

$$\begin{aligned} \Delta IRP_{i T_a} &= \alpha_i + \beta_{i1} \Delta PCDIGR_{i T_a} + \beta_{i2} \Delta WMCI_{i T_a} + \beta_{i3} \Delta CPI_{i T_a} + \beta_{i4} \Delta M2GR_{i T_a} + \beta_{i5} \Delta CGPI_{i T_a} + \psi_{i1} \Delta ROE_{i T_a} \\ &\quad + \psi_{i2} \Delta NPM_{i T_a} + \psi_{i3} \Delta TEGR_{i T_a} + \psi_{i4} \Delta TATR_{i T_a} + \psi_{i5} \Delta RLA_{i T_a} + \psi_{i6} \Delta TAGR_{i T_a} \\ &\quad + \psi_{i7} \Delta ORGR_{i T_a} + \psi_{i8} \Delta TPGR_{i T_a} + \theta_{i1} \Delta TR_{i T_a} + \theta_{i2} \Delta IAGR_{i T_a} + \theta_{i3} \Delta TVGR_{i T_a} + \varepsilon_{i T_a} \\ &\quad (i = 1, 2, \dots, 24; \alpha = 1, 2, \dots, 15). \end{aligned} \quad (17)$$

$\Delta PCDIGR$  is per capita disposable income growth rate.  $\Delta WMCI$  is weighted macroeconomic climate index.  $\Delta CPI$  is consumer price index.  $\Delta M2GR$  is growth rate of M2 supply of money and quasi money.  $\Delta CGPI$  is weighted corporate goods price index.  $\Delta ROE$  is return of equity.  $\Delta NPM$  is net profit margin.  $\Delta TEGR$  is total expenses, including operating expenses, administrative expenses, and financial expenses divided by gross revenue.  $\Delta TATR$  is total assets turnover ratio.  $\Delta RLA$  is ratio of liabilities to assets.  $\Delta TAGR$  is total assets growth rate.  $\Delta ORGR$  is operating revenue growth rate.  $\Delta TPGR$  is total

profit growth rate.  $\Delta TR$  is turnover rate.  $\Delta IAGR$  is investor account growth rate.  $\Delta TVGR$  is trading volume growth rate.

In Equation (17), macroeconomic dimension includes front five independent variables, and noise investor irrational sentiment dimension includes last three independent variables, and industry value dimension includes middle eight independent variables.

### 3.1. Volatility of industry risk premium

Industry average  $\Delta IRP$  mean is  $-0.978\%$ , and the minimum is  $-192.02\%$ , whereas the maximum is  $166.4\%$ . Absolute value of variation coefficient of  $\Delta IRP$  is  $80.1341$ . RF is weighted three months deposit rate. The biggest volatility of industry risk is Retailing industry, and its  $\Delta IRP$  absolute value of variation coefficient is  $1,989.8453$ . The smallest volatility of industry risk is Energy industry, and its  $\Delta IRP$  absolute value of variation coefficient is  $19.2367$ . Ten industries' risk volatilities are higher than industry average level whereas other thirteen industries' risk volatilities are lower than industry average level. Five industries'  $\Delta IRP$  means are positive, which are Media, Banks, Consumer Durables & Apparel, Technology Hardware & Equipment, Household & Personal Products, and other industries'  $\Delta IRP$  means are negative. Affected by financial crisis in 2008, all industries'  $\Delta IRP$  appear significantly decreasing, all becoming negative from positive last year. The biggest decreasing industry of  $\Delta IRP$  is Diversified Financials, and the decreasing number is  $-275.85\%$ . The smallest decreasing industry of  $\Delta IRP$  is Software & Services, and the decreasing number is  $-148.23\%$  (see Table 1).

### 3.2. M dimension variables choosing

Just as the content mentioned in Introduction, macroeconomic variables generally include money supply, price index, income, etc. This paper chooses volatilities of the following variables in M dimension: Per capita disposable income growth rate ( $\Delta PCDIGR$ ), Weighted macroeconomic climate index ( $\Delta WMCI$ ), Consumer price index ( $\Delta CPI$ ), Growth rate of M2 supply of money and quasi money ( $\Delta M2GR$ ), Weighted corporate goods price index ( $\Delta CGPI$ ).  $\Delta PCDIGR$  mean is  $-0.0733\%$ , and absolute value of variation coefficient is  $39.8864$ .  $\Delta WMCI$  mean is  $-0.2253$ , and absolute value of variation coefficient is  $12.2658$ .  $\Delta CPI$  mean is  $0.0667$ , and absolute value of variation coefficient is  $40.6255$ .  $\Delta M2GR$  mean is  $0.072\%$ , and absolute value of variation coefficient is  $64.1453$ .  $\Delta CGPI$  mean is  $-0.3467$ , and absolute value of variation coefficient is  $16.9183$ . Affected by financial crisis in 2008,  $\Delta PCDIGR$  and  $\Delta WMCI$  become negative from positive last year (see Table 2).

### 3.3. V dimension variables choosing

Volatilities of the following variables are chosen in V dimension: Return of equity ( $\Delta ROE$ ), Net profit margin ( $\Delta NPM$ ), Total expenses including operating expenses, administrative expenses and financial expenses divided by gross revenue ( $\Delta TEGR$ ), Total assets turnover ratio ( $\Delta TATR$ ), Ratio of liabilities to assets ( $\Delta RLA$ ), Total assets growth rate ( $\Delta TAGR$ ), Operating revenue growth rate ( $\Delta ORGR$ ), Total profit growth rate ( $\Delta TPGR$ ).

Industry average  $\Delta ROE$  mean is  $0.2367\%$ , and the minimum is  $-3.66\%$ , whereas the maximum is  $5.92\%$ . Absolute value of variation coefficient of  $\Delta ROE$  is  $10.0706$ . The biggest  $\Delta ROE$  industry is Technology Hardware & Equipment whereas the smallest  $\Delta ROE$  industry is Household & Personal Products. Seventeen industries'  $\Delta ROE$  are higher than industry average level, whereas other six industries'  $\Delta ROE$  are lower than industry average level. Industry average  $\Delta NPM$  mean is  $0.0527\%$ , and the minimum is  $-7.13\%$ , whereas the maximum is  $3.55\%$ . Absolute value of variation coefficient of  $\Delta NPM$  is  $56.0747$ . The biggest  $\Delta NPM$  industry is Commercial and Special Services, whereas the smallest  $\Delta NPM$  industry is Health Care Equipment & Services. Five industries'  $\Delta NPM$  are higher than industry average level whereas other eighteen industries'  $\Delta ROE$  are lower than industry average level. Affected by financial crisis in 2008, except that the ability of profit gaining increases comparing with last year for Telecommunication Services and Health Care Equipment & Services industry, the ability of profit gaining decreases comparing with last year for other industries, among which the biggest decreasing industry is Semiconductors & Semiconductor Equipment whose  $\Delta ROE$  decreases  $-30.11\%$  and  $\Delta NPM$  decreases  $-23.63\%$ .

**Table 1. Volatility of industry risk premium**

| Industry and code  | Mean    | Absolute value of variation coefficient | Minimum   | Maximum  | Std. Deviation |
|--|---------|---|-----------|----------|----------------|
| Industry average <sup>1</sup>                                | -0.9780 | 80.1341                                 | -192.0200 | 166.4000 | 78.3712        |
| Energy <sup>2</sup>  | -5.1687 | 19.2367                                 | -244.5700 | 184.6900 | 99.4279        |
| Materials <sup>3</sup>                                       | -1.4213 | 66.0309                                 | -228.1000 | 197.9300 | 93.8519        |
| Capital goods <sup>4</sup>                                   | -0.7607 | 100.2171                                | -191.3700 | 146.0300 | 76.2318        |
| Commercial and special services <sup>5</sup>                 | -2.1267 | 35.1134                                 | -167.7100 | 120.8900 | 74.6745        |
| Transportation <sup>6</sup>                                  | -0.8287 | 93.7053                                 | -197.2200 | 158.3500 | 77.6504        |
| Automobiles & components <sup>7</sup>                        | -1.4527 | 73.2986                                 | -217.8900 | 249.3400 | 106.4785       |
| Consumer durables & apparel <sup>8</sup>                     | 0.8580  | 91.9109                                 | -181.0700 | 173.2300 | 78.8595        |
| Consumer services <sup>9</sup>                               | -0.9113 | 93.5004                                 | -198.5100 | 196.3900 | 85.2101        |
| Media <sup>10</sup>  | 1.1653  | 65.9854                                 | -166.9500 | 170.4700 | 76.8950        |
| Retailing <sup>11</sup>                                      | -0.0400 | 1989.8453                               | -196.2000 | 165.2600 | 79.5938        |
| Food & staples retailing <sup>12</sup>                       | -1.0333 | 66.0036                                 | -168.1600 | 136.6400 | 68.2037        |
| Food, beverage & tobacco <sup>13</sup>                       | -1.1793 | 60.0265                                 | -164.8000 | 156.0800 | 70.7913        |
| Household & personal products <sup>14</sup>                  | 0.4740  | 181.4536                                | -229.6800 | 166.5700 | 86.0090        |
| Health care equipment & services <sup>15</sup>               | -1.0727 | 78.3556                                 | -182.9000 | 190.2700 | 84.0495        |
| Pharmaceuticals, biotechnology & life sciences <sup>16</sup> | -1.9520 | 37.0697                                 | -173.1300 | 131.2300 | 72.3600        |
| Banks <sup>17</sup>  | 1.1160  | 57.2644                                 | -156.4100 | 117.7800 | 63.9070        |
| Diversified financials <sup>18</sup>                         | -3.9327 | 29.7237                                 | -275.8500 | 196.7700 | 116.8934       |
| Real estate <sup>19</sup>                                    | -0.5353 | 171.7842                                | -206.4800 | 194.6400 | 91.9618        |
| Software & services <sup>20</sup>                            | -0.1400 | 546.7267                                | -148.2300 | 157.6700 | 76.5417        |
| Technology hardware & equipment <sup>21</sup>                | 0.4900  | 159.1049                                | -169.9200 | 163.1800 | 77.9614        |
| Semiconductors & semiconductor equipment <sup>22</sup>       | -0.4880 | 183.2917                                | -178.6800 | 215.4200 | 89.4464        |
| Telecommunication services <sup>23</sup>                     | -1.4420 | 54.2562                                 | -178.5000 | 116.1700 | 78.2374        |
| Utilities <sup>24</sup>                                      | -2.0913 | 35.8951                                 | -194.1100 | 122.1700 | 75.0686        |

**Table 2. M dimension variables volatility**

| Variable        | Mean    | Absolute value of variation coefficient | Minimum  | Maximum | Std. Deviation |
|-----------------|---------|---|----------|---------|----------------|
| $\Delta$ PCDIGR | -0.0733 | 39.8864                                 | -5.6400  | 5.1600  | 2.9250         |
| $\Delta$ WMCI   | -0.2253 | 12.2658                                 | -4.4800  | 6.0500  | 2.7639         |
| $\Delta$ CPI    | 0.0667  | 40.6255                                 | -6.6000  | 4.0000  | 2.7084         |
| $\Delta$ M2GR   | 0.0720  | 64.1453                                 | -9.4700  | 10.6500 | 4.6185         |
| $\Delta$ CGPI   | -0.3467 | 16.9183                                 | -11.8900 | 11.5600 | 5.8650         |

Industry average  $\Delta\text{TGR}$  mean is  $-0.0993\%$ , and the minimum is  $-7.98\%$ , whereas the maximum is  $7.42\%$ . Absolute value of variation coefficient of  $\Delta\text{TGR}$  is  $32.9686$ . The biggest  $\Delta\text{TGR}$  industry is Commercial and Special Services, whereas the smallest  $\Delta\text{TGR}$  industry is Consumer Services. Two industries'  $\Delta\text{TGR}$  are higher than industry average level, whereas other twenty-one industries'  $\Delta\text{TGR}$  are lower than industry average level. Industry average  $\Delta\text{TATR}$  mean is  $0.0073$  times, and the minimum is  $-0.05$  times, whereas the maximum is  $0.07$  times. Absolute value of variation coefficient of  $\Delta\text{TATR}$  is  $6.1949$ . The biggest  $\Delta\text{TATR}$  industry is Real Estate, whereas the smallest  $\Delta\text{TATR}$  industry is Media. Eighteen industries'  $\Delta\text{TATR}$  are higher than industry average level, whereas other five industries'  $\Delta\text{TATR}$  are lower than industry average level.

Industry average  $\Delta\text{RLA}$  mean is  $0.2513\%$ , and the minimum is  $-5.69\%$ , whereas the maximum is  $9.15\%$ . Absolute value of variation coefficient of  $\Delta\text{RLA}$  is  $13.7941$ . The biggest  $\Delta\text{RLA}$  industry is Capital Goods, whereas the smallest  $\Delta\text{RLA}$  industry is Real Estate. Nine industries'  $\Delta\text{RLA}$  are higher than industry average level, whereas other fourteen industries'  $\Delta\text{RLA}$  are lower than industry average level. Industry average  $\Delta\text{TAGR}$  mean is  $-4.4073\%$ , and the minimum is  $-512.88\%$ , whereas the maximum is  $511.01\%$ . Absolute value of variation coefficient of  $\Delta\text{TAGR}$  is  $44.6629$ . The biggest  $\Delta\text{TAGR}$  industry is Telecommunication Services whereas the smallest  $\Delta\text{TAGR}$  industry is Energy. Six industries'  $\Delta\text{TAGR}$  are higher than industry average level, whereas other seventeen industries'  $\Delta\text{TAGR}$  are lower than industry average level.

Industry average  $\Delta\text{ORGR}$  mean is  $-7.8667\%$ , and the minimum is  $-603.77\%$ , whereas the maximum is  $614.25\%$ . Absolute value of variation coefficient of  $\Delta\text{ORGR}$  is  $30.1287$ . The biggest  $\Delta\text{ORGR}$  industry is Telecommunication Services, whereas the smallest  $\Delta\text{ORGR}$  industry is Food & Staples Retailing. Seven industries'  $\Delta\text{ORGR}$  are higher than industry average level, whereas other sixteen industries'  $\Delta\text{ORGR}$  are lower than industry average level. Industry average  $\Delta\text{TPGR}$  mean is  $-1.042\%$ , and the minimum is  $-529.79\%$ , whereas the maximum is  $593.4\%$ . Absolute value of variation coefficient of  $\Delta\text{TPGR}$  is  $248.8826$ . The biggest  $\Delta\text{TPGR}$  industry is Utilities, whereas the smallest  $\Delta\text{TPGR}$  industry is Health Care Equipment & Services. Four industries'  $\Delta\text{TPGR}$  are higher than industry average level, whereas other nineteen industries'  $\Delta\text{TPGR}$  are lower than industry average level (see Table 3).

### 3.4. S dimension variables choosing

Volatilities of the following variables are chosen in S dimension: Turnover rate ( $\Delta\text{TR}$ ), Investor account growth rate ( $\Delta\text{IAGR}$ ), Trading volume growth rate ( $\Delta\text{TVGR}$ ). Industry average  $\Delta\text{TR}$  mean is  $0.0613\%$ , and the minimum is  $-1.16\%$ , whereas the maximum is  $1.38\%$ . Absolute value of variation coefficient of  $\Delta\text{TR}$  is  $13.644$ . The biggest  $\Delta\text{TR}$  industry is Utilities whose absolute value of variation coefficient of  $\Delta\text{TR}$  is  $1893.4192$ . The smallest  $\Delta\text{TR}$  industry is Software & Services whose absolute value of variation coefficient of  $\Delta\text{TR}$  is  $4.8201$ . Fourteen industries'  $\Delta\text{TR}$  are higher than industry average level, whereas other nine industries'  $\Delta\text{TR}$  are lower than industry average level. Except that  $\Delta\text{TR}$  means are negative for Telecommunication Services, Energy, Transportation and Utilities industry,  $\Delta\text{TR}$  means of other nineteen industries are positive, which indicate that most industries totally exist common heterogeneous beliefs.

Industry average  $\Delta\text{IAGR}$  mean is  $0.924\%$ , and the minimum is  $-114.5\%$ , whereas the maximum is  $92.92\%$ . Absolute value of variation coefficient of  $\Delta\text{IAGR}$  is  $51.9466$ . The biggest  $\Delta\text{IAGR}$  industry is Telecommunication Services whose absolute value of variation coefficient of  $\Delta\text{IAGR}$  is  $282.3683$ . The smallest  $\Delta\text{IAGR}$  industry is Semiconductors & Semiconductor Equipment whose absolute value of variation coefficient of  $\Delta\text{IAGR}$  is  $5.0568$ . Five industries'  $\Delta\text{IAGR}$  are higher than industry average level, whereas other eighteen industries'  $\Delta\text{IAGR}$  are lower than industry average level. All industries'  $\Delta\text{IAGR}$  are positive in 2007, and because of influence of financial crisis in 2008, investors are generally pessimistic to future market expectation. Except that  $\Delta\text{IAGR}$  is still positive for Health Care Equipment & Services industry,  $\Delta\text{IAGR}$  of all the other industries greatly decrease becoming negative, among which the biggest decreasing industry is Energy, whose  $\Delta\text{IAGR}$  becomes  $-225.02\%$  from  $234.92\%$  last year, whereas the smallest decreasing industry is Diversified Financials whose  $\Delta\text{IAGR}$  becomes  $-2.31\%$  from  $90.98\%$  last year.



**Table 3. V Dimension Variables Volatility ( $\Delta ROE$  &  $\Delta NPM$ )**

| Industry                                       | $\Delta ROE$ |   |          |         |                | $\Delta NPM$ |   |           |         |                |
|--|--------------|---|----------|---------|----------------|--------------|---|-----------|---------|----------------|
|  | Mean         | Absolute value of variation coefficient | Minimum  | Maximum | Std. Deviation | Mean         | Absolute value of variation coefficient | Minimum   | Maximum | Std. Deviation |
| Industry average                               | 0.2367       | 10.0706                                 | -3.6600  | 5.9200  | 2.3834         | 0.0527       | 56.0747                                 | -7.1300   | 3.5500  | 2.9533         |
| Energy   | -0.1787      | 17.5118                                 | -4.3300  | 5.6100  | 3.1288         | -0.1420      | 14.2917                                 | -2.8600   | 6.0700  | 2.0294         |
| Materials                                      | -0.1307      | 29.9102                                 | -8.7900  | 5.0000  | 3.9083         | -0.2360      | 8.7238                                  | -4.2800   | 2.3200  | 2.0588         |
| Capital goods                                  | 0.1393       | 13.3939                                 | -3.2000  | 2.8400  | 1.8662         | 0.0593       | 14.7727                                 | -1.6600   | 1.4500  | 0.8765         |
| Commercial and special services                | 0.0407       | 588.4544                                | -32.5500 | 52.8100 | 23.9305        | -0.0013      | 27.335.0719                             | -112.7500 | 56.2200 | 36.4468        |
| Transportation                                 | 0.1200       | 40.5973                                 | -11.2900 | 9.1300  | 4.8717         | -0.0487      | 115.8236                                | -10.4400  | 10.6000 | 5.6367         |
| Automobiles & components                       | 0.5373       | 10.7517                                 | -7.0000  | 14.4200 | 5.7773         | 0.2967       | 9.1510                                  | -3.3400   | 7.0000  | 2.7148         |
| Consumer durables & apparel                    | 0.2867       | 15.0150                                 | -10.0300 | 6.4400  | 4.3043         | 0.2067       | 13.4159                                 | -7.6400   | 4.6500  | 2.7726         |
| Consumer services                              | 0.4220       | 4.9308                                  | -3.1700  | 6.2800  | 2.0808         | -0.0640      | 49.2533                                 | -4.8500   | 7.4800  | 3.1522         |
| Media  | -0.1347      | 23.7686                                 | -8.1700  | 5.7800  | 3.2008         | -0.9060      | 8.2816                                  | -18.0800  | 9.2700  | 7.5032         |
| Retailing                                      | 0.4480       | 7.3738                                  | -3.6500  | 6.6700  | 3.3034         | 0.1327       | 9.5749                                  | -1.4800   | 3.3400  | 1.2703         |
| Food & staples retailing                       | 0.1607       | 19.8908                                 | -6.0400  | 8.3200  | 3.1958         | -0.0033      | 211.3051                                | -1.2100   | 1.3500  | 0.7044         |
| Food, beverage & tobacco                       | 0.1453       | 19.7157                                 | -4.0600  | 4.7900  | 2.8653         | 0.0360       | 63.6657                                 | -4.9700   | 3.4700  | 2.2920         |
| Household & personal products                  | 2.2493       | 3.4210                                  | -9.5300  | 24.2800 | 7.6950         | 1.6173       | 4.0249                                  | -8.6200   | 18.9500 | 6.5096         |
| Health care equipment & services               | 0.0067       | 345.9786                                | -5.1600  | 3.8900  | 2.3065         | 0.7300       | 3.6351                                  | -2.1000   | 6.8000  | 2.6536         |
| Pharmaceuticals, biotechnology & life sciences | 0.2713       | 8.7946                                  | -3.1200  | 5.8100  | 2.3863         | 0.1907       | 10.8986                                 | -3.3600   | 4.5900  | 2.0780         |
| Banks  | 0.2080       | 9.3135                                  | -3.5000  | 2.9600  | 1.9372         | -0.3147      | 17.6997                                 | -15.0300  | 11.0200 | 5.5695         |
| Diversified financials                         | 0.6687       | 11.5855                                 | -12.6500 | 13.7200 | 7.7469         | 1.1740       | 23.9784                                 | -61.3700  | 73.8800 | 28.1506        |
| Real estate                                    | 0.3280       | 6.8060                                  | -4.1300  | 4.4900  | 2.2324         | -0.0147      | 176.7918                                | -6.0500   | 4.7700  | 2.5929         |
| Software & services                            | 0.4487       | 18.0422                                 | -15.9700 | 16.4200 | 8.0950         | 0.2320       | 26.8999                                 | -10.5700  | 10.5400 | 6.2408         |
| Technology hardware & equipment                | -0.0053      | 920.2894                                | -10.3500 | 9.4900  | 4.9082         | 0.2247       | 13.9765                                 | -5.4100   | 5.5700  | 3.1401         |
| Semiconductors & semiconductor equipment       | -0.1600      | 77.6691                                 | -30.1100 | 18.4100 | 12.4271        | -0.3040      | 34.0485                                 | -23.6300  | 15.3200 | 10.3507        |
| Telecommunication services                     | -0.0467      | 165.5913                                | -22.3400 | 16.7400 | 7.7276         | -0.7867      | 7.5098                                  | -15.8500  | 12.5600 | 5.9077         |
| Utilities                                      | -0.3960      | 10.6103                                 | -10.7700 | 8.3800  | 4.2017         | -0.8927      | 5.7769                                  | -14.2300  | 9.0100  | 5.1569         |

Industry average  $\Delta TVGR$  mean is 4.812%, and the minimum is -149.15%, whereas the maximum is 142.3%. Absolute value of variation coefficient of  $\Delta TVGR$  is 19.2198. The biggest  $\Delta TVGR$  industry is Health Care Equipment & Services whose absolute value of variation coefficient of  $\Delta TVGR$  is 383.7074. The smallest  $\Delta TVGR$  industry is Software & Services whose absolute value of variation coefficient of  $\Delta TVGR$  is 11.9629. Fifteen industries'  $\Delta TVGR$  are higher than industry average level, whereas other eight industries'  $\Delta TVGR$  are lower than industry average level (see Table 4).

#### 4. MVS three dimensions implicit factor analysis

In this paper, MVS model includes 24 individuals and 16 independent variables and is unable to directly estimate variable parameters. According to selected variables of MVS three dimensions, common factors are extracted separately from MVS three dimensions.

##### 4.1. M Dimension Common Factors Extracted from Variables

M dimension includes five variables: Per capita disposable income growth rate ( $\Delta PCDIGR$ ), Weighted macro-economic climate index ( $\Delta WMCII$ ), Consumer price index ( $\Delta CPI$ ), Growth rate of M2 supply of money and quasi money ( $\Delta M2GR$ ), Weighted corporate goods price index ( $\Delta CGPI$ ). Bartlett's Test of Sphericity indicates that five variables are strongly correlative and Table 5 is correlation matrix.

One common factor whose eigenvalue is greater than one is extracted from correlation matrix, which explains 73.6% of variance information. Conclusion can be made from loads matrix that this common factor and variables are strongly correlative, and this common factor can be explained as macroeconomic climate factor  $f_{X_1}$  (see Table 6).

##### 4.2. V dimension common factors extracted from variables

V dimension includes eight variables: Return of equity ( $\Delta ROE$ ), Net profit margin ( $\Delta NPM$ ), Total expenses including operating expenses, administrative expenses, and financial expenses divided by gross revenue ( $\Delta TEGR$ ), Total assets turnover ratio ( $\Delta TATR$ ), Ratio of liabilities to assets ( $\Delta RLA$ ), Total assets growth rate ( $\Delta TAGR$ ), Operating revenue growth rate ( $\Delta ORGR$ ), Total profit growth rate ( $\Delta TPGR$ ).

Bartlett's Test of Sphericity indicates that eight variables are strongly correlative. Three common factors whose eigenvalues are greater than one are extracted from correlation matrix, which explain 74.45% of variance information. Table 7 is loads matrix between three common factors and variables. The first common factor can be explained as industry scale increasing factor  $f_{Y_1}$ . The second common factor can be explained as industry cost debt factor  $f_{Y_2}$ . The third common factor can be explained as industry profit gaining and fluidity factor  $f_{Y_3}$ .

##### 4.3. S Dimension Common Factors Extracted from Variables

S dimension is noise investor irrational sentiment dimension, including three variables: Turnover rate ( $\Delta TR$ ), Investor account growth rate ( $\Delta IAGR$ ), and Trading volume growth rate ( $\Delta TVGR$ ).

Bartlett's Test of Sphericity indicates that three variables are strongly correlative. Two common factors which can't be observed directly and whose eigenvalues are greater than one are extracted from correlation matrix, which explain 96.55% of variance information of noise investor irrational sentiment. Table 8 is loads matrix between two common factors and variables. The first common factor can be explained as expectation confidence factor  $f_{Z_1}$ . The second common factor can be explained as heterogeneous beliefs factor  $f_{Z_2}$ .

All the absolute values of Spearman correlation coefficients for MVS three dimensions factors are no more than 0.36.

#### 5. Heterogeneous panel data analysis of MVS three dimensions vector factor model

According to MVS three dimensions vector factor model after extracting common factors, estimation is made to variable parameters of this heterogeneous panel. The advantages of using

**Table 4. S Dimension Variables Volatility ( $\Delta TR$  &  $\Delta IAGR$ )**

| Industry                                       | Mean    |   |         | $\Delta TR$ |                |         | Absolute value of variation coefficient |             |            | Std. Deviation |         |   | $\Delta IAGR$ |            |                | Maximum |   |             | Std. Deviation |                |  |
|--|---------|---|---------|-------------|----------------|---------|---|-------------|------------|----------------|---------|---|---------------|------------|----------------|---------|---|-------------|----------------|----------------|--|
|  | Mean    | Absolute value of variation coefficient | Minimum | Maximum     | Std. Deviation | Mean    | Absolute value of variation coefficient | Minimum     | Maximum    | Std. Deviation | Mean    | Absolute value of variation coefficient | Minimum       | Maximum    | Std. Deviation | Mean    | Absolute value of variation coefficient | Minimum     | Maximum        | Std. Deviation |  |
| Industry average                               | 0.0613  | 13.6440                                 | -1.1600 | 1.3800      | 0.8368         | 0.9240  | 51.9466                                 | -114.5000   | 92.9200    | 47.9986        | 0.9240  | 51.9466                                 | -114.5000     | 92.9200    | 47.9986        | 0.9240  | 51.9466                                 | -114.5000   | 92.9200        | 47.9986        |  |
| Energy   | -0.0360 | 26.0159                                 | -1.8900 | 1.6400      | 0.9366         | -1.9253 | 46.0982                                 | -225.0200   | 234.9200   | 88.7544        | -1.9253 | 46.0982                                 | -225.0200     | 234.9200   | 88.7544        | -1.9253 | 46.0982                                 | -225.0200   | 234.9200       | 88.7544        |  |
| Materials                                      | 0.0373  | 23.8383                                 | -1.1100 | 1.9700      | 0.8900         | -0.5560 | 64.8933                                 | -72.7100    | 101.0300   | 36.0807        | -0.5560 | 64.8933                                 | -72.7100      | 101.0300   | 36.0807        | -0.5560 | 64.8933                                 | -72.7100    | 101.0300       | 36.0807        |  |
| Capital goods                                  | 0.0053  | 207.0749                                | -1.4700 | 2.2200      | 1.1044         | 1.4880  | 22.6463                                 | -75.4100    | 70.8400    | 33.6978        | 1.4880  | 22.6463                                 | -75.4100      | 70.8400    | 33.6978        | 1.4880  | 22.6463                                 | -75.4100    | 70.8400        | 33.6978        |  |
| Commercial and special services                | 0.1233  | 10.7281                                 | -2.6000 | 2.9200      | 1.3231         | 2.8700  | 11.1078                                 | -43.4200    | 58.1900    | 31.8794        | 2.8700  | 11.1078                                 | -43.4200      | 58.1900    | 31.8794        | 2.8700  | 11.1078                                 | -43.4200    | 58.1900        | 31.8794        |  |
| Transportation                                 | -0.0293 | 46.1156                                 | -2.9000 | 3.3400      | 1.3527         | -0.3860 | 74.8223                                 | -69.4800    | 66.4500    | 28.8814        | -0.3860 | 74.8223                                 | -69.4800      | 66.4500    | 28.8814        | -0.3860 | 74.8223                                 | -69.4800    | 66.4500        | 28.8814        |  |
| Automobiles & components                       | 0.0620  | 9.8278                                  | -1.1900 | 1.0600      | 0.6093         | 2.1440  | 11.3141                                 | -34.4200    | 51.4300    | 24.2574        | 2.1440  | 11.3141                                 | -34.4200      | 51.4300    | 24.2574        | 2.1440  | 11.3141                                 | -34.4200    | 51.4300        | 24.2574        |  |
| Consumer durables & apparel                    | 0.1187  | 10.5496                                 | -1.9400 | 2.5300      | 1.2519         | 2.0527  | 12.1354                                 | -34.9400    | 57.6500    | 24.9099        | 2.0527  | 12.1354                                 | -34.9400      | 57.6500    | 24.9099        | 2.0527  | 12.1354                                 | -34.9400    | 57.6500        | 24.9099        |  |
| Consumer services                              | 0.0253  | 51.5132                                 | -2.3200 | 3.1800      | 1.3050         | 1.0287  | 27.7805                                 | -52.9200    | 82.7000    | 28.5769        | 1.0287  | 27.7805                                 | -52.9200      | 82.7000    | 28.5769        | 1.0287  | 27.7805                                 | -52.9200    | 82.7000        | 28.5769        |  |
| Media  | 0.0753  | 8.1280                                  | -1.5000 | 0.9400      | 0.6123         | -3.1087 | 12.9689                                 | -73.8100    | 101.1100   | 40.3161        | -3.1087 | 12.9689                                 | -73.8100      | 101.1100   | 40.3161        | -3.1087 | 12.9689                                 | -73.8100    | 101.1100       | 40.3161        |  |
| Retailing                                      | 0.0893  | 9.4257                                  | -1.4100 | 1.6500      | 0.8420         | 2.3707  | 12.0964                                 | -33.1500    | 79.5000    | 28.6766        | 2.3707  | 12.0964                                 | -33.1500      | 79.5000    | 28.6766        | 2.3707  | 12.0964                                 | -33.1500    | 79.5000        | 28.6766        |  |
| Food & staples retailing                       | 0.0680  | 14.6315                                 | -1.2400 | 2.5200      | 0.9949         | 0.1900  | 141.4345                                | -42.4500    | 66.4600    | 26.8726        | 0.1900  | 141.4345                                | -42.4500      | 66.4600    | 26.8726        | 0.1900  | 141.4345                                | -42.4500    | 66.4600        | 26.8726        |  |
| Food, beverage & tobacco                       | 0.0593  | 16.4437                                 | -1.2400 | 2.7500      | 0.9757         | -0.8573 | 27.4705                                 | -41.7300    | 60.9200    | 23.5514        | -0.8573 | 27.4705                                 | -41.7300      | 60.9200    | 23.5514        | -0.8573 | 27.4705                                 | -41.7300    | 60.9200        | 23.5514        |  |
| Household & personal products                  | 0.1033  | 11.4536                                 | -1.6400 | 3.2100      | 1.1835         | 2.7860  | 10.1644                                 | -32.8700    | 75.7100    | 28.3181        | 2.7860  | 10.1644                                 | -32.8700      | 75.7100    | 28.3181        | 2.7860  | 10.1644                                 | -32.8700    | 75.7100        | 28.3181        |  |
| Health care equipment & services               | 0.0740  | 15.1940                                 | -1.5800 | 1.9700      | 1.1244         | -2.3133 | 17.1028                                 | -81.5200    | 78.1800    | 39.5645        | -2.3133 | 17.1028                                 | -81.5200      | 78.1800    | 39.5645        | -2.3133 | 17.1028                                 | -81.5200    | 78.1800        | 39.5645        |  |
| Pharmaceuticals, biotechnology & life sciences | 0.0573  | 16.3116                                 | -1.2700 | 2.5900      | 0.9352         | 0.4060  | 64.8615                                 | -55.6300    | 68.7500    | 26.3338        | 0.4060  | 64.8615                                 | -55.6300      | 68.7500    | 26.3338        | 0.4060  | 64.8615                                 | -55.6300    | 68.7500        | 26.3338        |  |
| Banks  | 0.0067  | 214.1893                                | -2.2400 | 3.1600      | 1.4279         | -3.4453 | 20.9832                                 | -199.2200   | 132.0300   | 72.2941        | -3.4453 | 20.9832                                 | -199.2200     | 132.0300   | 72.2941        | -3.4453 | 20.9832                                 | -199.2200   | 132.0300       | 72.2941        |  |
| Diversified financials                         | 0.0360  | 78.7927                                 | -5.4700 | 5.2700      | 2.8365         | -1.1827 | 31.4023                                 | -45.9000    | 90.9800    | 37.1384        | -1.1827 | 31.4023                                 | -45.9000      | 90.9800    | 37.1384        | -1.1827 | 31.4023                                 | -45.9000    | 90.9800        | 37.1384        |  |
| Real estate                                    | 0.0653  | 19.9812                                 | -1.7300 | 2.5500      | 1.3054         | 1.8607  | 12.5034                                 | -29.8800    | 57.4100    | 23.2647        | 1.8607  | 12.5034                                 | -29.8800      | 57.4100    | 23.2647        | 1.8607  | 12.5034                                 | -29.8800    | 57.4100        | 23.2647        |  |
| Software & services                            | 0.2120  | 4.8201                                  | -1.3400 | 2.6700      | 1.0219         | 5.9907  | 5.6040                                  | -42.4800    | 101.7000   | 33.5715        | 5.9907  | 5.6040                                  | -42.4800      | 101.7000   | 33.5715        | 5.9907  | 5.6040                                  | -42.4800    | 101.7000       | 33.5715        |  |
| Technology hardware & equipment                | 0.1140  | 6.5314                                  | -1.0700 | 1.2800      | 0.7446         | 0.7427  | 32.1823                                 | -32.2300    | 58.7600    | 23.9007        | 0.7427  | 32.1823                                 | -32.2300      | 58.7600    | 23.9007        | 0.7427  | 32.1823                                 | -32.2300    | 58.7600        | 23.9007        |  |
| Semiconductors & semiconductor equipment       | 0.2007  | 8.7760                                  | -3.1900 | 3.5200      | 1.7611         | 5.2367  | 5.0568                                  | -25.6700    | 59.4500    | 26.4808        | 5.2367  | 5.0568                                  | -25.6700      | 59.4500    | 26.4808        | 5.2367  | 5.0568                                  | -25.6700    | 59.4500        | 26.4808        |  |
| Telecommunication services                     | -0.0573 | 41.4467                                 | -4.7700 | 6.3100      | 2.3763         | 3.5720  | 282.3683                                | -2,679.9300 | 2,650.8900 | 1,008.6197     | 3.5720  | 282.3683                                | -2,679.9300   | 2,650.8900 | 1,008.6197     | 3.5720  | 282.3683                                | -2,679.9300 | 2,650.8900     | 1,008.6197     |  |
| Utilities                                      | -0.0007 | 1893.4192                               | -2.2200 | 2.5600      | 1.2623         | 2.2807  | 13.7556                                 | -64.2800    | 73.4900    | 31.3719        | 2.2807  | 13.7556                                 | -64.2800      | 73.4900    | 31.3719        | 2.2807  | 13.7556                                 | -64.2800    | 73.4900        | 31.3719        |  |

**Table 5. Correlation matrix of M dimension variables**

| Correlation matrix |                 |                 |               |              |               |               |
|--------------------|-----------------|-----------------|---------------|--------------|---------------|---------------|
| Variable           |                 | $\Delta$ PCDIGR | $\Delta$ WMCI | $\Delta$ CPI | $\Delta$ M2GR | $\Delta$ CGPI |
| Correlation        | $\Delta$ PCDIGR | 1.000           | 0.550         | 0.609        | -0.464        | 0.533         |
|                    | $\Delta$ WMCI   | 0.550           | 1.000         | 0.769        | -0.586        | 0.908         |
|                    | $\Delta$ CPI    | 0.609           | 0.769         | 1.000        | -0.619        | 0.936         |
|                    | $\Delta$ M2GR   | -0.464          | -0.586        | -0.619       | 1.000         | -0.630        |
|                    | $\Delta$ CGPI   | 0.533           | 0.908         | 0.936        | -0.630        | 1.000         |

**Table 6. Component matrix of M dimension variables**

| Component matrix |           |
|------------------|-----------|
| Variable         | Component |
|                  | 1         |
| $\Delta$ PCDIGR  | 0.717     |
| $\Delta$ WMCI    | 0.903     |
| $\Delta$ CPI     | 0.930     |
| $\Delta$ M2GR    | -0.760    |
| $\Delta$ CGPI    | 0.952     |

**Table 7. Component matrix of V dimension variables**

| Component matrix |           |        |        |
|------------------|-----------|--------|--------|
| Variable         | Component |        |        |
|                  | 1         | 2      | 3      |
| $\Delta$ ROE     | 0.060     | 0.183  | 0.729  |
| $\Delta$ NPM     | 0.060     | -0.841 | 0.033  |
| $\Delta$ TEGR    | -0.113    | 0.706  | -0.330 |
| $\Delta$ TATR    | 0.031     | -0.145 | 0.707  |
| $\Delta$ RLA     | 0.210     | 0.719  | 0.322  |
| $\Delta$ TAGR    | 0.984     | 0.034  | -0.084 |
| $\Delta$ ORGR    | 0.986     | 0.024  | -0.066 |
| $\Delta$ TPGR    | 0.952     | -0.089 | -0.026 |

**Table 8. Component matrix of S dimension variables**

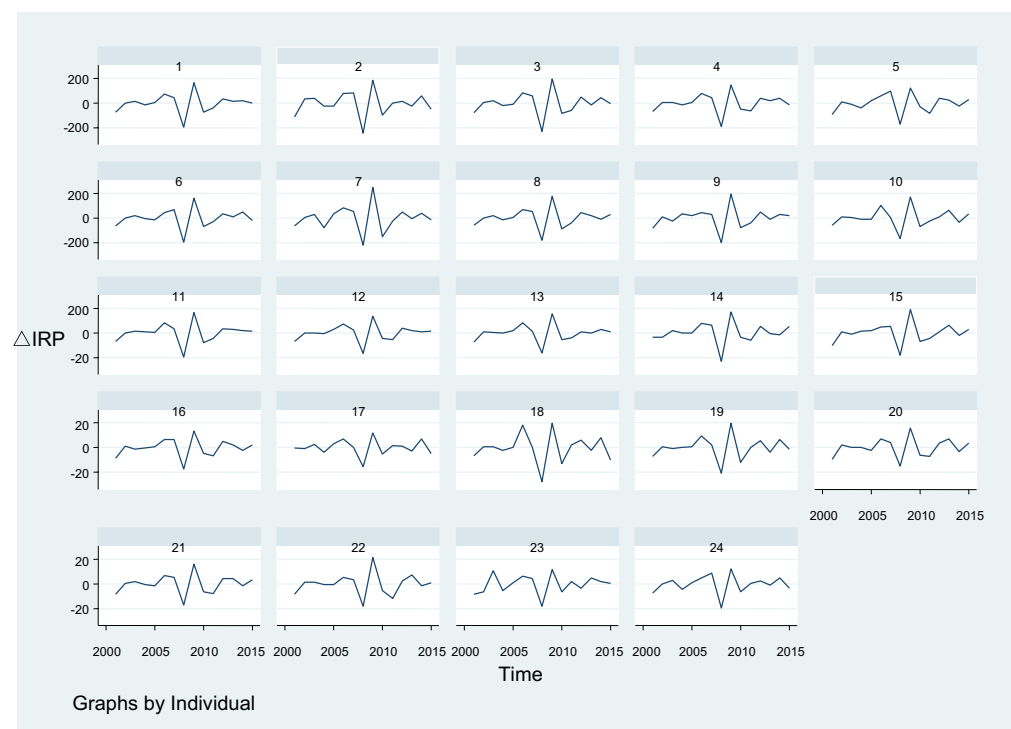
| Component matrix |           |       |
|------------------|-----------|-------|
| Variable         | Component |       |
|                  | 1         | 2     |
| $\Delta$ TR      | 0.15      | 0.99  |
| $\Delta$ IAGR    | 0.96      | -0.19 |
| $\Delta$ TVGR    | 0.97      | 0.04  |

heterogeneous panel analysis are considering simultaneously linkage of cross-sectional data and time data and solving the question of omitted variables. Because different industries'  $\Delta$ IRP are different, this kind of difference can be found through heterogeneous panel analysis. Figure 1 is time tendency figure of different industries'  $\Delta$ IRP.  $\Delta$ IRP means of most industries volatilize in [-200, 200]

interval around zero, which indicate that most industries'  $\Delta IRP$  keep generally stable tendency from 2001 to 2015. Affected by financial crisis in 2008, all industries'  $\Delta IRP$  express significantly decreasing, among which the biggest decreasing industry is No.18 Diversified Financials. Because China's government adopts economy stimulating plan in the later, these industries'  $\Delta IRP$  express rapidly increasing.

Random-coefficients regression of MVS three dimensions vector factor model indicates that P value of the model approximately equals to zero and total regression model is statistically significant. Test of parameter constancy indicates that P value approximately equals to zero and the model is varying coefficients panel model. Changes of MVS three dimensions variable factor lead to the difference of every industry's  $\Delta IRP$  and different sensitivity of every industry risk to MVS three dimensions variable factor. Total regression model indicates that  $\Delta IRP$  is significantly correlative to macroeconomic climate factor  $f_{X_1}$  and expectation confidence factor  $f_{Z_1}$  of noise investor irrational sentiment and that macroeconomic condition and noise investor irrational sentiment have intense influences on industry risk. Total regression model also indicates that  $\Delta IRP$  isn't significantly correlative to industry scale increasing factor  $f_{Y_1}$ , cost debt factor  $f_{Y_2}$  and profit gaining and fluidity factor  $f_{Y_3}$  and that industry value has a weak influence on industry risk. But for some industries, such as Software & Services, Diversified Financials, Banks and Retailing,  $\Delta IRP$  is significantly correlative to industry scale increasing factor  $f_{Y_1}$ , cost debt factor  $f_{Y_2}$  or profit gaining and fluidity factor  $f_{Y_3}$ , which indicates that these industries values have intense influences on industry risk. Furthermore,  $\Delta IRP$  isn't significantly correlative to heterogeneous beliefs factor  $f_{Z_2}$ . But for some industries such as Transportation, Commercial and Special Services and Banks,  $\Delta IRP$  is significantly correlative to heterogeneous beliefs factor  $f_{Z_2}$ , which indicates that the influence of this factor to industry risk is weak (see Table 9).

**Figure 1. Time tendency figure of different industries'  $\Delta IRP$ .**



**Table 9. Random-coefficients regression of MVS three dimensions vector factor model**

| Random-coefficients regression |           |           |          |         | Number of obs = 360       |           |
|--------------------------------|-----------|-----------|----------|---------|---------------------------|-----------|
| Group variable: Industry       |           |           |          |         | Number of groups = 24     |           |
|                                |           |           |          |         | Obs per group: min = 15   |           |
|                                |           |           |          |         | avg = 15.0                |           |
|                                |           |           |          |         | max = 15                  |           |
|                                |           |           |          |         | Wald $\chi^2(6) = 226.19$ |           |
|                                |           |           |          |         | Prob > $\chi^2 = 0.0000$  |           |
| $\Delta IRP$                   | Coef.     | Std. Err. | z        | P> z    | [95% CI]                  |           |
| $f_{X_1}$                      | -16.66244 | 4.73547   | -3.52000 | 0.00000 | -25.94379                 | -7.38109  |
| $f_{Y_1}$                      | 126.49850 | 104.62680 | 1.21000  | 0.22700 | -78.56630                 | 331.56340 |
| $f_{Y_2}$                      | 0.24869   | 21.75617  | 0.01000  | 0.99100 | -42.39261                 | 42.89000  |
| $f_{Y_3}$                      | 9.81417   | 11.53764  | 0.85000  | 0.39500 | -12.79919                 | 32.42752  |
| $f_{Z_1}$                      | 170.81630 | 16.85810  | 10.13000 | 0.00000 | 137.77500                 | 203.85760 |
| $f_{Z_2}$                      | 2.45629   | 5.79160   | 0.42000  | 0.67100 | -8.89502                  | 13.80761  |
| _cons                          | 0.59886   | 2.58457   | 0.23000  | 0.81700 | -4.46680                  | 5.66452   |

Notes: Test of parameter constancy:  $\chi^2(161) = 385.77$  Prob >  $\chi^2 = 0.0000$ .

On industry average level,  $\Delta IRP$  is significantly correlative to macroeconomic climate factor  $f_{X_1}$ , industry scale increasing factor  $f_{Y_1}$ , profit gaining and fluidity factor  $f_{Y_3}$  and expectation confidence factor  $f_{Z_1}$  of noise investor irrational sentiment, which indicates that variable factors of macroeconomic dimension, industry value dimension and noise investor irrational sentiment dimension simultaneously have significant influences on industry average risk (see Table 10).

Changes of macroeconomic dimension variable factors have influences on demand and supply of industries leading to changes of  $\Delta IRP$ , and the influences generally affect most industries' risks. The model indicates that  $\Delta IRP$  is significantly correlative to macroeconomic climate factor  $f_{X_1}$  and changes of  $f_{X_1}$  will make  $\Delta IRP$  change. Changes of  $f_{X_1}$  usually lead to changes of  $\Delta IRP$  in the same direction and risk comovements of different industries. In the stable growth stage of the economy, the returns of most industries also express tendency of stable growth and industry risk is commonly low. In the drastic declining stage of the economy, the returns of most industries also express declining tendency and industry risk is commonly high. This point is indicated by that industry average  $\Delta IRP$  and all industries'  $\Delta IRP$  are negative correlative to macroeconomic climate factor  $f_{X_1}$  (see Table 11). Some common factors can lead to the risk comovements of different industries (Chiu, Peña, & Wang, 2015; Chou et al., 2012).

**Table 10. Random-coefficients regression on industry average level**

| Group variable: Industry average |            |           |          |         |            |           |
|----------------------------------|------------|-----------|----------|---------|------------|-----------|
| $\Delta IRP$                     | Coef.      | Std. Err. | z        | P >  z  | [95% CI]   |           |
| $f_{X_1}$                        | -20.97019  | 7.97395   | -2.63000 | 0.00900 | -36.59884  | -5.34154  |
| $f_{Y_1}$                        | -149.14160 | 73.11899  | -2.04000 | 0.04100 | -292.45220 | -5.83100  |
| $f_{Y_2}$                        | -6.60444   | 36.85904  | -0.18000 | 0.85800 | -78.84682  | 65.63795  |
| $f_{Y_3}$                        | 54.42608   | 17.23106  | 3.16000  | 0.00200 | 20.65383   | 88.19833  |
| $f_{Z_1}$                        | 176.66950  | 30.25549  | 5.84000  | 0.00000 | 117.36980  | 235.96920 |
| $f_{Z_2}$                        | 10.87883   | 10.68739  | 1.02000  | 0.30900 | -10.06808  | 31.82573  |
| _cons                            | 1.21460    | 3.25224   | 0.37000  | 0.70900 | -5.15967   | 7.58887   |

**Table 11. Coefficients of MVS variable factors**

| Industry                                       | $f_{x_1}$ | $f_{y_1}$  | $f_{y_2}$ | $f_{y_3}$ | $f_{z_1}$ | $f_{z_2}$ | _cons    |
|--|-----------|------------|-----------|-----------|-----------|-----------|----------|
| Industry average                               | -20.97019 | -149.14160 | -6.60444  | 54.42608  | 176.66950 | 10.87883  | 1.21460  |
| Energy   | -15.73251 | 60.56367   | 64.17254  | 3.09665   | 231.80260 | -8.81249  | 0.39770  |
| Materials                                      | -15.65044 | 431.08900  | 43.10264  | -15.50516 | 227.54170 | -6.04884  | -2.66665 |
| Capital goods                                  | -10.70527 | -125.05640 | -13.01150 | 25.42028  | 172.93470 | 10.81857  | 1.74005  |
| Commercial and special services                | -10.90145 | -46.78872  | 0.02810   | 6.31184   | 107.24610 | 22.81812  | 0.87568  |
| Transportation                                 | -31.10155 | -109.75430 | 2.63305   | 50.12944  | 197.16240 | -28.56211 | 2.54764  |
| Automobiles & components                       | -24.78544 | 327.20480  | 17.31860  | 5.63323   | 215.30720 | -5.63081  | -0.99250 |
| Consumer durables & apparel                    | -31.30670 | -31.17036  | -5.65125  | 25.00085  | 183.25770 | -6.24954  | 2.08077  |
| Consumer services                              | -22.84086 | 293.30860  | 12.75066  | 3.05782   | 205.26190 | 1.70984   | -1.24938 |
| Media  | -21.34773 | 191.44980  | 26.61033  | 11.23670  | 211.99350 | -3.51904  | 0.26980  |
| Retailing                                      | -6.71475  | 382.03740  | 85.37997  | -9.47978  | 183.27040 | 17.09488  | -3.65944 |
| Food & staples retailing                       | -5.99654  | 333.41500  | -6.36958  | -15.55171 | 159.02040 | 0.98413   | 0.11584  |
| Food, beverage & tobacco                       | -23.49480 | 460.83150  | -28.24828 | -2.21079  | 159.22910 | 1.07187   | -0.40581 |
| Household & personal products                  | -20.54661 | 340.92590  | -28.07301 | -23.53138 | 181.97080 | 1.00498   | 0.36036  |
| Health care equipment & services               | -15.24876 | 119.77240  | -20.45014 | 18.08223  | 137.83210 | -6.43722  | 3.43879  |
| Pharmaceuticals, biotechnology & life sciences | -12.64302 | 408.21800  | -41.41587 | -21.02281 | 173.73480 | -1.64450  | -0.19983 |
| Banks  | -6.40596  | -100.85190 | -12.03998 | 23.62605  | 85.71844  | 25.67161  | 1.50555  |
| Diversified financials                         | -16.16937 | 132.37620  | 28.84768  | 32.58611  | 173.04530 | 0.91216   | -0.71854 |
| Real estate                                    | -17.46303 | -78.17347  | -27.68537 | 32.71354  | 157.60140 | 19.59680  | 1.61309  |
| Software & services                            | -18.55480 | 218.58330  | -65.56739 | -24.44426 | 167.38400 | -9.29273  | 1.98267  |
| Technology hardware & equipment                | -21.81561 | 77.43596   | 18.85807  | 16.26157  | 151.53840 | 6.91168   | 0.94685  |
| Semiconductors & semiconductor equipment       | -10.59395 | 46.49481   | -24.45235 | 11.79327  | 125.45530 | 12.83924  | 0.95444  |
| Telecommunication services                     | -9.17557  | -150.77960 | -22.40764 | -9.41680  | 147.98410 | -6.31382  | 3.79971  |
| Utilities                                      | -9.73364  | 3.97459    | 8.24379   | 37.32704  | 166.62930 | 9.14939   | 0.42135  |

Changes of  $f_{x_1}$  will make demand and supply of different industries express volatility of different ranges and produce different influences on these industries' risks. To industries with different products demand elasticity, supply elasticity or income elasticity, changes of  $f_{x_1}$  will produce different  $\Delta$ IRP influences. Schwartz and Altman (1973) find that sensitivity differentials can cause price volatility differentials among different industries. The model indicates that the smallest influence industry of  $f_{x_1}$  changes to  $\Delta$ IRP is Food & Staples Retailing, because this industry belongs to necessities producing industry and its product demand elasticity is low. The biggest influence industry of  $f_{x_1}$  changes to  $\Delta$ IRP is Consumer Durables & Apparel, because product demand elasticity of this industry is high and changes of  $f_{x_1}$  will lead to greater  $\Delta$ IRP changes.

Changes of industry value dimension variable factors can also lead to  $\Delta$ IRP changes of different ranges, and this kind of value changes mainly expresses in industry profit gaining ability, debt repaying ability and operating ability, etc. The biggest influence industry of industry scale increasing factor  $f_{Y_1}$  changes to  $\Delta$ IRP is Food, Beverage & Tobacco, and the smallest influence industry is Utilities. The biggest influence industry of industry cost debt factor  $f_{Y_2}$  changes to  $\Delta$ IRP is Retailing, and the smallest influence industry is Commercial and Special Services. The biggest influence industry of industry profit gaining and fluidity factor  $f_{Y_3}$  changes to  $\Delta$ IRP is Transportation, and the smallest influence industry is Food, Beverage & Tobacco.

Changes of noise investor irrational sentiment dimension variable factors also can obviously affect changing ranges of  $\Delta$ IRP and the model indicates that expectation confidence factor  $f_{Z_1}$  is significantly correlative to  $\Delta$ IRP and changes of  $f_{Z_1}$  will make  $\Delta$ IRP change. There are massive noise traders in the market who have cognition deviations and heterogeneous beliefs to asset pricing and bring irrational investment behaviors, which make stock prices deviate rational intervals and create unusual market phenomenon that stock prices volatilize drastically and deviate from normal condition in capital market. This point is indicated by that industry average  $f_{Z_1}$  and all industries'  $f_{Z_1}$  are significantly positive correlative to  $\Delta$ IRP, which means that changes of noise investor irrational sentiment will lead to industry risk volatility of great ranges.

Comparing with macroeconomic dimension and industry value dimension variable factors,  $f_{Z_1}$  changes of noise investor irrational sentiment dimension will lead to greater changes of  $\Delta$ IRP, which indicate that noise investor irrational sentiment is decisive factor affecting industry risk. Industry average  $f_{Z_1}$  coefficient is 176.67, which is obviously higher than macroeconomic dimension and industry value dimension factor coefficient. Except that  $f_{Z_1}$  coefficient of Banks industry is 85.72,  $f_{Z_1}$  coefficients of all the other industries volatilize in [107.25, 231.8] interval. The biggest  $f_{Z_1}$  coefficient industry is Energy, which indicates that changes of noise investor irrational sentiment have the biggest influence on this industry's  $\Delta$ IRP. Comparing with the first common factor  $f_{Z_1}$ , the second common factor  $f_{Z_2}$ 's influence is weaker. The smallest influence industry of this factor is Diversified Financials, and the biggest influence industry is Transportation.

## 6. Conclusions

Many factors can affect the levels and volatility ranges of industry risk. This paper constructs an industry MVS three dimensions vector factor model to analyze the factors consistent and affecting extent to industry risk. Furthermore, this paper analyzes simultaneously the linkage effect and working mechanism of multi-industries risks and gives an empirical research to determinants mechanism affecting industry risk.

Changes of macroeconomic variables have an important influence on industry risk. Changes of macroeconomic variables can lead to risk comovements of different industries. In the stable growth stage of the economy, the returns of most industries also express tendency of stable growth and industry risk is commonly low. In the drastic declining stage of the economy, the returns of most industries also express declining tendency and industry risk is commonly high. Macroeconomic variables can affect differently to industries with different products demand elasticity, supply elasticity, or income elasticity. Industry value variables can also affect change ranges of industry risk, and this kind of value changes mainly expresses in industry profit gaining ability, debt repaying ability, and operating ability, etc.

Data analysis indicates that noise investor irrational sentiment variables are significantly correlative to industry risk volatility. Noise investor irrational sentiment is that because investors' personal knowledge, asset investment experience, risk preference, psychology change and others are different, they have cognition deviations and heterogeneous beliefs to asset pricing. Comparing with macroeconomic variables and industry value variables, noise investor irrational sentiment variables will lead to greater influences on industry risk, which are decisive factors affecting industry risk.



When investors give an analysis of industry risk for investment allocation, it is necessary for them to know the detailed factors affecting industry risk and the affecting extent. Using industry MVS three dimensions vector factor model, investors can give empirical data analysis for industry risk. Investors can identify separately the affecting extent to every industry's risk for macroeconomic dimension, industry value dimension and noise investor irrational sentiment dimension, and give comparison and analysis among multi industries for further investment decision. An investor can select industries with suitable risk levels and risk affecting factors according to his/her own preferred investment principle. For example, a risk aversion investor will probably select industries with bigger affecting extent of macroeconomic factors or industry value factors.

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