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Article

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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 Kavonìus (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

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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_α is time variable. The stock price at $t_{\alpha\eta}$ period is $P^J_{it_{\alpha\eta}}$ for No. J enterprise stock in No. i industry, and the stock price at last period is $P^J_{it_{\alpha(\eta-1)}}$. Its weighted coefficient in the industry is $\gamma^J_{it_{\alpha\eta}}$. Industry risk premium is defined as industry stocks weighted return rate minus risk-free rate of return, and its mathematical equation is:

$$\begin{aligned} IRP_{it_{\alpha\eta}} = \sum_{J=1}^{K_i} \frac{P^J_{it_{\alpha\eta}} - P^J_{it_{\alpha(\eta-1)}}}{P^J_{it_{\alpha(\eta-1)}}} * \gamma^J_{it_{\alpha\eta}} - RF_{it_{\alpha\eta}} \quad (i = 1, 2, \ldots, M; J = 1, 2, \ldots, K_i; \eta = 1, 2, \ldots, N; \\ t_{\alpha\eta} = T_\alpha / N; \alpha = 1, 2, \ldots). \end{aligned} \tag{1}$$

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

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

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, $X = (X_1, X_2, \ldots, X_{n1})^T$; Y vector represents industry value dimension variables, $Y = (Y_1, Y_2, \ldots, Y_{n2})^T$; Z vector represents noise investor irrational sentiment dimension variables, $Z = (Z_1, Z_2, \ldots, Z_{n3})^T$; α represents constant vector; $\mathbf{B}$, $\mathbf{\Psi}$, $\mathbf{\Theta}$ represent coefficient vector; ε represents random error vector, $\varepsilon \sim$ i.i.d$N(0, \delta^2_{T_\alpha})$. 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):

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

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

That is

$$\Delta \mathrm{IRP}_{\mathrm{T}_\alpha} = \alpha + \mathrm{B}\Delta \mathrm{X}_{\mathrm{T}_\alpha} + \Psi \Delta \mathrm{Y}_{\mathrm{T}_\alpha} + \Theta \Delta \mathrm{Z}_{\mathrm{T}_\alpha} + \varepsilon_{\mathrm{T}_\alpha}. \tag{4}$$

M industries' risks can be represented as follows:

$$\Delta \mathrm{IRP}_{i\mathrm{T}_\alpha} = \alpha_i + \sum_{X_k=1}^{n1} \beta_{iX_k} \Delta X_{X_k i T_\alpha} + \sum_{Y_k=1}^{n2} \psi_{iY_k} \Delta Y_{Y_k i T_\alpha} + \sum_{Z_k=1}^{n3} \theta_{iZ_k} \Delta Z_{Z_k i T_\alpha} + \varepsilon_{iT_\alpha} \quad i = 1, 2, \ldots, \mathrm{M}. \tag{5}$$

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 υ represents mean vector while f represents factor vector. ε is the random error vector, $\varepsilon \sim$ i.i.d$N(0, \delta^2)$. ς is the coefficient vector. I is the unit matrix.

$$\begin{aligned}
\Delta \mathrm{X}_{\mathrm{T}_\alpha} &= \upsilon_{\mathrm{XT}_\alpha} + \varsigma_{\mathrm{XT}_\alpha} f_{\mathrm{XT}_\alpha} + \varepsilon_{\mathrm{XT}_\alpha};\\
\Delta \mathrm{Y}_{\mathrm{T}_\alpha} &= \upsilon_{\mathrm{YT}_\alpha} + \varsigma_{\mathrm{YT}_\alpha} f_{\mathrm{YT}_\alpha} + \varepsilon_{\mathrm{YT}_\alpha};\\
\Delta \mathrm{Z}_{\mathrm{T}_\alpha} &= \upsilon_{\mathrm{ZT}_\alpha} + \varsigma_{\mathrm{ZT}_\alpha} f_{\mathrm{ZT}_\alpha} + \varepsilon_{\mathrm{ZT}_\alpha}.
\end{aligned} \tag{6}$$

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

$$f_{\mathrm{XT}_\alpha} = (f_{X_1 T\alpha}, f_{X_2 T\alpha}, \ldots, f_{X_{g1} T\alpha})^{\mathrm{T}};\ f_{\mathrm{YT}_\alpha} = (f_{Y_1 T\alpha}, f_{Y_2 T\alpha}, \ldots, f_{Y_{g2} T\alpha})^{\mathrm{T}};\ f_{\mathrm{ZT}_\alpha} = (f_{Z_1 T\alpha}, f_{Z_2 T\alpha}, \ldots, f_{Z_{g3} T\alpha})^{\mathrm{T}}$$
$$(\mathrm{g1} < \mathrm{n1}; \mathrm{g2} < \mathrm{n2}; \mathrm{g3} < \mathrm{n3}). \tag{7}$$

Assume that:

$$\mathrm{E}(f_{\mathrm{XT}_\alpha}) = 0;\ \mathrm{V}(f_{\mathrm{XT}_\alpha}) = \mathrm{I};\ \mathrm{E}(f_{\mathrm{YT}_\alpha}) = 0. \tag{8}$$

$$\mathrm{V}(f_{\mathrm{YT}_\alpha}) = \mathrm{I};\ \mathrm{E}(f_{\mathrm{ZT}_\alpha}) = 0;\ \mathrm{V}(f_{\mathrm{ZT}_\alpha}) = \mathrm{I}. \tag{9}$$

$$\mathrm{Cov}(f_{\mathrm{XT}_\alpha}, \varepsilon_{\mathrm{XT}_\alpha}) = 0;\ \mathrm{Cov}(f_{\mathrm{YT}_\alpha}, \varepsilon_{\mathrm{YT}_\alpha}) = 0;\ \mathrm{Cov}(f_{\mathrm{ZT}_\alpha}, \varepsilon_{\mathrm{ZT}_\alpha}) = 0. \tag{10}$$

$$\mathrm{Cov}(f_{\mathrm{XT}_\alpha}, f_{\mathrm{YT}_\alpha}) = 0;\ \mathrm{Cov}(f_{\mathrm{XT}_\alpha}, f_{\mathrm{ZT}_\alpha}) = 0;\ \mathrm{Cov}(f_{\mathrm{YT}_\alpha}, f_{\mathrm{ZT}_\alpha}) = 0. \tag{11}$$

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(6) is substituted into (4), then

$$\Delta \mathrm{IRP}_{T_\alpha} = \alpha + \mathrm{B}(\upsilon_{\mathrm{XT}_\alpha} + \varsigma_{\mathrm{XT}_\alpha} f_{\mathrm{XT}_\alpha} + \varepsilon_{\mathrm{XT}_\alpha}) + \Psi(\upsilon_{\mathrm{YT}_\alpha} + \varsigma_{\mathrm{YT}_\alpha} f_{\mathrm{YT}_\alpha} + \varepsilon_{\mathrm{YT}_\alpha}) + \Theta(\upsilon_{\mathrm{ZT}_\alpha} + \varsigma_{\mathrm{ZT}_\alpha} f_{\mathrm{ZT}_\alpha} + \varepsilon_{\mathrm{ZT}_\alpha}) + \varepsilon_{T_\alpha}. \quad (12)$$

Order that:

$$\alpha^* = \alpha + \mathrm{B}\upsilon_{\mathrm{XT}_\alpha} + \Psi\upsilon_{\mathrm{YT}_\alpha} + \Theta\upsilon_{\mathrm{ZT}_\alpha}. \quad (13)$$

$$\mathrm{B}^* = \mathrm{B}\varsigma_{\mathrm{XT}_\alpha}; \Psi^* = \Psi\varsigma_{\mathrm{YT}_\alpha}; \Theta^* = \Theta\varsigma_{\mathrm{ZT}_\alpha}. \quad (14)$$

$$\varepsilon^*_{T_\alpha} = \mathrm{B}\varepsilon_{\mathrm{XT}_\alpha} + \Psi\varepsilon_{\mathrm{YT}_\alpha} + \Theta\varepsilon_{\mathrm{ZT}_\alpha} + \varepsilon_{T_\alpha}. \quad (15)$$

MVS model converts to MVS three dimensions vector factor model:

$$\begin{aligned}\Delta \mathrm{IRP}_{T_\alpha} &= \alpha^* + \mathrm{B}^* f_{\mathrm{XT}_\alpha} + \Psi^* f_{\mathrm{YT}_\alpha} + \Theta^* f_{\mathrm{ZT}_\alpha} + \varepsilon^*_{T_\alpha} \\ &= \alpha^* + \sum_{l=1}^{g1} \beta^*_l f_{X_l T_\alpha} + \sum_{c=1}^{g2} \psi^*_c f_{Y_c T_\alpha} + \sum_{d=1}^{g3} \theta^*_d f_{Z_d T_\alpha} + \varepsilon^*_{T_\alpha}.\end{aligned} \quad (16)$$

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 ΔIRP, 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 ΔIRP include macroeconomic dimension, industry value dimension, and noise investor irrational sentiment dimension variables. In each dimension, a few representative variables are chosen to measure ΔIRP. 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 ΔIRP.

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

$$\begin{aligned}\Delta \mathrm{IRP}_{iT_\alpha} = {} & \alpha_i + \beta_{i1}\Delta \mathrm{PCDIGR}_{iT_\alpha} + \beta_{i2}\Delta \mathrm{WMCI}_{iT_\alpha} + \beta_{i3}\Delta \mathrm{CPI}_{iT_\alpha} + \beta_{i4}\Delta \mathrm{M2GR}_{iT_\alpha} + \beta_{i5}\Delta \mathrm{CGPI}_{iT_\alpha} + \psi_{i1}\Delta \mathrm{ROE}_{iT_\alpha} \\ & + \psi_{i2}\Delta \mathrm{NPM}_{iT_\alpha} + \psi_{i3}\Delta \mathrm{TEGR}_{iT_\alpha} + \psi_{i4}\Delta \mathrm{TATR}_{iT_\alpha} + \psi_{i5}\Delta \mathrm{RLA}_{iT_\alpha} + \psi_{i6}\Delta \mathrm{TAGR}_{iT_\alpha} \\ & + \psi_{i7}\Delta \mathrm{ORGR}_{iT_\alpha} + \psi_{i8}\Delta \mathrm{TPGR}_{iT_\alpha} + \theta_{i1}\Delta \mathrm{TR}_{iT_\alpha} + \theta_{i2}\Delta \mathrm{IAGR}_{iT_\alpha} + \theta_{i3}\Delta \mathrm{TVGR}_{iT_\alpha} + \varepsilon_{iT_\alpha} \\ & (i = 1, 2, \ldots, 24; \alpha = 1, 2, \ldots, 15).\end{aligned} \quad (17)$$

ΔPCDIGR is per capita disposable income growth rate. ΔWMCI is weighted macroeconomic climate index. ΔCPI is consumer price index. ΔM2GR is growth rate of M2 supply of money and quasi money. ΔCGPI is weighted corporate goods price index. ΔROE is return of equity. ΔNPM is net profit margin. ΔTEGR is total expenses, including operating expenses, administrative expenses, and financial expenses divided by gross revenue. ΔTATR is total assets turnover ratio. ΔRLA is ratio of liabilities to assets. ΔTAGR is total assets growth rate. ΔORGR is operating revenue growth rate. ΔTPGR is total

profit growth rate. ΔTR is turnover rate. ΔIAGR is investor account growth rate. ΔTVGR 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 ΔIRP mean is −0.978%, and the minimum is −192.02%, whereas the maximum is 166.4%. Absolute value of variation coefficient of ΔIRP is 80.1341. RF is weighted three months deposit rate. The biggest volatility of industry risk is Retailing industry, and its ΔIRP absolute value of variation coefficient is 1,989.8453. The smallest volatility of industry risk is Energy industry, and its ΔIRP 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' ΔIRP means are positive, which are Media, Banks, Consumer Durables & Apparel, Technology Hardware & Equipment, Household & Personal Products, and other industries' ΔIRP means are negative. Affected by financial crisis in 2008, all industries' ΔIRP appear significantly decreasing, all becoming negative from positive last year. The biggest decreasing industry of ΔIRP is Diversified Financials, and the decreasing number is −275.85%. The smallest decreasing industry of ΔIRP 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 (ΔPCDIGR), Weighted macroeconomic climate index (ΔWMCI), Consumer price index (ΔCPI), Growth rate of M2 supply of money and quasi money (ΔM2GR), Weighted corporate goods price index (ΔCGPI). ΔPCDIGR mean is −0.0733%, and absolute value of variation coefficient is 39.8864. ΔWMCI mean is −0.2253, and absolute value of variation coefficient is 12.2658. ΔCPI mean is 0.0667, and absolute value of variation coefficient is 40.6255. ΔM2GR mean is 0.072%, and absolute value of variation coefficient is 64.1453. ΔCGPI mean is −0.3467, and absolute value of variation coefficient is 16.9183. Affected by financial crisis in 2008, ΔPCDIGR and ΔWMCI 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 (ΔROE), Net profit margin (ΔNPM), Total expenses including operating expenses, administrative expenses and financial expenses divided by gross revenue (ΔTEGR), Total assets turnover ratio (ΔTATR), Ratio of liabilities to assets (ΔRLA), Total assets growth rate (ΔTAGR), Operating revenue growth rate (ΔORGR), Total profit growth rate (ΔTPGR).

Industry average ΔROE mean is 0.2367%, and the minimum is −3.66%, whereas the maximum is 5.92%. Absolute value of variation coefficient of ΔROE is 10.0706. The biggest ΔROE industry is Technology Hardware & Equipment whereas the smallest ΔROE industry is Household & Personal Products. Seventeen industries' ΔROE are higher than industry average level, whereas other six industries' ΔROE are lower than industry average level. Industry average ΔNPM mean is 0.0527%, and the minimum is −7.13%, whereas the maximum is 3.55%. Absolute value of variation coefficient of ΔNPM is 56.0747. The biggest ΔNPM industry is Commercial and Special Services, whereas the smallest ΔNPM industry is Health Care Equipment & Services. Five industries' ΔNPM are higher than industry average level whereas other eighteen industries' ΔROE 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 ΔROE decreases −30.11% and ΔNPM 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[1]	−0.9780	80.1341	−192.0200	166.4000	78.3712
Energy[2]	−5.1687	19.2367	−244.5700	184.6900	99.4279
Materials[3]	−1.4213	66.0309	−228.1000	197.9300	93.8519
Capital goods[4]	−0.7607	100.2171	−191.3700	146.0300	76.2318
Commercial and special services[5]	−2.1267	35.1134	−167.7100	120.8900	74.6745
Transportation[6]	−0.8287	93.7053	−197.2200	158.3500	77.6504
Automobiles & components[7]	−1.4527	73.2986	−217.8900	249.3400	106.4785
Consumer durables & apparel[8]	0.8580	91.9109	−181.0700	173.2300	78.8595
Consumer services[9]	−0.9113	93.5004	−198.5100	196.3900	85.2101
Media[10]	1.1653	65.9854	−166.9500	170.4700	76.8950
Retailing[11]	−0.0400	1989.8453	−196.2000	165.2600	79.5938
Food & staples retailing[12]	−1.0333	66.0036	−168.1600	136.6400	68.2037
Food, beverage & tobacco[13]	−1.1793	60.0265	−164.8000	156.0800	70.7913
Household & personal products[14]	0.4740	181.4536	−229.6800	166.5700	86.0090
Health care equipment & services[15]	−1.0727	78.3556	−182.9000	190.2700	84.0495
Pharmaceuticals, biotechnology & life[16] sciences	−1.9520	37.0697	−173.1300	131.2300	72.3600
Banks[17]	1.1160	57.2644	−156.4100	117.7800	63.9070
Diversified financials[18]	−3.9327	29.7237	−275.8500	196.7700	116.8934
Real estate[19]	−0.5353	171.7842	−206.4800	194.6400	91.9618
Software & services[20]	−0.1400	546.7267	−148.2300	157.6700	76.5417
Technology hardware & equipment2[1]	0.4900	159.1049	−169.9200	163.1800	77.9614
Semiconductors & semiconductor[22] equipment	−0.4880	183.2917	−178.6800	215.4200	89.4464
Telecommunication services[23]	−1.4420	54.2562	−178.5000	116.1700	78.2374
Utilities[24]	−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
ΔPCDIGR	−0.0733	39.8864	−5.6400	5.1600	2.9250
ΔWMCI	−0.2253	12.2658	−4.4800	6.0500	2.7639
ΔCPI	0.0667	40.6255	−6.6000	4.0000	2.7084
ΔM2GR	0.0720	64.1453	−9.4700	10.6500	4.6185
ΔCGPI	−0.3467	16.9183	−11.8900	11.5600	5.8650

Industry average ΔTEGR mean is −0.0993%, and the minimum is −7.98%, whereas the maximum is 7.42%. Absolute value of variation coefficient of ΔTEGR is 32.9686. The biggest ΔTEGR industry is Commercial and Special Services, whereas the smallest ΔTEGR industry is Consumer Services. Two industries' ΔTEGR are higher than industry average level, whereas other twenty-one industries' ΔTEGR are lower than industry average level. Industry average ΔTATR 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 ΔTATR is 6.1949. The biggest ΔTATR industry is Real Estate, whereas the smallest ΔTATR industry is Media. Eighteen industries' ΔTATR are higher than industry average level, whereas other five industries' ΔTATR are lower than industry average level.

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

Industry average ΔORGR mean is −7.8667%, and the minimum is −603.77%, whereas the maximum is 614.25%. Absolute value of variation coefficient of ΔORGR is 30.1287. The biggest ΔORGR industry is Telecommunication Services, whereas the smallest ΔORGR industry is Food & Staples Retailing. Seven industries' ΔORGR are higher than industry average level, whereas other sixteen industries' ΔORGR are lower than industry average level. Industry average ΔTPGR mean is −1.042%, and the minimum is −529.79%, whereas the maximum is 593.4%. Absolute value of variation coefficient of ΔTPGR is 248.8826. The biggest ΔTPGR industry is Utilities, whereas the smallest ΔTPGR industry is Health Care Equipment & Services. Four industries' ΔTPGR are higher than industry average level, whereas other nineteen industries' ΔTPGR 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 (ΔTR), Investor account growth rate (ΔIAGR), Trading volume growth rate (ΔTVGR). Industry average ΔTR mean is 0.0613%, and the minimum is −1.16%, whereas the maximum is 1.38%. Absolute value of variation coefficient of ΔTR is 13.644. The biggest ΔTR industry is Utilities whose absolute value of variation coefficient of ΔTR is 1893.4192. The smallest ΔTR industry is Software & Services whose absolute value of variation coefficient of ΔTR is 4.8201. Fourteen industries' ΔTR are higher than industry average level, whereas other nine industries' ΔTR are lower than industry average level. Except that ΔTR means are negative for Telecommunication Services, Energy, Transportation and Utilities industry, ΔTR means of other nineteen industries are positive, which indicate that most industries totally exist common heterogeneous beliefs.

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

Table 3. V Dimension Variables Volatility (ΔROE&ΔNPM)

Industry	ΔROE					ΔNPM				
	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

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Industry average ΔTVGR mean is 4.812%, and the minimum is −149.15%, whereas the maximum is 142.3%. Absolute value of variation coefficient of ΔTVGR is 19.2198. The biggest ΔTVGR industry is Health Care Equipment & Services whose absolute value of variation coefficient of ΔTVGR is 383.7074. The smallest ΔTVGR industry is Software & Services whose absolute value of variation coefficient of ΔTVGR is 11.9629. Fifteen industries' ΔTVGR are higher than industry average level, whereas other eight industries' ΔTVGR 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 (ΔPCDIGR), Weighted macro-economic climate index (ΔWMCI), Consumer price index (ΔCPI), Growth rate of M2 supply of money and quasi money (ΔM2GR), Weighted corporate goods price index (ΔCGPI). 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 (ΔROE), Net profit margin (ΔNPM), Total expenses including operating expenses, administrative expenses, and financial expenses divided by gross revenue (ΔTEGR), Total assets turnover ratio (ΔTATR), Ratio of liabilities to assets (ΔRLA), Total assets growth rate (ΔTAGR), Operating revenue growth rate (ΔORGR), Total profit growth rate (ΔTPGR).

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 (ΔTR), Investor account growth rate (ΔIAGR), and Trading volume growth rate (ΔTVGR).

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 (ΔTR&ΔIAGR)

Industry			ΔTR					ΔIAGR		
	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
Energy	−0.0360	26.0159	−1.8900	1.6400	0.9366	−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
Capital goods	0.0053	207.0749	−1.4700	2.2200	1.1044	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
Transportation	−0.0293	46.1156	−2.9000	3.3400	1.3527	−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
Consumer durables & apparel	0.1187	10.5496	−1.9400	2.5300	1.2519	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
Media	0.0753	8.1280	−1.5000	0.9400	0.6123	−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
Food & staples retailing	0.0680	14.6315	−1.2400	2.5200	0.9949	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
Household & personal products	0.1033	11.4536	−1.6400	3.2100	1.1835	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
Pharmaceuticals, biotechnology & life sciences	0.0573	16.3116	−1.2700	2.5900	0.9352	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
Diversified financials	0.0360	78.7927	−5.4700	5.2700	2.8365	−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
Software & services	0.2120	4.8201	−1.3400	2.6700	1.0219	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
Semiconductors & semiconductor equipment	0.2007	8.7760	−3.1900	3.5200	1.7611	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
Utilities	−0.0007	1893.4192	−2.2200	2.5600	1.2623	2.2807	13.7556	−64.2800	73.4900	31.3719

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Table 5. Correlation matrix of M dimension variables

Correlation matrix

Variable		ΔPCDIGR	ΔWMCI	ΔCPI	ΔM2GR	ΔCGPI
Correlation	ΔPCDIGR	1.000	0.550	0.609	−0.464	0.533
	ΔWMCI	0.550	1.000	0.769	−0.586	0.908
	ΔCPI	0.609	0.769	1.000	−0.619	0.936
	ΔM2GR	−0.464	−0.586	−0.619	1.000	−0.630
	ΔCGPI	0.533	0.908	0.936	−0.630	1.000

Table 6. Component matrix of M dimension variables

Component matrix

Variable	Component
	1
ΔPCDIGR	0.717
ΔWMCI	0.903
ΔCPI	0.930
ΔM2GR	−0.760
ΔCGPI	0.952

Table 7. Component matrix of V dimension variables

Component matrix

Variable	Component		
	1	2	3
ΔROE	0.060	0.183	0.729
ΔNPM	0.060	−0.841	0.033
ΔTEGR	−0.113	0.706	−0.330
ΔTATR	0.031	−0.145	0.707
ΔRLA	0.210	0.719	0.322
ΔTAGR	0.984	0.034	−0.084
ΔORGR	0.986	0.024	−0.066
ΔTPGR	0.952	−0.089	−0.026

Table 8. Component matrix of S dimension variables

Component matrix

Variable	Component	
	1	2
ΔTR	0.15	0.99
ΔIAGR	0.96	−0.19
ΔTVGR	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' ΔIRP are different, this kind of difference can be found through heterogeneous panel analysis. Figure 1 is time tendency figure of different industries' ΔIRP. ΔIRP means of most industries volatilize in [−200, 200]

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interval around zero, which indicate that most industries' ΔIRP keep generally stable tendency from 2001 to 2015. Affected by financial crisis in 2008, all industries' ΔIRP 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' ΔIRP 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 ΔIRP and different sensitivity of every industry risk to MVS three dimensions variable factor. Total regression model indicates that ΔIRP 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 ΔIRP 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, ΔIRP 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, ΔIRP isn't significantly correlative to heterogeneous beliefs factor f_{Z_2}. But for some industries such as Transportation, Commercial and Special Services and Banks, ΔIRP 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).

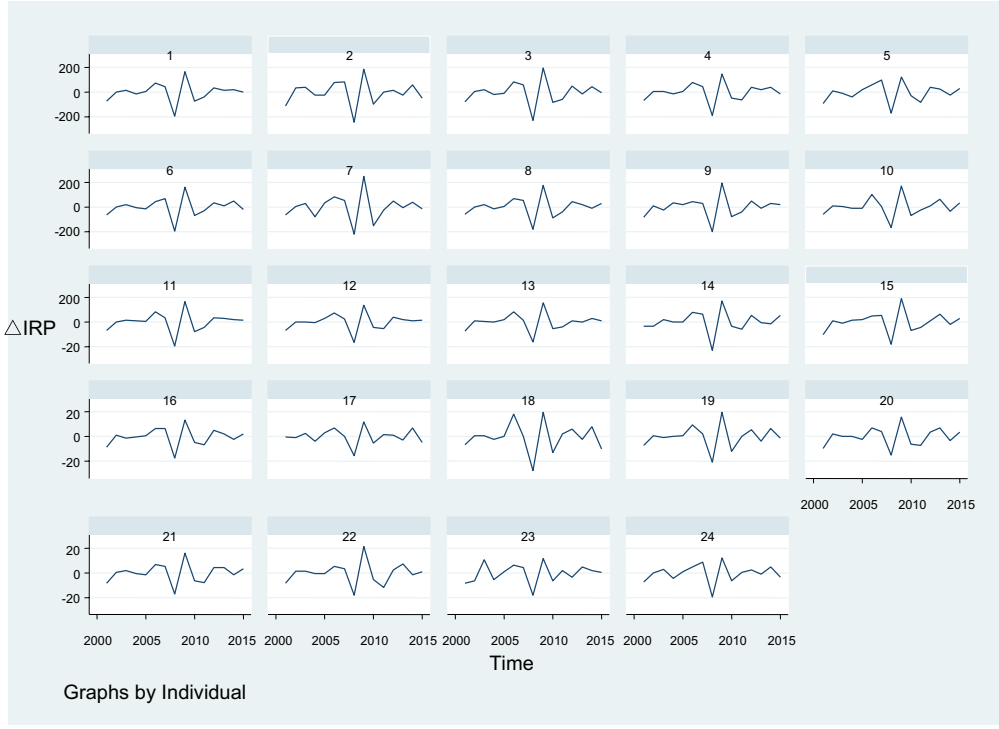

Figure 1. Time tendency figure of different industries' ΔIRP.

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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 > χ^2 = 0.0000	
ΔIRP	**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 > χ^2 = 0.0000.

On industry average level, ΔIRP 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 ΔIRP, and the influences generally affect most industries' risks. The model indicates that ΔIRP is significantly correlative to macroeconomic climate factor f_{X_1} and changes of f_{X_1} will make ΔIRP change. Changes of f_{X_1} usually lead to changes of ΔIRP 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 ΔIRP and all industries' ΔIRP 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

ΔIRP	**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 ΔIRP 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 ΔIRP is Food & Staples Retailing, because this industry belongs to necessaries producing industry and its product demand elasticity is low. The biggest influence industry of f_{X_1} changes to ΔIRP is Consumer Durables & Apparel, because product demand elasticity of this industry is high and changes of f_{X_1} will lead to greater ΔIRP changes.

Changes of industry value dimension variable factors can also lead to ΔIRP 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 ΔIRP 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 ΔIRP 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 ΔIRP 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 ΔIRP and the model indicates that expectation confidence factor f_{Z_1} is significantly correlative to ΔIRP and changes of f_{Z_1} will make ΔIRP 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 ΔIRP, 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 ΔIRP, 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 ΔIRP. 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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