Mathematical Nonlinear Modeling of Information Environment Risk Factor Pricing with Generalized Method of Moments (GMM) Approach in Tehran Stock Exchange

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ABSTRACT

Transparency of the information environment and proper pricing system can lead to the allocation efficiency of financial markets in the long run. Information risk is one of the factors through which the impact of the company's information environment on the discovery of companies' stock prices can be examined. The purpose of this study is to evaluate the information risk factor in increasing the power to explain the excess return on companies' stocks. Using the monthly stock' excess return data of 201 companies listed on the Tehran Stock Exchange during the period 2012 to 2021, combined information risk factor (information asymmetry, stock price synchronicity, stock price delay reaction and conservatism) was added to the five-factor model of Fama and French (2013) and by the Generalized Method of Moments (GMM) method on the monthly return of excess stock regressed. The results showed that by adding the combined information risk factor nonlinearly to the five-factor model of Fama and French (2013), its explanatory power increases by 4.5% and can explain approximately 18.5% of the monthly excess return on risk of the company's stock.

Keywords:

Information risk, Excess return, Five-factor model, Generalized Method of Moments.

1. Introduction

The purpose of investors in buying stocks is to earn returns, and in this regard, one of the most important needs of investors in the stock market is to have scientific information about how to buy and sell stocks (Moeinaddin et al., 2013). Also, stock return is one of the important factors in attracting capital, because for potential investors, it is a sign that is sent to the market from the company and indicates the performance of the company (Barzegari Khaneghah and Jamali, 2016). On the other hand, most investments are risky due to the volatility that occurs in their returns, so that one of the important issues in this field is the compatibility of returns and stock prices with the risk borne by investors. Therefore, expected return and risk is an important issue that financial researchers pay much attention to and researchers and investors have always considered the need to measure the sensitivity of the portfolio of financial assets in proportion to their level of risk (Rostamian and Javanbakht, 2010). One of the most challenging topics in the financial literature is understanding the decision-making process of capital market participants. One of the most important hypotheses in this regard is the efficient market hypothesis, which refers to the speed and completeness of the stock price response to the announcement of new information. In general, in an efficient market, stock price is a correct and unbiased estimate of future stock values, and investors have reasonable and informed expectations of future stock prices (Bekhrdi Nasab, 2018). Over the past few decades, the efficient market hypothesis has been used as a reference hypothesis to describe investor behavior, relying on rational investors' use of all available information. In an efficient securities market, prices can accurately reflect all available information and price changes in such a market over time are random and unpredictable (Moeinaddin et al., 2013). In other words, the efficient market hypothesis believes that the market cannot be overcome and earn the return higher than the market average. Also, stock price changes are random and in fact follow a random step, so it is not possible to achieve abnormal returns (above the average market) using historical information. Also, this hypothesis claims that there is no trend in market prices and returns and cannot profit from market trends (Saeedi and Bagheri, 2011). In previous studies, contradictory results have been obtained regarding the effect of information risk on stock returns, and most previous studies have dealt with one dimension of information risk. For example, Easley and O’Hara (2004) found the amount of private information and the accuracy of both the private information and public information will affect the information risk premium, and they provided evidence that information risk was priced based on a multiple assets theory model including informed and uninformed traders. However, the research of Lambert et al. (2007) shows that the influence of information asymmetry on expected return may be dispersed in big economies and the author owed the result of Easley and O’Hara (2004) to the limited assets used in the model. Also Kim and Qi. (2010) found that the U.S. stock market existed information risk premiums related to macroeconomic environment and the company’s economic activities after eliminating the low price stocks. But Mouselli et al. (2013) studied the market pricing of information risk characterized by accrual quality in the UK stocks market and the results failed to get the support evidence. The discovery process of the stock price is actually a process that which stock price reflects information related to listed companies. In the process, whether the information obtained by investors is timely, full, and accurate will affect whether their knowledge of the corporate is clear, complete, undistorted, and comparable, thus having a crucial impact on the formation of the stock market prices. At the same time, there is no agreement about whether the relevant information risk can be dispersed effectively through portfolios or whether information risk is priced by the market. In this study with a comprehensive approach to the concept of information risk in the investment environment in securities, information asymmetry as market efficiency risk, stock price Synchronicity as a relative risk of company-specific information to market information, stock price delay reaction as a financial reporting quality risk and conditional conservatism as disclosure quality risk have been selected, and by combining them, an information risk-based pricing factor has been added to the Fama and French (2013) five-factor pricing model to examine the possibility of increasing the predictive power of this model. Because in multi-factor pricing models, information risk is not considered as an effective factor in the stock pricing models.

2. Theoretical Foundations and Literature Review

Undoubtedly, through careful analysis, the risk of the capital market or the risk of investors can be reduced and the extreme losses resulting from improper investment results can be neutralized. The importance of predicting stock returns has led researchers to look for indicators that can explain and predict stock returns and provide them with the necessary information for proper investment (Barzegari Khaneghah and Jamali, 2016). So far, financial economists have proposed different models to explain the risk and return on investment. The first model was the Capital Asset Pricing (CAPM) model of Sharpe (1964), which has long been considered by financial researchers as the only plausible model for predicting returns. After the introduction of various irregularities in the capital asset pricing model and the challenges it faced, multifactorial models emerged as more complete financial models, including the Ross' Arbitrage pricing models (1976), Fama–French' three-factor model (1993), Carhart model (1997), Fama and French' five-factor model (2013), etc. pointed out that they have more explanatory power in predicting the expected return than previous models (Salehi et al., 2015). One of the main factors in investment decisions is to determine the risk factors that are effective in explaining fluctuations in stock returns. This has led accounting researchers to seek to discover the risk factors that affect a company's stock returns. Although the Fama and French' five-factor model (2013) is better able to explain fluctuations in stock returns than the capital asset pricing model and other factor models, there is still a lot of research being done to discover other risk factors that affect stock returns, in order to achieve a more complete model with higher explanatory power (Aflatooni et al., 2015). In addition to the risks in securities markets that are common to all markets; Such as systematic risk (market risk or irreversible risk), unsystematic risk (reduced risk or company-specific risk) and liquidity risk, there are other risks in the securities market. One of these risks is information risk. This risk originates from the category of information and information. Researchers in recent research have shown that information risk is an undiversified risk in capital markets (Sahrakaran and Rezaei, 2018). The information environment in which investors trade is constantly changing with the release (flow) of information. This change in the flow of information leads to a reassessment of investor risk. Information risk is caused by various factors. What is more important than ever is the existence of an information environment that reduces ambiguity and uncertainty and, as a result, increases the investor's ability to predict and analyze (Rashidi baqhi, 2019). Therefore, the factor through which the impact of the information environment on the discovery of companies' stock prices can be examined is information risk. Companies with high information risk are companies that have less public information and informed shareholders are informed of company news in a confidential manner (Ghaemi and Taghizadeh, 2016). Information risk can be due to non-symmetrical distribution of information, insufficient disclosure of company-specific information, poor quality financial reporting, or aggressive information reporting. Information asymmetry means that some of the market participants such as firm managers have more or better information than the others. This may lead to so-called informed trading, and cause subsequent price effect of stocks (Lai and Lin, 2020). So information imbalance about assets traded in a financial market poses a risk to investors, who might, therefore, ask for a premium to trade those assets they perceive as riskier in terms of information level. Thus, the information risk of an asset may be one of the factors priced by market makers (Siqueira et al, 2017). Also an important proxy of information environment that has received lesser attention in prior literature is the stock price synchronicity. The stock price movements are explained by systematic influences, industry influences, and firm-specific characteristics. Synchronicity incorporates market and industry level of information; lower synchronicity reflects more firm-specific information. The measured coefficient of determination (R2) of the market model is called synchronicity which captures the changes in the stock price in the market and industry level. Thus, lower coefficient of determination (R2) incorporates more firm-specifics. In other words, markets with lower synchronicity (higher idiosyncratic volatility) are more informative (Zhang and Zhou, 2020). When firm-specific information is noisy, investors are unable to discern the true value of firm-specific information, leading to high stock price synchronicity (Chen and Doukas, 2022). So lower stock price synchronicity reflects greater incorporation of firm-specific information within the stock price, which allows the investors to improve their financial decision-making and allocate capital more efficiently (Almaharmeh et al, 2021). According to Roll (1988), the stock prices are formed by a set of specific information about the company and more general information, arising from the market as a whole. The more the stock prices embody the company's specific information to the detriment of market information, the better the quality of the stock prices would be in reflecting the company's potential in generating future economic benefits and their risks. Thus, the stock prices would present low synchronicity with the market (Figlioli et al, 2019). In addition, in frictionless capital markets with complete information and rational investors, stock prices adjust to new information instantaneously and completely. According to the efficient market hypothesis (EMH) of Fama (1970) investors' response to new information, plays the main role in the degrees of the securities market efficiency. If the investors' response is quick, the market moves toward the efficiency and in case of any delay or disruption in the investors' response, the efficient market efficiency degrees get less. If information diffuses gradually across the population, prices underreact in the short run (Madanchi Zaj et al, 2017). The theory of efficient market hypothesis (EMH) states that all market information is reflected in prices. Price adjustment is the process of reflecting information in stock prices. Market efficiency is related to the quick and complete reflection of the information at prices, therefore, a faster and more complete price adjustment would represent a more efficient market (Bakhtiari et al, 2019). In the traditional perfect capital markets paradigm, updating baseline cash flow forecasts and the stock price adjustment occur quickly and completely because there are no market frictions such as poor quality information, either newly arriving or preexisting. But in fact investors have better quality information about some securities than about other securities. So their perceived risk of the low-information-quality securities is higher than their perceived risk of high-information quality securities that have the same market beta. In equilibrium, investors require higher returns to compensate them for holding high-estimation risk stocks (Lu et al, 2011). Finally, corporate managers have incentives to overstate financial performance by strategically withholding bad news and accelerating the release of good news, hoping that poor current performance will be camouflaged by strong future performance (Kim and Zhang, 2016). Prior work suggests that conservatism is potentially useful in mitigating agency problems associated with managers' investment decisions. conservatism provides directors and shareholders with timely signals for investigating the existence of negative net present value projects (NPV) and taking corrective actions (Ahmed and Duellman, 2010). Watts (2003) emphasized the degree of gain and loss verification in the definition of conservative accounting, in which there is a higher degree of verifying of gains compared to losses (Hejranijamil et al, 2020). Conservatism becomes a policy that reduces uncertainty. Conservative practices have a long-term positive effect because the company will avoid misrepresenting profits that allow the company to suffer a decrease in its profits or even future accumulative losses. Conservatism can also reduce information risk and provide benefits to the capital market (Solikhah and Jariyah, 2020). In the face of reduced conservatism, trying to access information through other channels in the capital market results in imposing unrealistic information risks onto the investor and the limited part of the expected return in the form of information acquisition costs (Dutta & Nezlobin, 2017). In this study, information risk factors of companies (information asymmetry, stock price synchronicity, stock price delay reaction and accounting conservatism) that arise from the information environment and their financial reporting policies and processes and are transmitted to shareholders and can be a mechanism to affect stock pricing in an efficient market, separately in the five-factor model of capital asset pricing of Fama and French (2013) is introduced as an information risk factor and then the explanatory power of risk premium (excess return) of the proposed model is compared with the five-factor model of capital asset pricing of Fama and French (2013) and the model that has the most explanation can be selected as the best model of capital asset pricing based on information risk. The following are previous studies that have addressed the relationship between information risk and corporate stock returns.

Krismiaji and Sururi (2021) examined the conservatism, profit quality and stock prices of companies listed on the Indonesia Stock Exchange for the fiscal year 2016-2018. Profit quality and stock prices are negatively related to conditional conservatism. Stock prices are also negatively associated with unconditional conservatism.

Saleem and Usman (2021) examine the impact of information risk on the Cost of Equity (COE) and whether the risk of a stock price crash mediates the relation between information risk and COE of non-financial firms listed on the Pakistan Stock Exchange (PSX) from 2007- 2018. The results of this study show that all three types of information risk, as well as the risk of the share price crash, increases the COE. The crash risk strengthens the impact of information risk on the COE.

Mehdizadeh Masouleh (2020) in a study examined the effect of unconditional conservatism and the amount of cash held on the abnormal returns of shares of 416 companies listed on the Tehran Stock Exchange during the period 2013 to 2018. Findings indicate that increasing cash balance leads to an increase in abnormal stock returns and in contrast to conservatism reduces abnormal stock returns.

Long et al. (2020) In a study examined stock price synchronicity, specific risk, and expected stock returns of 2,700 listed companies between 1998 and 2018. The results showed that the stock price synchronicity with cross-sectional future returns has a negative and significant relationship. An investment strategy based on a weighted average value that is done for a long (short) period creates a monthly alpha of -0.61% in the six factor model in the minimum (maximum) stock price synchronicity quartile.

Habibi et al. (2020) in a study examined the effect of conservatism on abnormal returns at the portfolio level. The results showed that the returns of portfolios that are in the quarters of high-low accruals and also have a lower overall degree of conservatism, are higher than the returns of similar portfolios with a higher overall degree of conservatism.

Baghani et al. (2019) in a study examined the relationship between corporate governance and information asymmetry with the stock returns of companies listed on the Tehran Stock Exchange. Findings indicate that there is a significant and negative relationship between corporate governance and information asymmetry and a negative and significant relationship between information asymmetry and stock returns.

MirAskari et al. (2019) in a study investigated the relationship between the synchronization of stock prices and distribution of returns. The results show that high stock price synchronization is likely to produce a positive sequence compared to low synchronization companies. In addition, there is a positive relationship between stock price synchronicity and skewness; As a result, investors in companies with high stock price synchronicity are less likely to react negatively to negative news than companies with low stock price synchronicity.

Figlioli and Lima (2019) in a study examined the spricing of stock price synchronicity in Latin America (Argentina, Brazil, Chile, Mexico and Peru). The results showed that the stock price synchronicity is associated with positive risk. Risk premium is obtained by the capital asset pricing model (CAPM) and the Fama and French three- and five-factor models.

Etemadi and Abdoli (2018) in a study examined the relationship between conservatism and stock value performance (stock returns and abnormal stock returns) in times of financial crisis. The results show that in companies without financial crisis, there is a negative and significant relationship between conservatism with stock returns and abnormal stock returns, while in companies with financial crisis, there is a positive and significant relationship between conservatism with stock returns and abnormal stock returns.

Zamanian et al. (2018) in a study investigated the effect of information asymmetry on stock returns and trading volume in selected companies of Tehran Stock Exchange. The results of the study showed that the asymmetry of information in general has a positive effect on stock returns, which in turn also affects the volatility of stock returns. On the other hand, information asymmetry also has a positive effect on trading volume.

Nguyen et al. (2018) in a study examined company-specific information and stock returns. The results of the research using Fama-MacBeth two-stage regression show that the specific information coefficients of the company are statistically significant and positive. In other words, company-specific information can explain cross-sectional returns.

Siqueira et al. (2017) in a study, they examined the effect of information asymmetry risk on stock returns of Brazilian companies. To test the effect of information asymmetry risk on stock returns, a factor related to the level of suspicion of orders (probability of informed trading and volume-synchronized probability of informed trading) was added to the three, four and five factor models. The Gibbons, Ross, & Shanken (GRS) (1989) test showed that a combination of factors that optimize the explanation of the portfolio yield created includes market factors, size, profitability, investment, and information risk.

Safdar and Yan (2017) investigated information risk in relation to the stock returns of a firm and whether information risk is priced in China. They used accruals quality (AQ) as their measure of information risk and performed Fama-Macbeth regressions to investigate association of AQ with future realized stock returns. The authors found poor AQ being associated with higher future realized stock returns. Moreover, they found evidence of market pricing of AQ in addition to existing factors in the Fama French three-factor model.

Borochin and Rush (2016) in a study identified and priced the risk of unfavorable selection using the Volume Synchronized Probability of Informed Trading (VPIN) as an indicator of the risk of information asymmetry. They used the Volume Synchronized Probability of Informed Trading (VPIN) to create a pricing factor. The research results show the pricing of information risk by the market.

Foroghi and Rahravi Dastjerdi (2015) in a study examined the relationship between price delay and expected returns of stock of 57 companies listed on the Tehran Stock Exchange during the years 2008 to 2011. The results show that the quality of accruals has a significant and negative effect on stock price delay and also the non-accounting component of stock price delay has a positive and significant effect on expected returns, but the delay accounting component has no effect on expected stock returns.

3. Research Hypotheses

The prevalence of covert and private information in the market benefits the holders of this information and, on the other hand, causes disadvantages for the uninformed traders with whom they enter into a transaction. Thus, in addition to systematic and unsystematic risks, uninformed traders also face the risk of incurring losses due to trading with holders of confidential information, which Ohara (2003) called information risk. (Mehrara and Soheili, 2018). The main question of this study is whether the information risk increases the explanatory power of the five-factor model of Fama and French (2013) in predicting the monthly excess return of companies listed on the Tehran Stock Exchange?

According to the objectives of the research and the theoretical foundations the research hypothesis has been formulated as follows:

Information risk factor increases the explanatory power of the five-factor model of Fama and French (2013) in explaining the monthly return in excess of the cross-sectional risk of corporate stocks.

4. Research Methodology

This research is classified as "applied research" in terms of purpose and "descriptive-correlation" in terms of data collection and research. Also, because the data collected is related to events that have occurred in the past, it is chronologically part of "retrospective" research. The research data collection approach is "time series". The library method has been used to compile the theoretical foundations and research background and the documentary method has been used to collect the data required to test the hypotheses. Theoretical foundations, research background and financial and non-financial data required for statistical tests of this research have been recorded and collected through the Fish tool. In order to perform calculations and prepare the financial data required for the research, Excel 2016 software were used and EVIEWS 12 software was used for statistical analysis of the data.

In this study the statistical population includes all companies listed on the Tehran Stock Exchange from 2012 to 2021. Statistical sampling was performed by targeted (systematic) elimination method and the following limitations were considered for selecting statistical sample companies:

1) Have been listed on the Tehran Stock Exchange since the beginning of 2011 and have a continuous presence in the stock exchange until the end of 2021;
2) Their fiscal year ends at the end of December of each year;
3) Have not changed their activity or changed their financial year during the research period;
4) Companies that are not part of investment companies, holdings and financial intermediaries, banks and insurance companies.

5) The company should not have a trading interval of more than three months in each year of the research period.

After applying the above restrictions to the statistical population, 201 companies were selected as the statistical sample. Given that the monthly time series data of the stock returns of 201 companies were collected during 10 years, the total number of research data is 24120 months-companies.

5. Research Modelling

Since the purpose of this study is to provide a factor model for pricing capital assets based on information risk to increase the ability to explain the risk and more accurately predict stock returns in the Iranian capital market, so the steps of the research are described in three stages:

Step 1: Calculate the information risk factor:

In this study, information risk factors (information asymmetry, stock price synchronicity, stock price delay reaction and accounting conservatism) are first calculated and using them, a combined information risk factor is obtained as a proposed explanatory variable to investigate the possibility of increasing power. A simple explanation of the risk of the five-factor model of Fama and French (2013) is added to this model. Therefore, it is first necessary to calculate the information risk variables for each company in each year as follows.

- Information Asymmetry (IA): Following Tessema (2019) research, in this study, the fluctuation criterion of daily stock price return is used as an indicator of information asymmetry. This variable is measured based on the scatter (standard deviation) in the daily stock price returns during the year under review. The higher the level of information asymmetry investors face, the more likely they are to inaccurately predict stock returns, and therefore it is expected that companies with more information asymmetry will have more fluctuations in their stock returns (Tessema, 2019).

$$IA_{i,t}=\sqrt{\frac{\sum_{n=1}^{k}\left(RET_{i,n}-\overline{RET}\right)^2}{k-1}} \quad (1)$$

where in:

$RET_{i,n}$= daily return on stock price of company i on day n during year t

- Stock price synchronization (SYNCH): In this study, following the research of Neifar & Ajili (2019) in order to measure the synchronicity of the annual stock price of each company, first the coefficient of determination (R^2) obtained from estimating the expanded market model by ordinary least squares regression (OLS) based on monthly returns the shares for each company during each year are calculated separately from the following equation.

$$r_{i,k,w}=\alpha_i+\beta_i r_{m,w}+\gamma_i r_{k,w}+\varepsilon_{i,t} \quad (2)$$

where in:

$r_{i,k,w}$= Monthly returns of company i in industry k per month w

$r_{m,w}$= balanced market returns per month w

$r_{k,w}$= industry-weighted returns k per month w

Since the coefficient of determination (R^2) is in the range of zero to one, to obtain a near-normal distribution, according to the studies of Piotroski & Roulstone (2004), Morg & Yung uo (2000) and Janson (2009), from The conversion of the natural logarithm of the coefficient of determination (R^2) is used as follows (Neifar & Ajili, 2019):

$$SYNCH_{i,t}=LN\left(\frac{R_{i,t}^2}{1-R_{i,t}^2}\right) \quad (3)$$

- Delayed stock price reaction (DELAY): The Hou & Moskowitz (2005) model is used to measure the stock price delay reaction. In this approach, using monthly data for each company, Equation (4) is satisfied by the ordinary least squares regression (OLS) method and the model determination coefficient is extracted:

$$R_{i,t}=\alpha_i+\beta_i Rm_t+\sum_{n=1}^{4}\gamma_{i,t-n}Rm_{t-n}+\varepsilon_{i,t} \quad (4)$$

where in:

$R_{i,t}$= Monthly stock return of company i in month t

Rm_t = Monthly market return (percentage of changes in price and cash index) in month t

The coefficient of determination obtained from the estimation of relation (4) for each company is called unrestricted coefficients of determination (R^2Unrestricted). The following equation (5), in which all the coefficients $\gamma_{i,t-n}$ are bound to zero, is estimated for each company by the ordinary least squares (OLS) regression method:

$$R_{i,t}=\alpha_i+\beta_i Rm_t+\varepsilon_{i,t} \quad (5)$$

The coefficients of determination obtained from the estimation of relation (5) for each company are called the coefficients of constraint (R^2Restricted).

The speed of stock price reaction to market information can be measured by the regression coefficients of relations (4) and (5). For example, for a stock with a high reaction rate to market information, the coefficient β_i is significantly different from zero (in this case there is no price reaction delay and the information quickly affects the stock price) and the coefficients of delay $\gamma_{i,t-n}$ must be close to zero. For a stock with a low reaction rate to market information, the coefficient β_i must be small or in other words insignificant, and one or some of the delay coefficients $\gamma_{i,t-n}$ must be significantly different from zero. For each year, the amount of price reaction delay of each company is calculated using Equation (6):

$$DELAY_{i,t}=1-\frac{R^2_{Restrited}}{R^2_{Unrestrited}} \qquad 0\le Delay_{i,t}\le 1 \qquad (6)$$

The larger the value in Equation (6), the higher the stock price delay rate and the lower the rate at which information is reflected in stock prices. If the price of a stock does not react slowly to market information $DELAY_{i,t}$ will be larger (i.e. closer to one), because the bulk of stock returns is defined by market delays. If a stock reacts quickly to market news $DELAY_{i,t}$ will be smaller (close to zero) because a small portion of stock returns is defined by delayed market returns and a large portion by returns Market current is defined (Hassas Yeganeh and Omidi, 2013).

Accounting conservatism (CC): This research will use news-related conservatism called conditional conservatism (post-event or temporal asymmetry of profits). To measure conditional conservatism, khan and watts (2009) model, which is based on Basu (1997) model, is used. Basu (1997) time asymmetry model is one of the most widely used conditional conservatism models used to estimate company-year conditional conservatism. In Basu's conservative model, the positive return represents the good news and the negative return represents the bad news. According to Basu, the reaction of profit to bad news is more timely than the reaction of profit to good news. Basu cross-sectional regression (1997) is as follows:

$$\frac{E_{i,t}}{P_{i,t}}=\alpha_0+\beta_{1,i}NEG_{i,t}+\beta_{2,i}RET_{i,t}+\beta_{3,i}NEG_{i,t}\times RET_{i,t}+\varepsilon \qquad (7)$$

where in:

$E_{i,t}$= Company's net profit at the end of year t

$P_{i,t}$= Company's market value at the end of year t

$NEG_{i,t}$= is a virtual variable, if there is bad news (negative return) it is equal to one and otherwise it is equal to zero.

$RET_{i,t}$= Return on shares of the company in year t, which is the difference between the price of each company share at the end of the period and the price of each share at the beginning of the period plus adjustments resulting from stock earnings (including dividends, bonus shares and ...) Dividend per share price is defined at the beginning of the period.

In Basu conservative model, β_2 measures profit response to good news (positive return) and is a measure of when good news is present. β_3 also measures when bad news is different from good news, or conservatism. Therefore (β_2 + β_3) measures the reaction of profit to bad news (negative return) and is the criterion when all the bad news is present. If $\beta_2 + \beta_3 > \beta_2$, then $\beta_3 > 0$ and then there is conservatism, because the profit response to bad news (negative return) is better than the profit response to good news (positive return). β_3 is in fact the temporal asymmetry of profit and the measure of conservatism. In other words, if β_3 is the opposite of zero and positive, it indicates the degree of conditional conservatism, which is calculated for each company separately and each year. Basu's model of conservatism (1997) measures conditional conservatism.

Khan and Watts (2009) stated that conservatism is a function of the specific characteristics of each company and is related to the size of the company, the ratio of market value to equity book and the company's financial leverage. Based on this, they developed Basu's (1997) model of conservatism and expressed β_2 and β_3 separately as a linear function of these three properties as described in Equations (8) and (9).

$$G-Score=\beta 2=\mu_1+\mu_2 SIZE_i+\mu_3 MTB_i+\mu_4 LEV_i \qquad (8)$$

$$C-Score=\beta 3=\lambda_1+\lambda_2 SIZE_i+\lambda_3 MTB_i+\lambda_4 LEV_i \qquad (9)$$

where in:

G-Score = Measure when good news is present

C-Score = Criterion when bad news increases over good news (conservative criterion)
SIZE = Company size (natural logarithm of equity market value) Company i
MTB = ratio of market value to book value of company equity i
LEV = financial leverage (ratio of total debt to equity) of the company i

To calculate the criterion of conservatism based on the conservative model of Khan and Watts (2009), we first replace equations (8) and (9) in Basu's conservative model (1997), ie equation (7), and by expanding the Basu model of relation (10) is obtained.

$$\frac{E_{i,t}}{P_{i,t}} = \alpha_0 + \beta_1 NEG_i + (\mu_1 + \mu_2 SIZE_i + \mu_3 MTB_i + \mu_4 LEV_i) RET_i + (\lambda_1 + \lambda_2 SIZE_i + \lambda_3 MTB_i + \lambda_4 LEV_i)\ NEG_i \times RET_i + (\delta_1 SIZE_i + \delta_2 MTB_i + \delta_3 LEV_i + \delta_4 NEG_i \times SIZE_i + \delta_5 NEG_i \times MTB_i + \delta_6 NEG_i \times LEV_i) + \varepsilon_{i,t} \quad (10)$$

Then, to estimate the coefficients μ_i and λ_i, we estimate the relation (10) cross-sectionally by the ordinary least squares regression (OLS) method for each year. Because Equation (10) is cross-sectionally fitted, the estimated coefficients between firms are constant and vary over time. Since we are considering conservatism in this study, we use the λ_i coefficients estimated through Equation (10) for all firms in each year and the specific characteristics of each firm (firm size, market value-to-equity ratio and financial leverage of the company) over the years of the research period using Equation (11) criterion when bad news is increasing relative to good news (conservative criterion or $C-Score_{i,t}$) for each The company is estimated every year.

$$C\text{-}Score_{i,t} = \beta3 = \hat{\lambda}_1 + \hat{\lambda}_2\ SIZE_{i,t} + \hat{\lambda}_3 MTB_{i,t} + \hat{\lambda}_4 LEV_{i,t} \quad (11)$$

Because the estimated λ_i coefficients per year and the characteristics of each company (company size, market-to-equity ratio and company leverage) change each year, the conservative criterion$C-Score_{i,t}$) will change between companies and over time. Therefore, the criterion of conditional conservatism is measured according to Khan and Watts model (2009) for each company and in each year (Meshki Miavaghi and Mohammadi, 2019).

Combined Information Risk (CIR): After calculating each of the information risk factors, the combined information risk index is calculated following the research of Mehrabanpour et al. (2019) as follows. First, the annual amount of each of the information risk factors (information asymmetry, stock price synchronicity, stock price delay reaction, and accounting conservatism) is normalized based on Equation (12).

$$X^*_{i,t} = \frac{X_{i,t} - \bar{X}}{\sigma_X} \quad (12)$$

where in:
$X^*_{i,t}$= i's normalized information risk index in year t
$X_{i,t}$ = the annual amount of each of the information risk indicators of company i in year t
$\bar{X}$= Average time series of each of the information risk indicators in year t
σ_X = Deviation of the time series criterion of each of the information risk indicators in year t

Then, by adding the normalized amount of each information risk factor for each company in each year, the combined information risk index is obtained from Equation (13).

$$CIR_{i,t} = \sum_{i=1}^{4} X^*_{i,t} \quad (13)$$

Step 2: Statistical modeling:
Considering that the purpose of this study is to add information risk factor to the five-factor model of Fama and French (2013) as an explanatory variable (predictor) to examine the possibility of increasing the ability to explain the excess return (risk) of stocks of this model, so the model Five-factor Fama and French (2013) is used as the base model and the combined information risk factor is added to the five-factor model of Fama and French (2013) and a six-factor model is obtained which its ability to explain are compared by the five-factor model of Fama and French (2013) through appropriate statistical criteria and the superior model is selected. The five-factor model of Fama and French (2013) is as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i (R_{m,t} - R_{f,t}) + S_i(SMB_t) + H_i(HML_t) + R_i(RMV_t) + C_i(CMA_t) + \varepsilon_{i,t} \quad (14$$

)

where in:

$R_{i,t}$-$R_{f,t}$= Expenditure on risk (difference between stock returns and risk-free returns) i stock in month t

α_i= width of origin

β_i= Systematic (beta) risk of stock returns i

$R_{m,t}$-$R_{f,t}$= Market risk expenditure (difference between monthly market portfolio return and risk-free return) in month t

S_i= Company size factor i in month t

SMB_t= Corporate size factor in month t

H_i= Company's stock growth factor i in month t

HML_t= Corporate stock growth factor in month t

R_i= coefficient of profitability of company i shares in month t

RMV_t= Corporate stock profitability factor in month t

C_i= Company's stock investment coefficient i in month t

CMA_t= Corporate stock investment factor in month t

$\varepsilon_{i,t}$= Unconventional return on Company i in month t

In relation (14) $R_{i,t}$-$R_{f,t}$ is the excess return (risk premium) of the company's shares relative to the risk-free return (one-year deposit interest rate of state-owned banks). According to the five-factor model of Fama and French (2013), this excess return is related to five factors. The first factor is market risk, which is the beta factor (β_i) provided by the capital asset pricing model (CAPM). This factor is called the market factor (MKT) by Fama and French and is measured by the difference between market returns and risk-free returns ($R_{m,t}$-$R_{f,t}$). The second factor is the difference between the average returns of a small company stock portfolio and the stock portfolio of large companies, which are classified based on market value, which is called the size factor (SMB). The third factor is the difference between the average returns of the stock portfolio of companies with a ratio of book value to high market value and the stock portfolio of companies with a ratio of book value to low market value, which is commonly called the growth factor (HML). The fourth factor is the difference between the average returns of a high-yield corporate stock portfolio and the low-yield corporate stock portfolio, which is classified based on the return on equity, which is called the profitability factor (RMW). The fifth factor is the difference between the average returns of corporate stock portfolios with high-investment (aggressive) companies and low-investment (conservative) corporate stocks, which are classified based on asset growth. This is called an investment factor (CMA). In relation (14) α_i (width of origin) is the average abnormal return on stock i, which is assumed to be equal to zero in the capital asset pricing model (CAPM).

According to the previous explanations, the purpose of this study is to modify the five-factor model of Fama and French (2013) and present a new factor model by adding a combined information risk factor as an explanatory variable to increase the predictive power of the five-factor model of Fama and French (2013). Therefore, the proposed adjustment model by adding the combined information risk factor is as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{m,t} - R_{f,t}) + S_i(SMB_t) + H_i(HML_t) + R_i(RMV_t) + C_i(CMA_t) + I_i(CIR_t) + \varepsilon_{i,t} \quad (15)$$

where in:

I_i= Company's information risk factor coefficient in month t

CIR_t= Combined information risk factor of companies in month t

Combined information risk factor (CIR), the difference between the returns of portfolios consisting of shares of high information risk companies and the returns of portfolios consisting of shares of companies with low information risk, while the variables of size and ratio of book value to market value are controlled. In fact, this variable indicates the degree to which the expected return behavior per share matches the information risk factor or the additional return due to the information transparency factor in the market.

Step 3: Mathematical modeling:

The Generalized Method of Moments (GMM) method is a powerful estimator that, unlike the maximum likelihood estimation (MLE) method, does not require accurate information on disturbance sentence distributions. This method, which is used in dynamic panel data (DPD), is based on the assumption that equation-disruption sentences are not correlated with a set of instrumental variables. In fixed or random effect models, in terms of the fact that the error sentence may be correlated with delay variables, it can lead to the presentation of an inconsistent estimator or bias. When the dependent variable appears as an interrupt on the right side of the model in the panel data model, the ordinary least squares (OLS) estimates will no longer be consistent. Generalized Method of Moments (GMM) estimation method by selecting the correct instrumental variables and applying a weight matrix, it can be a powerful estimator for variance heterogeneity conditions as well as unknown autocorrelations. In the Generalized Method of Moments (GMM) model, the dependent variable interrupt is entered as an independent variable to the right of the equation, thus allowing the model to be re-parameterized using the dynamic integrated data model method (Meshki, 2011). The mathematical and algebraic form of the generalized torque method is expressed as follows:

$$Y_{i,t} = \alpha_1 + \beta_2 Y_{i,t-1} + \gamma X_{i,t} + \eta_i + \mathcal{E}_{i,t} \quad (16)$$

where in:
Y = dependent variable
X = A set of explanatory variables
η = indicates the individual or fixed effects of companies
Ɛ = Disorder sentence (i and t also indicate the unit of time period observation).

As stated, and based on the views of Arlano and band (1991), a method was proposed in relation to the subject of estimating the Generalized Method of Moments (GMM), which involves eliminating individual special effects independent of the ηi time by taking the first-order difference from Equation (16).

$$Y_{i,t}-Y_{i,t-1}=\beta\left(Y_{i,t-1}-Y_{i,t-2}\right)+\gamma(X_{i,t}-X_{i,t-1})+(\mathcal{E}_{i,t}-\mathcal{E}_{i,t-1}) \quad (17)$$

In this case $(Y_{i,t-1} - Y_{i,t-2})$ with $(\mathcal{E}_{i,t}-\mathcal{E}_{i,t-1})$ Are correlated. The ordinary least squares (OLS) estimate of Equation (17) does not provide a consistent, unbiased estimate of β. Therefore, a valid tool for the model must be found. Assuming that (a) the error statements are not serially correlated:

$$E(\varepsilon_{i,t}-\varepsilon_{i,t-1})=0 \quad ,fori=1,\ldots,N \quad \text{and} \quad s\neq t \quad (18)$$

And (b) the initial states are predetermined:

$$E(Y_{i,t}\ \varepsilon_{i,t-1}) = 0 \quad ,fori=1,\ldots,N \quad \text{and} \quad t \geq 2 \quad (19)$$

Arlano and Bond (1991) stated the following torque limitations:

$$E[Y_{i,t}\ (\mathcal{E}_{i,t}-\mathcal{E}_{i,t-1})]=0 \quad ,fori=1,3,\ldots,T \quad \text{and} \quad s \geq 2 \quad (20)$$

Since the values of two or more intermittent periods $Y_{i,t}$ with $(Y_{i,t-1} - Y_{i,t-2})$ and not with $(\mathcal{E}_{i,t}-\mathcal{E}_{i,t-1})$ are correlated, they can be considered as valid tools for the equation (Movahed Manesh, 2016). On the other hand, due to the fact that the effects of combined information risk factor at different levels of surplus return on firm risk may not be the same and there is not necessarily a linear relationship between information risk and surplus return, in this study, the nonlinear and quadratic relationship between information risk and excess return on companies' stock risk will be investigated.

Therefore, according to the five-factor model of Fama and French (2013) and also the proposed research model in which the combined information risk factor is added to the five-factor model of Fama and French (2013), the following models are based on the Generalized Method of Moments (GMM) approach Achieved.

$$\begin{aligned} R_{i,t} - R_{f,t} = \alpha_i &+ \mu(R_{i,t-1} - R_{f,t-1}) \\ &+ \beta_i\left(R_{m,t} - R_{f,t}\right) \\ &+ S_i(SMB_t) + H_i(HML_t) \\ &+ R_i(RMV_t) + C_i(CMA_t) \\ &+ \varepsilon_{i,t} \end{aligned} \quad (21)$$

$$\begin{aligned} R_{i,t}-R_{f,t} = \alpha_i &+ \mu(R_{i,t-1} - R_{f,t-1}) \\ &+ \beta_i\left(R_{m,t} - R_{f,t}\right) \\ &+ S_i(SMB_t) + H_i(HML_t) \\ &+ R_i(RMV_t) + C_i(CMA_t) \\ &+ I_i(CIR_t) + ISQ_i(CIR_t)^2 \\ &+ \varepsilon_{i,t} \end{aligned} \quad (22)$$

As can be seen, in the above models, the dependent variable (risk-return) is present with an interval as an independent variable to the right of the regression. After estimating the above models, by comparing the criteria of Root Mean Square Error (RMSE) and the adjusted coefficient of determination (R^2) related to the research regression models with each other, a decision is made to reject or accept the research hypotheses. The coefficient of determination indicates the explanatory power of the model. The coefficient of determination indicates what percentage of the changes in the dependent variable are explained by the independent variables. The coefficient of determination in regression equations is denoted by R^2 and indicates the probability of correlation between the two data sets in the future. This coefficient actually expresses the approximate results of the desired parameter in the future based on a defined mathematical model that is consistent with the available data. The coefficient of determination is calculated as follows:

$$R^2 = \frac{SST - SSE}{SST} \quad (23)$$

where in:
SST: The sum of the quadratic power of errors when independent variables are not used.
SSE: The sum of the quadratic power of errors when independent variables are used.
Of course, the following adjustment coefficient is used to decide on the explanatory power of the model:

$$R^2_{Adj} = 1 - \frac{(1 - R^2) - (N - 1)}{N - P - 1} \quad (24)$$

where in:
N: Total number of observations
P: Number of predictor variables
The Root Mean Square Error (RMSE) also measures the amount of error between two data sets. This parameter usually compares the predicted values and the measured values.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \hat{x}_i)^2}{N}} \quad (25)$$

where in:
x_i: The actual values of the dependent variable
$\hat{x}_i$: Predicted values of dependent variables
Therefore, each of the research models that have the highest value of the adjusted coefficient of determination (R^2_{Adj}) and the lowest value of the Root Mean Square Error (RMSE) has the highest accuracy and is introduced as a proposed model. The decision to reject or confirm the hypotheses is made.

6. Data Analysis

6.1. Descriptive Statistics

Table (1) show descriptive statistics of research variables that include information about central tendency indexes (mean and median) and dispersion index (standard deviation, skewness and kurtosis).

The following matrix of correlation coefficients between research variables at the error level of 0.05 is presented in Table (2).

Table (1): Descriptive statistics of research variables

	RP	MKT	SMB	HML	RMW	CMA	CIR
Mean	0.021549	0.023808	0.008206	-0.017070	-0.003092	-0.005492	0.030075
Median	-0.014200	0.008700	0.006750	-0.012650	-0.002150	-0.007350	0.019750
Maximum	10.49450	0.494700	0.146000	0.146200	0.214300	0.216900	0.421200
Minimum	-0.988400	-0.213700	-0.120500	-0.266000	-0.164400	-0.130600	-0.187100
Std. Dev.	0.209837	0.099836	0.045199	0.060076	0.053918	0.047911	0.078522
Skewness	6.607486	1.750604	0.251258	-0.288895	0.317705	0.981369	1.316361
Kurtosis	269.5425	8.311345	3.967081	4.700362	5.067445	8.558262	8.675200
Jarque-Bera	71575612	40671.19	1193.707	3241.196	4701.463	34920.35	39334.82
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	519.7707	574.2570	197.9247	-411.7284	-74.57100	-132.4590	725.4090
Sum Sq. Dev.	1061.998	240.4000	49.27339	87.04762	70.11632	55.36380	148.7107
Observations	24120	24120	24120	24120	24120	24120	24120

Source: Research Findings

Table (2): Matrix of correlation coefficients of research variables

Variable	RP	MKT	SMB	HML	RMW	CMA	CIR
MKT	0.346361	1.000000					
t-Statistic	57.33890	-----					
Probability	0.0000	-----					
SMB	0.042487	-0.338594	1.000000				
t-Statistic	6.604222	-55.88445	-----				

Variable	RP	MKT	SMB	HML	RMW	CMA	CIR
Probability	0.0000	0.0000	-----				
HML	0.154195	0.273694	0.347821	1.000000			
t-Statistic	24.23628	44.19199	57.61383	-----			
Probability	0.0000	0.0000	0.0000	-----			
RMW	-0.178303	-0.180714	-0.350796	-0.424125	1.000000		
t-Statistic	-28.14141	-28.53463	-58.17549	-72.73210	-----		
Probability	0.0000	0.0000	0.0000	0.0000	-----		
CMA	-0.083071	0.107658	-0.348440	-0.078467	0.430811	1.000000	
t-Statistic	-12.94568	16.81696	-57.73062	-12.22361	74.13750	-----	
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	-----	
CIR	0.254239	0.133449	0.161708	0.029513	-0.205842	-0.112548	1.000000
t-Statistic	40.82477	20.91167	25.44813	4.585409	-32.66679	-17.59049	-----
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-----

Source: Research Findings

6.2. Inferential Statistics

To estimate time series data by Generalized Method of Moments (GMM) method, the Multicollinearity of independent variables and the stationarity of research variables should be investigated. First, the collinearity of the independent variables of the research models has been investigated. Collinearity means that there is a strong relationship between the independent and control variables in the model. The results of the collinearity intensity test of the independent variables of the research models through the variance inflation factor (VIF) are presented in Table (3).

Table (3): Test of no alignment between explanatory (independent) variables of research models

VIF	Coefficient Variance	Variable	Model
1.072024	3.76E-05	RP(-1)	FF5[1]
1.585061	0.000245	MKT	
1.736799	0.001312	SMB	
1.562753	0.000668	HML	
1.613035	0.000856	RMW	
1.353189	0.000910	CMA	
1.064170	5.47E-05	RP(-1)	FF5+CIR[2]
1.684227	0.000488	MKT	
2.606939	0.002715	SMB	
3.103965	0.001744	HML	
4.954614	0.004010	RMW	
1.616776	0.002046	CMA	
2.626003	0.000942	CIR	
1.923157	0.015933	CIR^2	

Source: Research Findings

According to Table (3), the results of the variance inflation factor test (VIF) show that in the research models, the rate of variance inflation of the independent variables is within the allowable limit (less than 10) and there is no collinearity problem.

Also, the next step in estimating time series is to examine the stationarity of the variables. Given that the time series used in this study are more frequent than annual; It is necessary to check the existence of the monthly unit root. For this purpose, the stationarity of these variables has been investigated using the phillips-perron (1988) unit root test, the results of which are described in Table (4).

Table (4): Unit root test (stationarity) of research variables

Stationary Level	Test result	Phillips-Perron test Null Hypothesis: series has a unit root		Variable
		Probability	Statistic	
I(0)	no unit roots	0.0001	-209.2476	RP
I(0)	no unit roots	0.0001	-212.9992	MKT
I(0)	no unit roots	0.0001	-354.2729	SMB
I(0)	no unit roots	0.0001	-375.1801	HML

[1] FF5: Five Fama and French (2013)
[2] FF5 + CIR: Modified model of Panjfama and French (2013) with combined information risk factor

I(0)	no unit roots	0.0001	-367.5420	RMW
I(0)	no unit roots	0.0001	-255.5732	CMA
I(0)	no unit roots	0.0001	-302.4358	CIR

Source: Research Findings

According to the results of the Phillips-Peron unit root test (1988) according to Table (4), the probability value of the stationarity test' statistic for all research variables is less than the research error level of 0.05, so all research variables during the research period stationarity in the level or is I (0) and the mean and variance of the variables over time and the covariance of the variables between different periods have been constant. As a result, the use of these variables in the model does not cause false regression and the models can be estimated as a time series without worry. The results of estimating the regression models of the research using the Generalized Method of Moments (GMM) method are described in Tables (5) and (6).

Table (5): Estimation results of the five-factor model of Fama and French (2013)

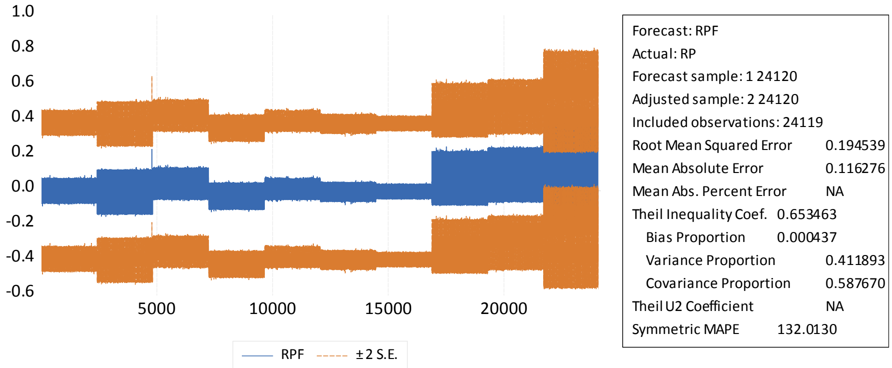
Model: FF5				
Dependent Variable: RP				
Method: Generalized Method of Moments				
Sample (adjusted): 2 24120				
Included observations: 24119 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.014360	0.001226	-11.70934	0.0000
RP(-1)	0.020891	0.007391	2.826484	0.0047
MKT	0.769482	0.019081	40.32643	0.0000
SMB	0.443094	0.041457	10.68792	0.0000
HML	-0.306530	0.028232	-10.85771	0.0000
RMW	-0.529241	0.033510	-15.79372	0.0000
CMA	-0.467990	0.039047	-11.98540	0.0000
R-squared	0.140496	Mean dependent var		0.021548
Adjusted R-squared	0.140282	S.D. dependent var		0.209841
S.E. of regression	0.194567	Sum squared resid		912.7908
Durbin-Watson stat	2.018730	J-statistic		7.749347
Instrument rank	8	Prob(J-statistic)		0.257048
Wald Test	F-statistic	383.7620		
	Probability	0.0000		

Source: Research Findings

In the lower part of Table (5), the results of diagnostic tests of the estimated five-factor model of Fama and French (2013) by the Generalized Method of Moments (GMM) method are presented. The Wald test statistic, which has a chi-square distribution with a degree of freedom equivalent to the number of explanatory variables minus the fixed component, is 383.7620 and its significance level is 0.0000, indicating that the null hypothesis of this test that says coefficients is zero at a significant level of 0.05 in the estimated model is rejected and as a result, the validity of the estimated coefficients of the model is confirmed. Sargan test statistic (J-statistic) is also 7.749347 and its significance level is 0.257048 and indicates that it does not reject the null hypothesis that the residues are not correlated with instrumental variables and shows the validity of instrumental variables and compatibility of Generalized Method of Moments (GMM); Therefore, the results of the estimated coefficients are statistically confirmed and interpretable. Also, Durbin-Watson test statistic is 2.018730, which indicates the lack of first-order autocorrelation of the model residues. The adjusted coefficient (Adjusted R-squared) of the five-factor model of Fama and French (2013) is also 0.140282, which indicates that the five-factor model of

Fama and French (2013) approximately can predict 14% of the monthly excess return of companies.

Also, to test the predictive power of the five-factor model of Fama and French (2013), the return premium forecasted (RPF) by the model is compared with the actual return premium (RP) and whatever the Bias proportion and squared The Root Mean Square Error (RMSE) close to zero indicates the predictive power of the model. The results of comparing the return premium forecasted (RPF) by the five-factor model of Fama and French (2013) with the actual return premium (RP) are as shown in Figure 1.



Source: Research Findings

Figure 1. Fama and French (2013) five-factor model predictive power test

As can be seen in Figure 1, for the five-factor model of Fama and French (2013), the Bias proportion is 0.000437 and the Root Mean Square Error (RMSE) is 0.194539.

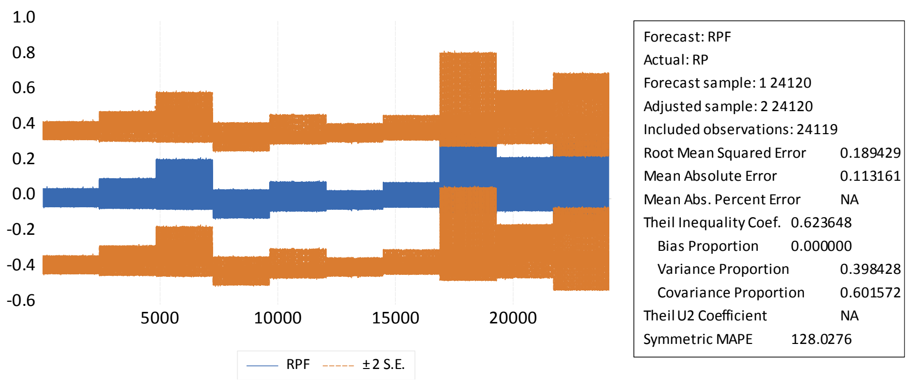
Table (6): Results of estimating the five-factor model of Fama and French (2013) modified with information risk factor

Model: FF5+CIR				
Dependent Variable: RP				
Method: Generalized Method of Moments				
Sample (adjusted): 2 24120				
Included observations: 24119 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.018088	0.001368	-13.22423	0.0000
RP(-1)	0.010907	0.007395	1.474855	0.1403
MKT	0.738525	0.022096	33.42324	0.0000
SMB	0.527571	0.052104	10.12526	0.0000
HML	-0.025158	0.041762	-0.602414	0.5469
RMW	-0.085050	0.063321	-1.343155	0.1792
CMA	-0.224851	0.045232	-4.971059	0.0000
CIR	0.382292	0.030690	12.45641	0.0000
CIR^2	0.574908	0.126224	4.554653	0.0000
R-squared	0.185052	Mean dependent var		0.021548
Adjusted R-squared	0.184782	S.D. dependent var		0.209841
S.E. of regression	0.189465	Sum squared resid		865.4724
Durbin-Watson stat	1.999946	J-statistic		5.926224
Instrument rank	10	Prob(J-statistic)		0.878241
Wald Test	F-statistic	371.8537		
	Probability	0.0000		

Source: Research Findings

In the lower part of Table (6), the results of diagnostic tests of the estimated five-factor model of Fama and French (2013) modified with information risk factor by the method of Generalized Method of Moments (GMM) are presented. The Wald test statistic, which has a chi-square distribution with a degree of freedom equivalent to the number of explanatory variables minus the fixed component, is 371.8537 and its significance level is 0.0000, indicating that the null hypothesis of this test that says coefficients is zero at a significant level of 0.05 in the estimated model is rejected and as a result, the validity of the estimated coefficients of the model is confirmed. Sargan test statistic (J-statistic) is also 5.926224 and its significance level is 0.878241 and indicates that it does not reject the null hypothesis that the residues are not correlated with instrumental variables and shows the validity of instrumental variables and compatibility of Generalized Method of Moments (GMM); Therefore, the results of the estimated coefficients are statistically confirmed and interpretable. Also, Durbin-Watson test statistic is 1.999946, which indicates the lack of first-order autocorrelation of the model residues. The adjusted coefficient (Adjusted R-squared) of the five-factor model of Fama and French (2013) modified with information risk factor is also 0.184782, which indicates that the five-factor model of Fama and French (2013) modified with information risk factor approximately can predict 18/5% of the monthly excess return of companies.

Also, to test the predictive power of the five-factor model of Fama and French (2013) adjusted with the information risk factor, the return premium forecasted (RPF) predicted by the model was compared with the actual return premium (RP), the results of which were compared. As shown in Figure 2.



Source: Research Findings

Figure 2. Fama and French (2013) five-factor model adjusted with the information risk factor predictive power test

As can be seen in Figure 2, for the five-factor model of Fama and French (2013) adjusted with the information risk factor, the Bias proportion is 0.000000 and the Root Mean Square Error (RMSE) is 0.189429.

A summary of comparative criteria for estimating the two five-factor models of Fama and French (2013) and the five-factor model of Fama and French (2013) adjusted with the information risk factor is described in Table (7).

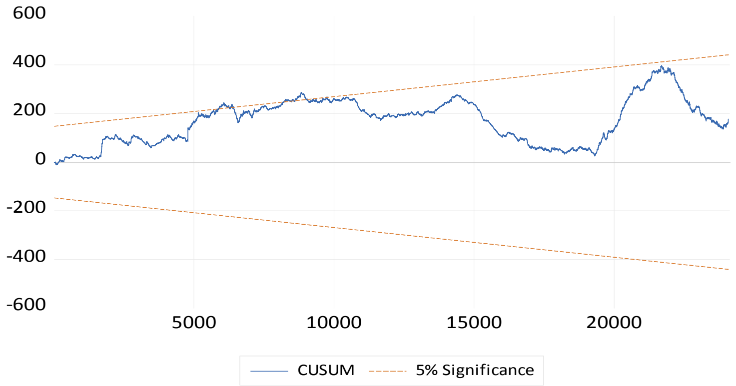
Table (7): Summary of comparative criteria for estimating the two models

Model	Adjusted R-squared	Bias proportion	RMSE
FF5	0.140282	0/000437	0/194539
FF5+CIR	0.184782	0/000000	0/189429

Source: Research Findings

First, the five-factor model of Fama and French (2013) was estimated by the Generalized Method of Moments (GMM), and then by adding the combined information risk factor to the five-factor model of Fama and French (2013), it was estimated again by the Generalized Method of Moments (GMM). As can be seen in Table (7) by adding a combined information risk factor to the five-factor model of Fama and French (2013), based on the statistical criteria of adjusted coefficient of determination ($AdjR^2$), bias proportion and Root Mean Square Error (RMSE), the ability to explain the modified five-factor model of Fama and French (2013) increases by approximately 4.5%, so the research hypothesis is confirmed.

Also, the results of the cumulative sum of recursive residuals (CUSUM) test to evaluate the structural stability of the five-factor model of Fama and French (2013) adjusted with the information risk factor are as shown in Figure 3.



Source: Research Findings

Figure 3, Cumulative sum of recursive residuals of Fama and French (2013) five-factor model adjusted with the information risk factor

According to the results of the cumulative sum of recursive residuals (CUSUM) test, the statistics are approximately within the 95% confidence interval, and the null hypothesis of structural stability of the model is not rejected, and at the 95% confidence level, the results obtained from the estimation of the Fama and French (2013) five-factor model adjusted with the information risk factor, are reliable and valid.

7. Discussion and Conclusions

Research on stock prices and returns has led to two conflicting perspectives known as competing hypotheses. One of these hypotheses is the random walk hypothesis, which emphasizes the unpredictability of stock returns. The opposite hypothesis believes that the price can be predicted based on a set of information. Efficient market hypothesis, capital asset pricing model, factor or index models, arbitrage model, technical analysis and fundamental analysis all refer to these two hypotheses in forecasting and determining stocks prices and returns. Therefore, the importance of predicting stock returns led researchers to look for variables and indicators that can explain stock returns. The debate over the forecast of stock returns in developed countries has long been considered as one of the most interesting scientific debates. Although effective steps have been taken in this regard, due to many problems, accurate forecasting of stock returns still remains a challenge. The results of some researches in Iran (Izadinia et al. 2014, Salehi et al. 2015, Vakilifard et al. 2017, Amiri and Alizadeh Ahvazi 2018, Khermandar et al. 2020, etc.) show the low explanatory power of the mentioned pricing models in the Iranian capital market. On the other hand, considering that the Iranian capital market is an emerging market that is not desirable in terms of information efficiency, and also due to the presence of small and or inexperienced investors, the colorful presence of the government in the major ownership of companies, limited resources information about financial and non-financial information of companies, the nascent corporate governance system, especially the audit committee, and the lack of sufficient transparency in the information environment of companies, cause anomalies in the pricing of companies' shares. Therefore, it is necessary to study the effect of information risk in the Iranian capital market on excess return (risk premium) and research to increase the ability to predict pricing factor models in accordance with the information environment of the Iranian capital market. In this study, the combined information risk index is calculated using the normalized sum of the values of information asymmetry, stock price synchronicity, stock price delay reaction, and accounting conservatism, and then the difference between the average portfolio return of companies with high information risk and portfolio return of companies with low information risk were calculated and added to the five-factor model of Fama and French (2013) as a predictor to explain the stock returns of companies. To estimate the research models, the Generalized Method of Moments (GMM) was used. In this method, the dependent variable interrupt (risk premium) is entered as an instrumental variables and on the other hand, in the proposed model, the nonlinear relationship of combined information risk with excess return (risk premium) was evaluated by Generalized Method of Moments (GMM). The results show that the combined information risk factor is able to explain part of the pricing anomaly in the Iranian capital market and the ability to explain the five-factor model of Fama and French (2013) increases by about 4.5%. Therefore, investors, creditors and capital market analysts are suggested to pay attention to information risk factors as factors affecting excess return (risk premium) in predicting the stock returns of companies.

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