

Determining Corporate Characteristics on the Relationship between Labor Investment Efficiency and Stock Price Crash risk

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Abstract: One of the factors that all investors should consider is the optimal investments of the economic unit. In this regard, investors purchase assets for investment with the hope that they will earn returns over the next few periods. Also, one of the most important market components for investors, in addition to the aforementioned issues, is the stock price Crash risk. Considering the above-mentioned issues, this research seeks to examine the effect of corporate characteristics on the relationship between Labor Investment Efficiency and stock price Crash risk. In this study, 168 companies listed on the Tehran Stock Exchange during the period 2013-2022 were studied. To test the hypotheses, a logistic regression model was used. The findings of the study show that Labor Investment Efficiency has a negative and significant effect on the risk of stock price collapse. Also, the company characteristics variables of company size and performance have a negative and significant effect on the relationship between Labor Investment Efficiency and stock price Crash risk, but bankruptcy risk does not have a significant effect on the aforementioned relationship.

Keywords: Labor Investment Efficiency, stock price Crash risk, company size, performance, bankruptcy risk

Introduction

A stock price crash is a phenomenon in which the stock price undergoes a sudden and severe negative adjustment. In other words, a stock price crash is a phenomenon in which a sudden and negative revision of investors' expectations regarding a company's shares occurs. Two main causes and components have always been discussed in research conducted on stock price crashes. First: the company's management, which may, due to selfish motives for its own personal interests or benevolently for the organization's goals, overstate the company's performance by delaying the release of bad news or accelerating the release of good news. This process will lead to the creation of a bubble in the company's stock price, and second: the accounting system that allows the company's management to take the above measures (Dianti Deilami et al., 2012). Understanding the factors and consequences of the risk of a stock price crash is very important because it has a direct impact on the welfare of investors. On the other hand, in the absence of the agency problem, managers will move towards maximizing shareholder benefits and will do this by choosing the optimal level of company investments (Ghaly et al., 2015). However, according to agency theory, there is a conflict between the interests of the owner and the manager, and this conflict also affects the company's investment policies and leads to overinvestment or underinvestment (Jensen and Meckling, 1976; Jensen, 1986). One of the most important investments of a company is investment in human resources. Decisions

related to investment in human resources are no exception to this rule. In other words, company managers may have several motives for inefficient investment at the macro level and inefficient investment in human resources in particular. One of the management motives for using human resources inefficiently can be explained according to the theory of domination (empire building) of the manager. Research conducted in this area shows that when a manager has a conflict of interest with the owner, he has the motive to overemploy human resources and hire too many people (Stein, 2003). Considering the above discussions and the role that Labor Investment Efficiency can have on the risk of stock price collapse. To clarify the issue, this study then presents the problem, research background, hypotheses, findings, and finally, research conclusions and suggestions.

Statement of the problem and research background

Jane and Myers (2006) examine how information asymmetry between inside and outside firms can be related to stock price crash risk. Specifically, they predict that ambiguous stocks are more prone to stock price crash risk due to managers' willingness to receive bad news for these stocks. According to research by Houghton et al. (2019), if a company is over-valued, it means that the company cannot provide the necessary performance to justify this stock price. Managers know that if the true value of the company is revealed, the "market" will punish the company. In this regard, in order to justify the market's desired price, managers must hide the company's unfavorable performance by manipulating financial statements in the short term. It is also possible that managers accept projects with negative NPV through "over-buying" or delay the company's existing projects (Chamnorr and Paglis, 2020). Previous research suggests that in semi-efficient markets, factors such as information asymmetry and agency problems may force managers to make inefficient investment decisions that lead to overinvestment and underinvestment. Underinvestment theory suggests that managers may choose projects that are risky but have high positive present value, especially when these projects are financed by shareholders. This can lead to an increase in the risk of stock price collapse (Andreou et al., 2023). Given that investment efficiency is not only in the area of using fixed assets of the economic unit and human resources as a capital should also be considered important for achieving the goals of the economic unit, Williamson (1963) stated that excessive recruitment of human resources by the manager indicates opportunistic behavior of management and is carried out with the aim of increasing the power, security, status and prestige of management. Excessive recruitment of human resources may also be carried out with the motive of retaining employees who have poor performance and hiring new employees to cover their shortcomings. Bertrand and Melinathan (2003) showed that managers sometimes do not engage in firing unproductive employees because they are looking for peace of mind (Habib and Hassan, 2021). In this regard, underinvestment in human resources can be due to pressure from investors outside the organization on the manager to hire low-quality employees or not to hire due to achieving the target profit. As Narayanan (1985), Bushey (1998), Stein (2003) and Porter (1992) have pointed out, pressure from external investors to control stock prices according to their opinion can cause management not to make optimal and profitable decisions and to miss out on suitable investment opportunities. The effect of decisions such as investment in human resources, research and development costs, advertising and human capital is visible only in the long run, and if the manager, under pressure from external factors, makes decisions that are only short-term and aimed at shareholder price goals, he may invest less in quality human resources (Habib and Hassan, 2021). Given the existence of incentives for inefficient investment (especially in human resources), previous research has examined drivers with the aim of explaining this phenomenon. The common theme of most of these studies is "management agency influence", which can lead to investment inefficiency and ultimately an increase in the risk of stock price collapse (Ha and Feng, 2018 and Mehrani and Samiei, 2019).

Investment efficiency is expected to prevent the risk of future stock price collapse because investment efficiency reduces the conflict of interest between managers and shareholders and helps managers act in the interests of shareholders. Therefore, the investments that managers make are not for personal gain but to maximize the value of the company. When the value of the company improves, stock price volatility will decrease and prices will enjoy relative stability in the market (Lai et al., 2020). Investment efficiency not only reduces the problems of underinvestment but also the agency costs associated with information asymmetry and managerial risk-taking incentives. Ultimately, implementing such mechanisms will prevent sudden price falls in the market, and the negative relationship between investment efficiency and stock price Crash risk will be exacerbated in environments with information asymmetry (Kim and Zhang, 2022). On the other hand, each company has a set of characteristics related to the type and nature of its activity (company-specific characteristics). Different business activities have different complexity, operating cycle, risk, return, capital, financial resources, goals and missions, which can lead to different risks of stock price collapse (Akhgar and Karami, 2014). In this regard, one of the specific characteristics of the company is its size. Large companies face less risk of stock price collapse due to better reputation, having sufficient guarantees and having diverse activities and due to less information asymmetry (Kim and Zhang, 2022). According to the theory of stable equilibrium (static equilibrium), profitability indicates the ability of companies to

maintain assets, and accordingly, it is predicted that profitable companies have relatively less debt. In addition, using the dynamic substitution relationship model, [Kayhan and Titman \(2007\)](#) proposed that there is a negative relationship between financial leverage and profitability. Accordingly, debt can prevent managers from abusing free cash flows and from making inadequate investment decisions in line with individual goals (which ultimately increases the cost of corporate bankruptcy). Finally, the relationship between various performance and profitability evaluation criteria and the leverage ratio (whether positive or negative) is expected to affect the stock price Crash risk ([Lee et al., 2017](#)). On the other hand, according to the hierarchy theory, companies with high stock price risk have more debt. It is claimed that these companies suffer from poor financing selection. In addition, companies with high stock price risk usually have limited access to the capital market for financing. As a result, companies with high stock price risk are expected to have higher financing costs. In addition, the tax shield is more likely to be fully used for companies with volatile cash flows. Accordingly, firm risk as one of the specific characteristics of the company can expose the economic unit to a higher stock price Crash risk ([Dennis and Strickland, 2016](#)). Considering the arguments raised regarding issues related to Labor Investment, this study examines the effect of corporate characteristics on the relationship between Labor Investment Efficiency and stock price Crash risk. The following are the references related to the main title of the study:

[Piriotakis et al. \(2024\)](#) examined the relationship between high-frequency trading and stock price downside risk. Using attention difference analysis, they found that stock price downside risk increases by more than 80% in the presence of high-frequency trading (HFT). Notably, the positive effect of HFT on downside risk is more pronounced for larger firms. Our results survive a series of robustness tests, including propensity score matching and placebo tests. Channel analysis suggests that HFT increases liquidity and makes stock prices noisier and less informative, which exacerbates investor disagreement and encourages managerial bad news speculation. Finally, the effect of HFT is moderated in countries with developed derivatives markets, for firms with higher analyst coverage, and in collectivist or religious societies. [Andreu et al. \(2023\)](#) believe that as the decline in the price of specific companies' stocks increased from 5.5% to 27% between 1950 and 2018, most of the existing literature in this field has attributed the decline in stock prices to reasons and agency problems such as hiding bad news (financial reporting) by managers and excessive investment. However, agency problems are not sufficiently able to explain the increasing frequency of stock price declines. [Kim and Zhang \(2022\)](#) examined the relationship between the aforementioned variables in a study titled "The Relationship between Investment Efficiency and Stock price Crash risk with Emphasis on Information Asymmetry". The results of the first hypothesis of their study showed that there is a positive relationship between investment inefficiency and stock price Crash risk. Also, in their study, the sample companies were divided by product market competition index and advertising expenditure. Companies with low competition and high advertising expenditure indicate high information asymmetry. The results of the second hypothesis of their study showed that the positive relationship between investment inefficiency and the risk of stock price collapse is stronger in companies with high information asymmetry than in companies with low information asymmetry. [Hyunmin and Sambuk \(2022\)](#) studied the effect of economic uncertainty on the relationship between corporate governance and Labor Investment Efficiency. They found that conflict of interest and information asymmetry between managers and owners increase the risk of inefficient decisions, especially in the area of Labor Investment, which is reduced by strengthening regulatory levers. Economic uncertainty also has a negative effect on this relationship and reduces the intensity of the relationship.

[He and Ren \(2021\)](#) believe that there is a positive and significant relationship between the company's financial constraints and the risk of future stock price collapse, and this direct relationship is stronger in companies with weak corporate governance. [Habib and Hassan \(2021\)](#) studied business strategy and Labor Investment Efficiency. Results using a large sample of US data show that firms with an exploratory business strategy are associated with inefficient Labor Investment, while those with a defensive business strategy are associated with efficient Labor Investment. [Lai et al. \(2020\)](#) examined the effect of manager overconfidence and Labor Investment efficiency. The findings suggest that firms with high-confidence CEOs have lower Labor Investment efficiency. Chiang Lee et al. (2018) conducted a study to investigate the relationship between managerial ability and investment opportunities of companies. This study examined whether companies managed by superior managers can obtain more favorable investment opportunities using data from US industrial companies over the years (1988-2015). The empirical results reveal that there is a positive relationship between managerial ability and investment opportunities, and this relationship is only significant in companies without financial constraints or companies with strong financial positions. In general, the findings support that companies with superior managers can earn more economic profits through better investment. Through our research, policymakers and investors can pay more attention to managerial ability ([Hyunmin and Sambok, 2022](#)). [Kim et al. \(2018\)](#) conducted a study to examine the relationship between CEO losses and the risk of stock price collapse. In general, CEOs, due to their opportunistic behaviors, lead to losses. Factors such as

information asymmetry, overconfidence, and lack of news release become undesirable, all of which have a positive impact on the risk of future stock price declines.

Research Method

The present study is considered an applied research in terms of its purpose. The purpose of applied research is to develop applied knowledge in a specific field. In other words, applied research is directed towards the practical application of knowledge. Also, in terms of the method of data collection, this research is descriptive (because it leads to a greater understanding of existing conditions and helps in the decision-making process) and correlational. Because it examines the degree of dependence of the dependent variable and the independent variable on each other. The research method is inductive in which the theoretical foundations and research background are collected through the library, articles and the Internet, and inductive reasoning is used to generalize the results in rejecting or proving the research hypothesis by using appropriate statistical methods. In this study, data will be used in the form of year-company to test the hypothesis.

Research Statistical population

The statistical population of the study includes all companies listed on the Tehran Stock Exchange and the OTC market, for which the following adjustments have been made for its selection. 1- The companies' fiscal year ends at the end of March; 2- During the time frame of the research, they have not stopped their activities and have not changed their fiscal period; 3- Due to information limitations, they are not part of the over-the-counter primary market companies; 4- They are not part of investment (holding) and financial intermediation (leasing and banking) and insurance companies; 5- During the time frame of the research, there has been no trading break of more than six months and their information is available for at least one year. After applying the above adjustments, 168 companies were included in the statistical population of this research. The time frame of the research is 10 fiscal periods (from 2013 to 2022) and 1680 company years. It should be noted that the data was collected using the new Rahavard software and the information published by the companies on the KODAL network and the Stock Exchange Organization's transaction archive.

Research Hypotheses

Based on the theoretical foundations mentioned, the research hypotheses are as follows:

Hypothesis (1): Labor Investment Efficiency affects the stock price Crash risk.

Hypothesis (2): Company characteristics affect the relationship between Labor Investment Efficiency and stock price Crash risk.

Hypothesis (2-1): Company size affects the relationship between Labor Investment Efficiency and stock price Crash risk.

Hypothesis (2-2): Company performance affects the relationship between Labor Investment Efficiency and stock price Crash risk.

Hypothesis (2-3): Bankruptcy risk affects the relationship between Labor Investment Efficiency and stock price Crash risk.

Research variables and their operational definitions

Given that the present study seeks to examine the corporate characteristics that determine the relationship between Labor Investment Efficiency and stock price Crash risk. Therefore, the hypothesis model based on [Kim and Zhang's \(2022\)](#) research is presented as follows:

Test model for main hypothesis (1):

$$CR_{it} = \beta_0 + \beta_1 LIE_{it} + \beta_2 MB_{it} + \beta_3 CFO_{it} + \beta_4 SALE_{it} + \beta_5 DIV_{it} + \beta_6 LOSS_{it} + \beta_7 IP_{it} + \beta_8 Q_{it} + \varepsilon_{it}$$

Sub-hypothesis testing model (2-1):

$$CR_{it} = \beta_0 + \beta_1 LIE_{it} + \beta_2 SIZE_{it} + \beta_3 SIZE * LIE_{it} + \beta_4 MB_{it} + \beta_5 CFO_{it} + \beta_6 SALE_{it} + \beta_7 DIV_{it} + \beta_8 LOSS_{it} + \beta_9 IP_{it} + \beta_{10} Q_{it} + \varepsilon_{it}$$

Sub-hypothesis testing model (2-2):

$$CR_{it} = \beta_0 + \beta_1 LIE_{it} + \beta_2 ROA_{it} + \beta_3 ROA * LIE_{it} + \beta_4 MB_{it} + \beta_5 CFO_{it} + \beta_6 SALE_{it} + \beta_7 DIV_{it} + \beta_8 LOSS_{it} + \beta_9 IP_{it} + \beta_{10} Q_{it} + \varepsilon_{it}$$

Sub-hypothesis testing model (2-3):

$$CR_{it} = \beta_0 + \beta_1 LIE_{it} + \beta_2 BR_{it} + \beta_3 BR * LIE_{it} + \beta_4 MB_{it} + \beta_5 CFO_{it} + \beta_6 SALE_{it} + \beta_7 DIV_{it} + \beta_8 LOSS_{it} + \beta_9 IP_{it} + \beta_{10} Q_{it} + \varepsilon_{it}$$

Table 1. Symbols of research variables

Variable name	Symbol	Variable name	Symbol
stock price Crash risk	CR	Company Loss	LOSS
Labor Investment Efficiency	LIE	Industry Performance	IP
Market-to-book value	MB	Company Value	Q
Operating cash flow	CFO	Company Size	SIZE
Sales revenue	SALE	Company Performance	ROA
Earnings per share	DIV	Bankruptcy Risk	BR

The following is the method of measuring each of the research variables:

How to calculate Labor Investment Efficiency

In this study, Labor Investment Efficiency is the independent variable, which is measured using the [Jang et al. \(2014\)](#) model as follows.

$$NET_HIRE_{it} = \beta_0 + \beta_1 SALES_GROWTH_{it-1} + \beta_2 SALES_GROWTH_{it} + \beta_3 \Delta ROA_{it} + \beta_4 \Delta ROA_{it-1} + \beta_5 ROA_{it} + \beta_6 RETURN_{it} + \beta_7 SIZE_{it} + \beta_8 QUICK_{it-1} + \beta_9 \Delta QUICK_{it-1} + \beta_{10} \Delta QUICK_{it} + \beta_{11} LEV_{it-1} + \varepsilon_{it}$$

Where NET_HIRE is the investment in human resources (percentage of changes in the total number of human resources), SALES_GROWTH is the growth in sales revenue (changes in sales revenue), ROA is the return on assets (the ratio of net income to total assets at the beginning of the period), ΔROA is the change in return on assets, RETURN is the return on equity (the equivalent of the closing price of the period minus the opening price of the stock plus cash dividends minus cash contributions from shareholders divided by the opening price), SIZE is the size of the company (the natural logarithm of the company's market value), QUICK is the immediate ratio (the ratio of cash and short-term investments to current liabilities), $\Delta QUICK$ is the immediate ratio change, LEV is the financial leverage (the ratio of long-term liabilities to total assets at the beginning of the period).

In the above model, it is assumed that changes in human resources (investment in human resources) should be a function of the economic situation of the company (which is explained by independent variables), and whatever is estimated by this model is the optimal amount of investment in human resources, and any excess or less than that indicates the inefficiency of investment in human resources. Therefore, the inefficiency of the model is determined by subtracting the values estimated by this model for each of the companies, and changes in excess of it indicate inefficiency. According to the research of [Jang et al. \(2014\)](#), the absolute value of the model's disturbance components ($|AB_NET_HIRE_{it}|$) indicates the inefficiency of investment in human resources, which is placed as a dependent variable in the next model. The disturbance components have a positive sign, indicating overinvestment in human resources, and a negative sign indicates underinvestment in human resources ([Hyunmin and Sambuk, 2022](#)). Accordingly, after calculating the absolute value of the model error for aligning this variable with other variables, the resulting value is multiplied by -1.

How to calculate stock price Crash risk

In this study, stock price crash risk is the dependent variable, which is measured using the [Hatton et al. \(2009\)](#) model. According to the study by [Hatton et al. \(2009\)](#), the crash period in a given fiscal year is the period during which the company's specific monthly return is 3/2 standard deviations lower than its average specific monthly return. The basis of this definition is the statistical concept that, assuming the normal distribution of the company's specific monthly return, fluctuations that fall within the range of the mean plus 3/2 standard deviations and the mean minus 3/2 standard deviations are considered normal fluctuations, and fluctuations outside this range are considered abnormal. Given that stock price crash is an abnormal fluctuation, the number 3/2 is considered the boundary between normal and abnormal fluctuations.

According to the model of [Hatton et al. \(2009\)](#), the risk of stock price crash is a dummy variable that is considered to be one if the company has experienced at least one crash period during the fiscal year and zero otherwise.

The specific monthly return of the company is calculated using the following equation.

$$W_{j,\theta} = \ln(1 + \varepsilon_{j,\theta})$$

In the above equation, $W_{j,\theta}$ is the specific monthly return of company j in month θ during the fiscal year and $\varepsilon_{j,\theta}$ is the residual return of company j stock in month. and the following equation is obtained from the residual of the regression model.

$$r_{j,\theta} = \beta_0 + \beta_1(r_{m,\theta-2}) + \beta_2(r_{m,\theta-1}) + \beta_3(r_{m,\theta}) + \beta_4(r_{m,\theta+1}) + \beta_5(r_{m,\theta+2}) + \varepsilon_{i,\theta}$$

In the above regression relationship $r_{j,\theta}$ the company's stock return j in month θ during the fiscal year; $r_{m,\theta}$ is the market return in month θ . The growth rate of the market index in each month is used to calculate the monthly market return. The regression model is fitted using multivariate linear regression and the mixed data method.

How to calculate company characteristics

In this study, company characteristics include company size, company performance, and bankruptcy risk, which are calculated as follows.

Company size: This variable is measured based on the natural logarithm of total assets. To virtualize the variable, first the variable is sorted from the lowest value to the highest value and the number 1 (one) is considered for above the median and the number 0 (zero) is considered for below the median. Year- above-median companies are considered as large companies and year- below-median companies are considered as small companies.

Company performance: To measure this variable, the return on assets ratio is used so that net profit is divided by the company's total assets (Osoulia et al., 2016). To virtualize the variable, the same steps are taken as for company size.

Bankruptcy Risk: To calculate bankruptcy risk, the Altman model is used according to Kuang's research (2021) as follows:

$$Z = 1.2 X_1 + 1.4 X_2 + 3.3 X_3 + 0.6 X_4 + 1.0 X_5$$

Where X_1 is the ratio of working capital to total assets, X_2 is the ratio of retained earnings to total assets, X_3 is the ratio of earnings before interest and taxes to total assets, X_4 is the market value of equity to total assets, and X_5 is the ratio of total sales to total assets (Chambariani, 2024).

Table 2. Bankruptcy Probability Categories

Row	Bankruptcy Probability	Range Z
1	Too much	$1.21 \leq Z$
2	Weak	$1.21 < Z \leq 2.99$
3	Not	$2.99 > Z$

For the year-companies in the "very high" bankruptcy probability category, the dummy variable is 1 (one) and for the other categories, the dummy variable is 0 (zero).

Control variables

The control variables of the study based on the research of Zhang et al. (2014) are as follows:

Market-to-book ratio: This variable is measured through the ratio of the market value of the stock to the book value.

Operating cash flows: This variable is measured through the ratio of cash flows to total assets.

Company sales revenue: This variable is measured based on the natural logarithm of the company's sales revenue.

Earnings per share: This variable is measured through the ratio of dividends to earnings per share.

Company loss-making: If the observation in the year-companies in question is loss-making, the dummy variable is 1, and otherwise the dummy variable is 0.

Industry performance: To calculate the industry effect, the research of Bari et al. (2019) and Lu et al. (2020) is used. In general, the average return on assets for each industry is used to calculate this variable.

Firm value: To calculate the value of the firm, the Q-Tobin ratio is used. This variable is obtained from the sum of the market value of equity and the book value of total liabilities divided by the book value of total assets (Swarnapali and Lee, 2018).

Research Findings

In general, the research findings are divided into two parts: descriptive and inferential statistics, which are presented as follows.

Descriptive statistics of research variables: A summary of the descriptive statistics related to the research variables after screening and removing outliers is as follows:

Table 3. Descriptive statistics of the research variables model in the total sample

Variable	Mean	Median	Max.	Min.	STD	Skewness	kurtosis
(LIE)	-0.077	-0.044	-0.000	-0.692	0.103	-3.176	15.452
(MB)	4.904	2.690	41.172	-4.811	6.775	63.367	16.213
(CFO)	0.126	0.105	0.740	-0.460	0.144	0.627	4.968
(SALE)	13.943	13.905	19.861	7.611	1.466	0.177	4.431
(DIV)	0.845	0.488	10.767	0.000	1.550	4.478	26.107
(IP)	0.133	0.137	0.545	-0.297	0.089	0.257	4.243
(Q)	2.802	1.681	37.018	0.617	3.681	5.544	42.532
(BR)	Year - Companies without bankruptcy risk: 1494 Year - Companies with bankruptcy risk: 186						
(CR)	Year - Companies without stock price crash risk: 1318 Year - Companies with stock price crash risk: 362						
(LOSS)	Year - Profitable companies: 1517 Year - Loss-making companies: 163						
(SIZE)	Year - Small-sized companies: 840 Year - Large-sized companies: 840						
(ROA)	Year - Companies with low company performance level: 840 Year - Companies with high company performance level: 840						

According to [Table 3](#), the number of observations of the year-company based on the balanced composite data was 1680 observations, equal to 168 companies in 10 years. According to the descriptive statistics, the above indicators can be divided into central, dispersion and other indicators, where the central indicators are the mean and median indicators, the dispersion indicators are the standard deviation indicators and the other indicators are the maximum, minimum, skewness and kurtosis indicators. In summary, the average bankruptcy risk shows that the year-companies without bankruptcy risk are 1494 observations and the year-companies with bankruptcy risk are 186 observations. The average risk of stock price collapse shows that the year-companies without stock price Crash risk are 1318 observations and the year-companies with stock price Crash risk are 362 observations. The average loss-making company shows that the year-companies with profit are 1517 observations and the year-companies with loss are 163 observations. Regarding the negative skewness coefficient of some variables, it can also be said that this indicates the existence of a rightward skewness and a tendency for these variables to have smaller values. Also, the positiveness of the skewness coefficients indicates that they are higher than the normal distribution and the data is concentrated around the mean.

Normality test of the distribution of the dependent variables of the study: In this study, the Kolmogorov-Smirnov (K-S) test is used to examine the normality of the research variables.

Table 4. Results of the normality test of the distribution of the dependent variable

dependent variable	Dependent variable Results of the K-S test (normality)
Stock price crash risk (CR)	.Given the qualitative nature of the variable, it is obvious that it is not normal

According to [Table 4](#), the significance level of the Z statistic of the KS test for the stock price crash risk variable (as the dependent variable) due to its qualitative nature indicates that the dependent variable of the research does not have a normal distribution, therefore, non-parametric statistical methods are used to test the hypotheses.

Results of inferential statistics for testing research hypotheses

The results of inferential statistics for testing research hypotheses are as follows:

Results of testing the first hypothesis

The results of testing the first hypothesis are as shown in [Table 5](#).

Table 5. Model estimation results for research hypothesis (1)

Variable name and symbol	Regression coefficient	Z statistic	Prob.	VIF statistic
(LIE)	-5.288	-9.212	0.000	1.018
(MB)	0.046	3.116	0.001	2.095
(CFO)	0.231	0.487	0.626	1.126
(SALE)	-0.093	-2.095	0.036	1.072
(DIV)	-0.028	-0.626	0.530	1.057
(LOSS)	1.106	5.620	0.000	1.164
(IP)	-2.698	-3.207	0.001	1.341
(Q)	-0.077	-2.499	0.012	2.130
Constant	-0.299	-0.482	0.629	-
LR Test		187.662		
Prob.		(0.000)		
HL statistic		11.166		
Prob.		(0.192)		
Andrews Statistic		11.112		
Prob.		(0.348)		
McFadden R-SQ		0.207		

According to the results of the main hypothesis test (1), which is presented in Table 5, the significance level of the LR statistic (0.000) is lower than the acceptable error level (5 percent) and the entire regression model is significant. The results of the goodness-of-fit test (HL and Andrews tests) also show that the regression model has a relatively good fit. Also, considering the low probability level (Prob.) of the Z statistic (0.000) from the acceptable error level, for the coefficient I_{it} (independent variable), the test results show that the efficiency of Labor Investment has a negative and significant effect on the risk of stock price collapse. The McFadden coefficient of determination also indicates that 20.7 percent of the changes in the risk of stock price collapse are explained by the variables entered in the model. Of the control variables, market-to-book value and loss-making of the company have a positive effect on the risk of stock price collapse, and sales revenue, industry performance and company value have a negative and significant effect on the risk of stock price collapse. Finally, with the collinearity test between the research variables, the VIF (variance inflation factor) statistic value for all variables was less than 5, indicating that there is no severe collinearity problem between the research variables.

Results of the first sub-hypothesis test

The results of the first sub-hypothesis test are as shown in Table 6.

Table 6. Model estimation results for research hypothesis (2-1)

Variable name and symbol	Regression coefficient	Z statistic	Prob.	VIF statistic
(LIE)	-4.936	-6.474	0.000	1.832
(SIZE)	-0.416	-2.055	0.039	2.363
(SIZE*LIE)	-0.790	-2.607	0.009	2.266
(MB)	0.048	3.248	0.001	2.108
(CFO)	0.141	0.296	0.766	1.135
(SALE)	-0.086	-2.280	0.031	1.914
(DIV)	-0.028	-0.640	0.521	1.057
(LOSS)	1.114	5.658	0.000	1.164
(IP)	-2.577	-3.059	0.002	1.346
(Q)	-0.080	-2.619	0.008	2.141
Constant	-1.169	-1.490	0.136	-
LR Test		192.063		
Prob.		(0.000)		
HL statistic		8.832		
Prob.		(0.356)		
Andrews Statistic		9.731		
Prob.		(0.464)		
McFadden R-SQ		0.209		

According to the results of the test of the sub-hypothesis (2-1), which is presented in Table 6, considering the low probability level (Prob.) of the Z statistic (0.009) of the acceptable error level, for the coefficient beta 3 (independent variable), the test results show that the size of the company has a negative and significant effect on the relationship between the efficiency of Labor Investment and the risk of stock price collapse. The McFadden coefficient of determination also indicates that 20.9 percent of the changes in the risk of stock price collapse are explained by the variables entered in the model. Of the control variables, the market-to-book value and the company's loss-making have a positive effect on the risk of stock price collapse, and sales revenue, industry performance and company value have a negative and significant effect on the risk of stock price collapse.

Results of the second sub-hypothesis test

The results of the second sub-hypothesis test are as shown in Table 7.

Table 7. Model estimation results for research hypothesis (2-2)

Variable name and symbol	Regression coefficient	Z statistic	Prob.	VIF statistic
(LIE)	-4.727	-5.977	0.000	2.054
(ROA)	-0.216	-1.120	0.262	2.092
(ROA*LIE)	-1.132	-2.541	0.009	2.176
(MB)	0.045	2.999	0.002	2.134
(CFO)	0.292	0.593	0.553	1.199
(SALE)	-0.092	-2.068	0.038	1.078
(DIV)	-0.033	-0.734	0.462	1.070
(LOSS)	1.058	5.236	0.000	1.222
(IP)	-2.478	-2.785	0.005	1.529
(Q)	-0.074	-2.383	0.017	2.185
Constant	-0.238	-0.381	0.703	-
LR Test		189.109		
Prob.		0.000		
HL statistic		6.888		
Prob.		0.548		
Andrews Statistic		9.151		
Prob.		0.517		
McFadden R-SQ		0.208		

According to the results of the test of the sub-hypothesis (2-2), which is presented in Table 7, considering the low probability level (Prob.) of the Z statistic (0.009) of the acceptable error level for the coefficient beta 3 (independent variable), the test results show that the company's performance has a negative and significant effect on the relationship between Labor Investment Efficiency and the risk of stock price collapse. The McFadden determination coefficient also indicates that 20.8 percent of the changes in the stock price Crash risk variable are explained by the variables entered in the model. Of the control variables, market-to-book value and the company's loss-making have a positive effect on the risk of stock price collapse, and sales revenue, industry performance, and company value have a negative and significant effect on the risk of stock price collapse.

Results of the third sub-hypothesis test

The results of the third sub-hypothesis test are as shown in Table 8.

Table 8. Model estimation results for research hypothesis (2-3)

Variable name and symbol	Regression coefficient	Z statistic	Prob.	VIF statistic
(LIE)	-5.574	-9.263	0.000	1.087
(BR)	1.348	5.398	0.000	2.037
(BR*LIE)	0.927	0.402	0.687	1.786
(MB)	0.045	2.912	0.003	2.101

Variable name and symbol	Regression coefficient	Z statistic	Prob.	VIF statistic
(CFO)	0.473	0.983	0.325	1.130
(SALE)	-0.095	-2.136	0.032	1.075
(DIV)	-0.058	-1.280	0.200	1.067
(LOSS)	0.456	2.012	0.044	1.479
(IP)	-2.543	-2.978	0.002	1.345
(Q)	-0.056	-1.836	0.066	2.163
Constant	-0.471	-0.751	0.452	-
LR Test		227.612		
Prob.		0.000		
HL statistic		6.819		
Prob.		0.556		
Andrews Statistic		7.210		
Prob.		0.705		
McFadden R-SQ		0.229		

According to the results of the test of the sub-hypothesis (2-3), which is presented in [Table 8](#), considering the low probability level (Prob.) of the Z statistic (0.000) of the acceptable error level for the coefficient beta 3 (independent variable), the test results show that the risk of bankruptcy does not have a significant effect on the relationship between Labor Investment Efficiency and the risk of stock price collapse (due to a significance level above 5 percent). The McFadden coefficient of determination also indicates that 22.9 percent of the changes in the risk of stock price collapse are explained by the variables entered in the model. However, among the control variables, the market-to-book value and the company's loss-making have a positive effect on the risk of stock price collapse, and sales revenue and industry performance have a negative and significant effect on the risk of stock price collapse.

Conclusions and Suggestions

Given that in the present study, the effect of corporate characteristics on the relationship between Labor Investment Efficiency and stock price Crash risk in Tehran Stock Exchange companies has been investigated. Therefore, the research findings show that Labor Investment Efficiency has a negative and significant effect on the stock price Crash risk, and also, among the company characteristics, the variables of company size and performance have a negative and significant effect on the relationship between Labor Investment Efficiency and stock price Crash risk, but bankruptcy risk does not have a significant effect on the aforementioned relationship. The results and findings obtained in the research hypotheses are in line with the theoretical framework mentioned in the research of [Kim and Zhang \(2022\)](#), [Habib and Hassan \(2021\)](#), [Kim et al. \(2018\)](#) and [Chambriani \(2024\)](#). Regarding the analysis of the first hypothesis, it can be said that, in general, Labor Investment Efficiency reduces the stock price Crash risk of companies. When companies face greater investment efficiency in the field of human resources. The economic unit faces profitability, income and business development in the business environment, and their long-term planning and decision-making are not challenged. This important point leads to an accurate assessment of the performance and future value of companies by investors, which ultimately reduces stock price fluctuations and ultimately the risk of stock price collapse. Regarding the first sub-hypothesis, it can be said that in general, when the company is large, there are more growth opportunities, because in these companies, more services are provided based on the company's resources. Often, in these companies, given their position in society, capable managers are always used. Accordingly, when the economic unit is in this situation, the managers of these companies try to maintain the efficiency of Labor Investment at the optimal point, which reduces stock price fluctuations and ultimately the risk of stock price collapse. Regarding the second sub-hypothesis, it can be said that in general, when a company faces favorable performance, this is considered as a factor affecting the productivity (sum of efficiency and effectiveness) of the economic unit and leads to an increase in the company's prominent market indicators. Therefore, in these conditions, the economic unit faces sufficient profitability and income, and by creating investment efficiency at the same time, investors obtain an accurate assessment of the future value of the companies, which reduces the risk of stock price collapse.

Regarding the third sub-hypothesis, it can be said that companies with unfavorable financial status and high bankruptcy risk, even in the presence of optimal investment efficiency, often have their prominent market indicators

disrupted. Accordingly, from a business perspective, this opportunity to use optimal Labor Investment Efficiency is likely to be directed towards companies with favorable financial status and lower bankruptcy risk. Because the two variables that have been used interactively in the third sub-hypothesis are in conflict with each other. The following are the research suggestions: Managers should pay attention to improving the risk of stock price collapse by increasing the efficiency of Labor Investment and company performance. Because this has a significant and significant impact on price fluctuations and ultimately a decrease in the risk of stock price collapse. Given that company managers seek to gain the trust of stakeholders, it is recommended that they always seek to increase investment efficiency. Because this has a positive sign in the market due to its role in the risk of stock price collapse and represents the desired performance of the economic unit in both the financial and stock market areas. Users of financial statements should always pay attention to variables such as investment efficiency, company size and performance when analyzing because their interests are related to these variables, which can have a strategic role in the selection of their investments. Capital market analysts are advised to pay attention to the negative relationship between Labor Investment Efficiency and the risk of stock price collapse. Because in general, not paying attention to market indicators can lead to increased information asymmetry and subsequent declines in important market indicators. It is suggested that the Stock Exchange Organization seek to create information content during the risk of stock price collapse and excessive price fluctuations in companies' stocks, and in the event of failure to disclose an acceptable level of information (in relation to prominent market indicators), use legal tools to force companies to do so.

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