Relationship between Stock Liquidity and Risk of Default in Iran's Petrochemical Industry and Oil Products Companies: The Roles of Stock Liquidity in Information Efficiency and Corporate Governance

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ARTICLE INFO

***Keywords*:**

Liquidity

Block holders

Default risk

Information efficiency

Corporate governance

Received: 1 April 2019
Revised: 15 May 2019
Accepted: 8 June 2019

ABSTRACT

The main purpose of this work is to explain why and how the stock liquidity affects the risk of default of petrochemical and petroleum products companies listed on Tehran Stock Exchange (TSE). The study used experimental data and parametric tests to estimate the relationship between stock liquidity and the risk of default through the roles of stock liquidity in information efficiency and corporate governance. The present research is applied in terms of purpose and is a descriptive-correlative study. All the data required regarding the stock liquidity, price, trading volume and days, stockholder ownerships, etc. were extracted from Rahavard Novin database software. To investigate the relationship between variables, the multivariate regression analysis model using panel least squares (PLS) method was applied in EViews platform. The empirical findings reveal a significant negative relationship between stock liquidity and the risk of default of petrochemical and petroleum product companies listed on TSE. Furthermore, stock liquidity influences the risk of default through pacifying information asymmetry in the stock pricing process and strengthening the corporate governance. These results could provide visible signals based on the realities of the market to improve models assessing and predicting the risk of default, to lead the managers and decision makers of suppliers, customers, partners, and stakeholders to conclude more flexible contracts with petrochemical and petroleum products companies, and to better mitigate business risks.

1. Introduction

One of the unpleasant incidents that may occur in a corporate life cycle is bankruptcy. Bankruptcy, through disturbing the supply chain of companies and the erosion of corporate staff, has a negative impact on the productivity of companies, increases the administrative and legal costs, and ultimately makes it difficult for companies to maintain the customers. Bankruptcy occurs when the company's cash flow is not sufficient to repay the principal and interest on debentures, accounts, and trade and nontrade accounts payable. Subsequently, the risk of bankruptcy increases if the company's cash flow is lower than the average cash flow of the current year, or its fluctuations increase (Brogaard et al., 2017). Corporate cash flow volatility increases default probability (Bharath and Shamwy, 2009). The risk of default is considered as one of the most important components of credit risk due to the borrower's inability or unwillingness to pay debts in due time to the creditor. In the International Finance and Banking Encyclopedia, if a party fails, whether intentionally or unintentionally, to act on all or part of its obligations, it commits a default. Historically, this risk was about bonds where lenders were worried about the repayment of the loan given to borrowers (Fallah Shams et al., 2017). In other words, default is happened when the average cash flow of a company decreases or fluctuates. Prior to the occurrence of the default, there is no way to identify the companies that fail, and at the best level, some estimates of default probabilities can only be obtained (Bharath and Shumway, 2009); however, Brogaard et al. (2017) argued that the risk of default could be estimated by market based (stock liquidity) signals. Liquidity is a factor in the structure of the market, which plays an important role in investors' decision to buy or sell stocks. A high-liquidity market allows investors to trade at a rational price, at a minimum cost, and at a higher speed. Considering the long queues in Iranian financial markets, one of the most important sources of risk which threatens investors' capitals is paying attention to liquidity when they make a decision on buying or selling shares (Bharath and Shamwy, 2009).

Markets with the appropriate liquidity level allow to enter and exit from the market with the least disruption and also the least transaction costs; therefore, liquidity can be regarded as one of the important factors in the growth and development of markets. Liquidity also has a profound effect on the stability of financial systems since high liquidity markets can better absorb systematic shocks and reduce their transmission to other components of the financial system; hence, liquidity prevents adverse effects of price fluctuations from extending over the other components of financial and macroeconomic systems, and the efforts of market authorities to understand the rules and regulations, service development, trade regulatory, and market structure reforms, which are aimed at increasing the depth and liquidity of capital markets, are perceivable (Karimi et al., 2012). Brogaard et al. (2017) argued that there is a negative and significant relationship between stock liquidity and the risk of default. They conducted a research on two occasions in the US Stock Exchange and showed that liquidity of stocks as a feature of each market could provide market-based and visible signals for predicting corporate risk default. The results of their studies also revealed that stock liquidity can reduce the risk of default through the roles of informational efficiency in the process of stock pricing and facilitating the formation of stockholder blocks to make governance mechanism robust. High liquidity allows shareholders to take advantage of their information and thus encourages investors to learn more about stock prices and to transact based on these information (Bharat and Shamwy, 2009), which leads to information-based pricing of stocks; moreover, since corporate executives use stock prices to manage company investment opportunities (Ozdenoren and Yuan, 2008), it enables them to make a better investment decision and create more cash flow for companies, which reduces fluctuations in corporate cash flow and thus results in a reduction in the risk of default (Brogaard et al., 2017). In addition, high liquidity facilitates the trading of stocks, especially for major stockholders, and this as a "threat to exit" can play a governance mechanism role (Maug, 1998). Good corporate governance regulates corporate executives and investment decisions. In fact, strong corporate governance forces managers to invest in opportunities with positive net worth and reduces managerial opportunism, so corporate governance can potentially drop the likelihood of the risk of default (Subrahmanyam, and Titman, 2001).

These empirical findings raise the question of whether this is true for Iranian petrochemical and oil products companies or not. Is it possible to predict the risk of default in the repayment of principal and interest on debt and other obligations using the stocks liquidity of petrochemical and oil products companies in Iran? In other words, could the stock liquidity of petrochemicals and refining companies affect their default risk? Therefore, the main issue of this research is the investigation of the relationship between stock liquidity and the default risk of petrochemical and oil products companies on Tehran Stock Exchange. The reason for choosing the statistical sample from the Tehran Stock Exchange, in addition to transparency in financial reporting and the existence of regulatory bodies and mechanisms, is simple access to accounting, financial, and trade information such as outstanding stocks, prices, volume of transactions, returns, risk, stockholders' composition, and other research variables. Examining such a connection in petrochemical and petroleum product industries is of great importance because these industries are the most concentrated sectors from a governance viewpoint, and there are block holders such as Tamin Petroleum and Petrochemical Investment Co. (TAPIKO), Vanaft (as a public joint stock oil industry investment company), Parsian, Persian Gulf Holding, Petrochemical Industries Investment Co., etc. operating in this context. Furthermore, these companies have strategic alliances and long-term contract with suppliers. Developing assessment and prediction models for the risk of default using stock liquidity will allow supplier companies, business partners, customers, and other stakeholders to assess the credibility of petrochemical and oil products companies, to conclude more flexible contracts, and to manage strategic risks. Aside from this, the study of the relationship between stock liquidity and corporate default risk offers a possibility for lawyers and policy makers of the capital market to focus on market-making or portfolio-making activities in petrochemical and petroleum product companies, which reduce the likelihood of default. Shareholders can also analyze the impact of policies adopted in TSE (market/portfolio-making) on the stock liquidity and subsequently corporate default risk.

The structure of the current paper is organized as follows. The second part examines the theoretical foundations of research and presents the literature review on the subject matter in Iran and other countries to reveal the gaps. The third part consists of methodology that discusses research method and design, and part four is devoted to analyzing the data. The last section is dedicated to concluding, discussing, interpreting, and justifying the results and providing suggestions.

2. Literature Review and Hypotheses Development

In the International Finance and Banking Encyclopedia, if a party fails, whether intentionally or unintentionally, to act on all or part of its obligations in relation to an agreed contract, it commits a default. The risk from the default is also known as credit risk. Historically, this risk was usually about bonds where lenders were worried about the repayment of the loan given to borrowers. For this reason, credit risk is also a risk of default (Fallah Shams, 2017). In general, default risk can be expressed as a probable loss occurring as a result of a credit event. The risk of default increases when the company's cash flow is lower than the average or is highly fluctuated (Brogaard et al., 2017). Liquidity refers to how fast an asset or stock can be sold at an intrinsic value on the market. More transactions for a stock mean more buyers and sellers are trading, which implies more liquidity (Cooper et al., 1985). Liquidity enables the holders of some assets, such as stocks, to buy, maintain, and sell their assets at the right time without worrying about the buyer for their assets (Sarin et al., 1996). If the sale and purchase of stocks on the market is of such a high volume that the stock market is not dominated by the seller, the price offered by the seller per share (quoted ask price) will be almost close to the price the seller would like to accept (quoted bid price). When the difference between the proposed and requested (bid and ask) prices increases, market liquidity will decline (Brogaard et al., 2017).

Liquidity affects default risk through pacifying the information asymmetry, i.e. increasing information efficiency, and reinforcing corporate governance mechanisms (Brogaard et al., 2017). Informational efficiency means that information on the value of assets equally and, of course, at the right speed are available to all market players, and certain investors cannot, through information rendering (asymmetry), generate more profits (abnormal returns) proportional to the risk taken (Cooper et al., 1985). On the other hand, corporate governance is a set of relationships between shareholders, managers, and auditors of a company that involves establishing a control system to preserve shareholder rights, enforcing the approvals of the forum properly, and preventing potential misuse. This mechanism, based on a system of responsibility, is a set of duties and responsibilities which must be exercised by the company's stakeholders to provide responsiveness and transparency (Copeland and Galai, 1983).

Higher informational efficiency can lead to optimized investment decisions and improved corporate performance (Wilson, 1978). A high degree of liquidity allows well-informed shareholders to take advantage of their own personal information, thereby encouraging investors to learn more about stocks and deal on the basis of that information (Brogaard et al., 2017). This leads to information-based pricing of stocks (Holden and Subrahmanyam, 1992). The role of liquidity in informational efficiency is to help stock prices reflect the surrounding facts (Lou, 2005), and since corporate executives use stock market prices to manage company investments decisions (Chen et al., 2006), this enables them to make a better investment decision on the capital markets and create more cash flow for companies (Bakke and Whited, 2010). This reduces the fluctuations in corporate cash flow and results in a drop in the risk of default (Polk and Sapienza, 2008). In general, the higher informational efficiency of stock liquidity (price) results in a greater decline in the likelihood of corporate default risk (Hou and Moskowitz, 2005). To sum up, Subrahmanyam and Titman (2001) argued that high stock liquidity increases the informational efficiency of stock prices through motivating arm's length and information-based transactions. Although executives are well-informed about the underlying information and investment opportunities of their company, outside investors can obtain better information about the factors related to the price of stocks such as the industry perspective and competitors' strategies because such information is always reflected in the stock prices, and stockholders perceive these facts in stock transactions. Managers also pay particular attention to information obtained through financial markets since they are accessed easily and inexpensively (Dow and Gorton, 1997). As a result, managers use stock price information to steer and guide corporate investment decisions (Lou, 2005), which affect the cash flow of companies (Chen et al., 2006) and subsequently the ability of companies to repay their debts and liabilities (Bakke and Whited, 2010). Brogaard et al. (2017) revealed that stock liquidity has a more powerful role in the informational efficiency than corporate governance to explain the relationship between stock liquidity and the risk of default. The second mechanism governing the relationship between stock liquidity and default risk is the role of stock liquidity in corporate governance. High liquidity facilitates the sale of stocks, especially for major corporate stockholders (blocks), and this issue can serve as a governance mechanism with a threat to exit (stock selling) (Admati and Pfleiderer, 2009). Good corporate governance regulates corporate executives and directs investment decisions (Harford et al., 2012). In fact, strong corporate governance forces managers to invest in opportunities with positive net worth and reduces managerial opportunistic behaviors, so corporate governance can potentially decrease the likelihood of default (Edmands, 2009). In general, the greater control of the governance will lead to less probable default risk (Edmands and Manso, 2010). Maug E. (1998) investigated and modelled the motivation of major stakeholders to monitor corporate activities and believed that stock liquidity would strengthen corporate governance where the supervision bears highly costs. Admati and Pfleiderer (2009) have also considered the threats to exit as one of the strongest alternatives to corporate governance and suggested that liquidity can strengthen corporate governance. Edmans and Manso (2011) have shown that stock liquidity increases the effectiveness of stockholder blocks in implementing and exercising governance power through systematic and consistent transactions (related to company's stocks) and thus creates a superior management for investment decisions. Edmans et al. (2013) argued that there is a causal relationship between stock liquidity and corporate governance improvement. He reported that liquidity facilitates the creation of stockholder blocks and leads to strengthening corporate governance through encouraging the transaction or taking selling positions against the stock (exist strategy).

On the whole, high liquidity allows shareholders to take advantage of their information and thus encourage investors to learn more about stock prices and transact based on this information (Brogaard et al., 2017). This leads to information-based pricing of stocks, and since corporate executives use stock prices to manage company investment opportunities (Ozdenoren and Yuan, 2008), it enables them to make a better investment decision and create more cash flow for companies, which reduces fluctuations in corporate cash flow and results in a decrease in the risk of default (Brogaard et al., 2017). Furthermore, high liquidity facilitates the trading of stocks, especially for major stockholders, and this, as a threat to exit, can play a governance mechanism role (Subrahmanyam and Titman, 2001). Good corporate governance regulates corporate executives and investment decisions. In fact, strong corporate governance forces managers to invest in opportunities with positive net worth and reduces managerial opportunism, so corporate governance can potentially decrease the likelihood of default. The role of liquidity in information efficiency also overcomes its role in governance to predict the risk of default (Brogaard et al., 2017). According to Afike et al. (2009), explanatory power of the role of liquidity in informational efficiency outweighs its role in governance to predict the probability of default in developed financial markets. Based on these and by regarding what mentioned in the previous sections, the hypotheses as well as conceptual framework of this research can be formulated as follows (see Figure 1):

H1: Stock liquidity has a negative and significant effect on default risk of petrochemical and oil products companies.

H2: The role of stock liquidity in information efficiency has a negative and significant effect on default risk of petrochemical and oil products companies.

H3: The role of stock liquidity in corporate governance has a negative and significant effect on default risk of petrochemical and oil products companies.

H4: The explanatory power of the role of liquidity in information efficiency outweighs the role of liquidity in corporate governance to predict the probability of default in petrochemical and oil products companies.

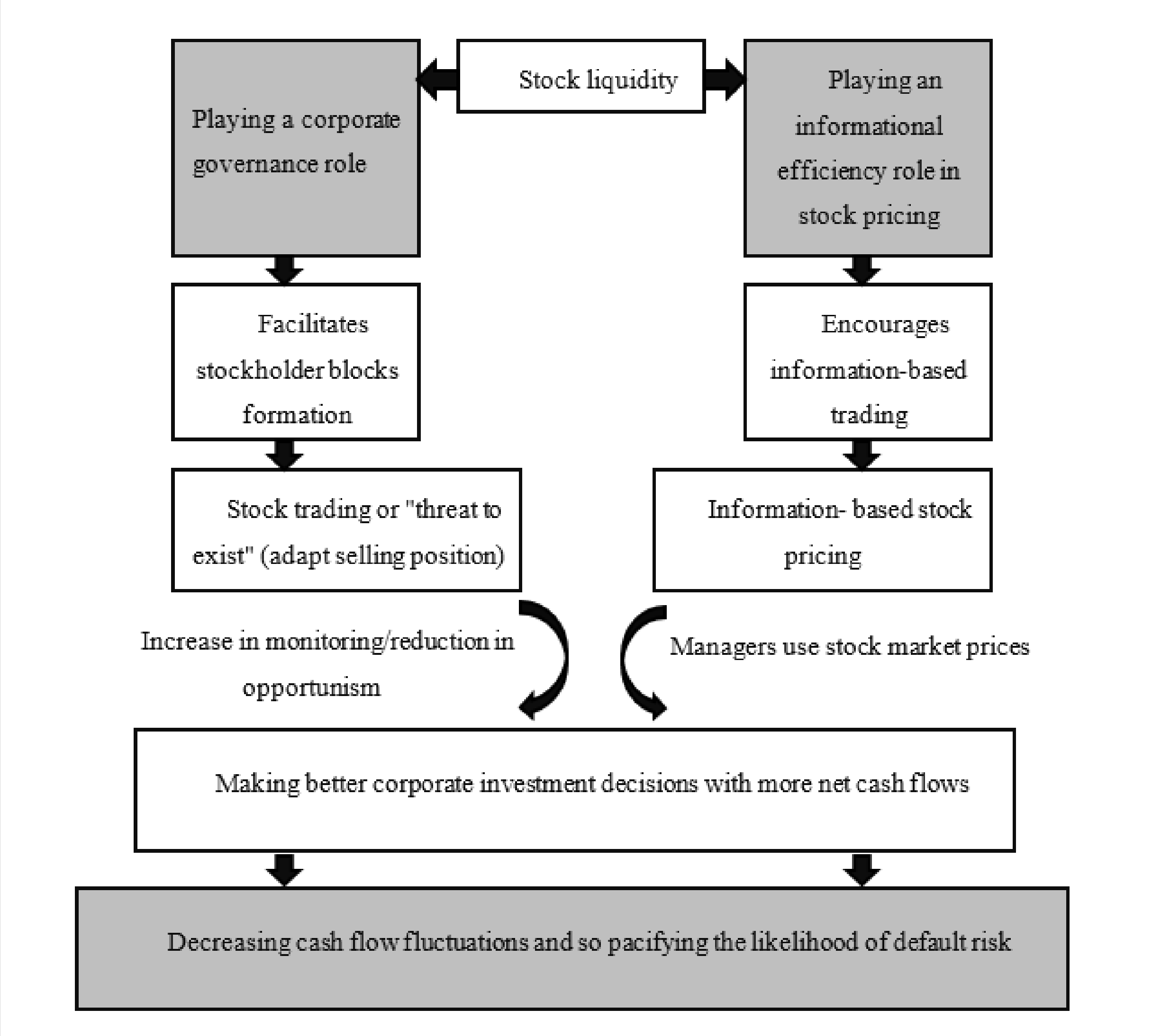

Figure 1. Conceptual framework of research.

Holmström and Tirole (1993) argued that stock liquidity affects corporate financial and management decisions. In their view, firms with more liquid stocks have fewer restrictions on investing even in risky projects. Hou and Moskowitz (2005) investigated the effects of stock liquidity on stock issuance costs and concluded that stock liquidity is an important indicator of the issuance costs of the stocks, and companies can reduce their stock issuance costs through increasing stock marketability (liquidity). Vassalou and Xing (2006) showed that low liquidity could result in a higher stock return only when the company encounters high levels of default risk; however, the reversion is not true. Lipson and Mortal (2009) used trading volumes and bid-ask price spreads with high-frequency data to measure stock liquidity. They believed that companies with more liquid stocks have lower leverage or rather less debt. Therefore, when raising capital, they prefer to finance through stock issuance instead of leverage. Fang et al. (2009) applied Tobin's Q benchmark, which divides the market value of assets by the book value of assets at the end of the fiscal year, as a performance indicator and the average effective spread index, which will be discussed in the next chapter, as a liquidity measure to assess the effects of stock liquidity on corporate value among the U.S. firms. They concluded that there is a positive and strong relationship between stock liquidity and corporate value, and stock liquidity improves company performance and increases its value through operating profitability. Izadinia and Rasaeian (2010) considered the percentage of the total ownership of stockholders blocks and bid-ask price spreads and investigated the relationship between them. Their results showed that there is no significant relationship between the distribution of ownership and stock liquidity in TSE. Also, Rahmani et al. (2011) concluded that there is a positive and significant relationship between institutional ownership and stock liquidity, and the concentration of institutional ownership reduces the liquidity of stocks. Khodamipour et al. (2013) investigated a positive relationship between companies' liquidity and stock returns. Karbasi Yazdi and Daryabari (2014) examined a positive and significant relationship between stock liquidity shocks and the expected return on stock price by studying 115 companies listed on Tehran Stock Exchange. Nyborg and Wang (2014) also explored a positive relationship between stock liquidity and available cash. If stock prices are reduced (negative effect), firms will have higher cost of capital and more restrictions. Under these circumstances, companies are forced to use their cash to reduce the negative effects of prices. Fang et al. (2014) argued that increasing stock liquidity leads to a reduction in corporate innovation. Some other studies have also regarded the stock liquidity and default risk as the dependent variables, and those which are closer to our conceptual framework are summarized in Table 1.

Table 1. Related literature on default risk.

Reference	Subject Matters	Materials and Methods	Remarks
Foroughi et al. (2010)	Investigating the relationship between stock liquidity and company performance (related to default risk) in TSE	They used bid-ask quoted price spreads as a measure of liquidity and Tobin's Q as a performance criterion.	There is a positive and significant relationship between stock liquidity and corporate performance. They suggested that stock liquidity can prevent default through optimal resource allocations.
Ahmadpour and Baghban (2012)	Investigating the relationship between sock liquidity and asset liquidity (related to default risk) among the companies listed on TSE	They calculated the bid-ask price spreads to measure stock liquidity and applied Amihud's liquidity measures to assets categories of 93 publicly-traded companies.	There is a positive and significant relationship between stock liquidity and asset liquidity. In their beliefs, stock liquidity accelerates the company's access to financial sources in the cases of financial distress and removes default hazard.
Edmans et al. (2013)	Examining the relationship between stock liquidity and corporate governance in the U.S. firms	They used bid-ask price spreads as stock liquidity measures and the number and percentage of the ownerships of stockholder blocks as the criteria for corporate governance.	The stock liquidity facilitates the stockholder blocks formation. Thus, greater liquidity of the stock results in the enforcement of governance from the majority of stockholders through the "threat to exist".
Lukail (2015)	Investigating the effects of stock liquidity on investment decisions (with an emphasis on default risk)	They studied 30 Tunisian firms between 1999 and 2010 and applied ordinary least squares (OLS) and generalized least squares (GLS) multiple regression models.	More liquid stocks boost corporate investment in more liquid assets and deal with the low risk of default and financial distress.
Khoshnoud and Farkhondeh (216)	Investigating the relationship between stock liquidity and free cash flow (related to default risk) among 75	They used four criteria for liquidity, including bid-ask price spreads, trading volume, trading turnover, and the percentage of trading days.	There is a significant and positive relationship between stock liquidity and free cash flow. They suggested that stock liquidity can pacify the corporate default risk.

Reference	Subject Matters	Materials and Methods	Remarks
	of the companies listed on TSE		
Brogaard et al. (2017)	Investigating the effect of stock liquidity on the default risk of the U.S. firms with an emphasis on the roles of liquidity in informational efficiency and corporate governance	They used two high-frequency and distinct measures, namely effective spreads and quoted spreads, to capture stock liquidity. They also measured the default risk in terms of expected default frequency (EDF) defined by Bharath and Shamwy (2008). The stock price autocorrelations, stockholder blocks, and the number of blocks (Nblocks) were also calculated for each firm.	There is a negative and significant relationship between stock liquidity and default risk, and the informational efficiency function of liquidity has a greater ability to explain the risk of default.
Vizvari et al. (2018)	Investigating the effect of stock liquidity on the default risk among 75 companies listed on TSE	They used Amihud's index and zero return for stock liquidity and employed EDF index for measuring the default risk. The methodology was based on OLS multivariate regression using panel data.	The stock liquidity significantly and negatively affects the default risk when using Amihud's liquidity measure, but this relationship is not significant for zero returns.

To the best of our knowledge, the mechanisms of the effect of stock liquidity on corporate default risk have not been simultaneously examined in Iran. Conducted studies have focused only on limited variables (one or two variables such as zero return or Amihud's index) to measure stock liquidity. It should also be noted that the relationship between stock liquidity and default risk in the Tehran Stock Exchange, which has lower levels of efficiency and transparency than the developed countries, has not been addressed yet. The current study seeks to bridge the existing gaps through examining the impact of stock liquidity on the default risk of petrochemical and oil product companies from informational efficiency and corporate governance points of views using market-based signal variables (bid-ask quoted spreads) as a measure of liquidity and default probability distribution functions (such as expected default frequency), which can be considered as contributions. Examining the relations between stock liquidity and default risk in petrochemical and petroleum product industries is of great importance because these industries are the most concentrated sectors from corporate governance viewpoint and there are block holders such as TAPIKO, Vanaft, Parsian, Persian Gulf Holding, Petrochemical Industries Investment Co., etc. operating in this context. Furthermore, these companies have strategic alliances and long-term contract with suppliers. Developing assessment and prediction models for the risk of default using stock liquidity allows supplier companies, business partners, customers, and other stakeholders to assess the credibility of petrochemical and oil products companies, to conclude more flexible contracts, and to manage strategic risks.

3. Methodology

The present work is an applied-development research in terms of purpose. In terms of methodology, it is a correlative-descriptive study because it seeks to better understand the existing relationships by studying the past behavior of research variables. The strategy of this research is an archival type, and since it begins with a general theory (hypothesis) it proceeds by deductive reasoning. Thus, the best way to perform this research is to use the quantitative (mono) methods. Time horizon was from March 2011 to March 2017. The statistical population is limited to all the petrochemical and oil products companies listed on TSE. The statistical sample was selected using a purposeful (biased) sampling method. Applying some of filters to trading days and financial year persistence (ended aligned with the calendar year) resulted in selection of 44 companies as the final sample; 32 companies were categorized in the petrochemical sector, and the remaining 12 companies were classified in the oil products companies. Information needed to measure the companies' variables were extracted from the databases of the TSE at www.codal.ir, information software of Rahavard Novin, Library of the Securities and Exchange Organization, and TSE Management and Information Technology Department.

3.1. Econometric Models

In the inferential statistics section, in order to answer the research questions and test the hypotheses, panel least squares multivariate regression model along with the control for standard classic assumptions is applied in EViews 8 software. The level of analysis is limited to organizations (companies). The research hypotheses can be tested as follows:

H1: Stock liquidity has a negative and significant effect on default risk of petrochemical and oil products companies.

Following Fang et al. (2009) as well as Brogaard et al. (2015 and 2017), the regression model for testing the first hypothesis is expressed by:

$$EDF\ i,\ t = \alpha + \beta Liquidity_{\ i,t-1} + \gamma_1\ Ln\ (Equity)\ i,_{t-1} + \gamma_2\ Ln\ (Debt)_{\ i,t-1} + \gamma_3\ 1\ /\sigma Ei,_{t-1} + \gamma_4\ Excess\ Return_{\ i,t-1} + \gamma_5\ Income\ /\ Asset\ s_{\ i,t-1} + Error_{\ i,t,}$$

where, Liquidity is either incorporated as effective spread or quoted spread.

H2: The role of stock liquidity in informational efficiency has a negative and significant effect on the default risk of petrochemical and oil products companies.

This hypothesis is tested using the following regression model:

$$EDF\ i,t = \alpha + \beta Correlation_{\ i,t-1} + \gamma_1\ Ln\ (Equity)\ i,_{t-1} + \gamma_2\ Ln\ (Debt)_{\ i,t-1} + \gamma_3\ 1\ /\sigma Ei,_{t-1} + \gamma_4\ Excess\ Return_{\ i,t-1} + \gamma_5\ Income\ /\ Asset\ s_{\ i,t-1} + \gamma_6\ Tobin's\ q_{i,t-1} + Error_{\ i,t,}$$

where, Correlation represents the absolute value of the correlation between the continuous weekly returns, i.e. the correlation between the return of the current week and that of the previous week. Tobin's Q variable is also introduced into the model to control the effects of the company's value following the works of Fang et al., 2009 and Brogaard et al., 2017.

H3: The role of stock liquidity in corporate governance has a negative and significant effect on the default risk of petrochemical and oil products companies.

The above hypothesis is also tested using the following regression model:

$$EDF\ i,\ t = \alpha + \beta Governance_{\ i,t-1} + \gamma_1\ Ln\ (Equity)\ i,_{t-1} + \gamma_2\ Ln\ (Debt)_{\ i,t-1} + \gamma_3\ 1\ /\sigma Ei,_{t-1} + \gamma_4\ Excess\ Return_{\ i,t-1} + \gamma_5\ Income\ /\ Asset\ s_{\ i,t-1} + \gamma_6\ Tobin's\ q_{i,t-1} + Error_{\ i,t,}$$

where Governance stands once for Block and then Nblock. We also used Tobin's Q as a control variable in this model since the coefficients of the models for the second and third hypotheses are compared to test the forth hypothesis. Fang et al. (2009) argued that rising stock liquidity increases the overall value of the companies, and, on average, companies with a higher market value are less likely to default. In order to control the effects of the company's value on the company's default risk, following the works of Fang et al. (2009) and Brogaard et al. (2017), we incorporated the Tobin's Q as a value indicator into the second and third hypothesis testing models. It should not be ignored that default risk can also affect the sock liquidity. As an example, when a company approaches default, the difference between the quoted bid and ask price increases, and the stock may fluctuate further. Further, the majority of market makers seek higher returns on risky stocks and may expand bid-ask quotes (Chordia et al., 2001). In order to overcome this concern, the independent and dependent variables are lagged behind for a period of one year (Hou and Moskowitz, 2005). This also solves the residual autocorrelation problems as one of the standard regression assumptions, without Durbin-Watson test (Gajerati, 2003).

H4: The explanatory power of the role of liquidity in informational efficiency outweighs the role of liquidity in corporate governance to predict the probability of default in petrochemical and oil products companies.

After examining the second and third hypotheses of the research, the fourth hypothesis is visually confirmed or rejected through comparing the R-squared values (R^2) (determinant coefficients) of each of the two models. Thus, it is necessary to run two-sample t-test statistically.

3.2. Variable specification

Expected default frequency (EDF) is the main index used to calculate default risk. EDF is a simplified form of the structural distance to default (DD) Merton (1974) model that considers the company's equity as a call option with an underlying asset equal to total company. This option has an exercise price equal to the nominal value of firm's debts. According to this model, a company defaults when the value of its assets is less than its nominal value of debts. Despite the large use of Merton model (Kilhofer and Corbat, 2001; Crosby and Ban, 2003; Vassalo and Jing; 2004; Duffie et al., 2007), Bharath and Shamwy (2008) claimed that basically the predictive power of the Merton model is derived from the form of its function, not the actual probability of default. Campbell et al. (2008) also confirmed this result. Bharath and Shamwy (2008) presented a model that includes both the structural form and the inputs of the Merton (1974) model and works well. Accordingly, this study uses EDF index to operationalize the default risk (as stated in Equation 1).

$$DD_{i,t} = \frac{\log\left(\frac{equity_{i,t} + debt_{i,t}}{debt_{i,t}}\right) + \left(r_{i,t-1} - \frac{\sigma_{Vi,t}^2}{2}\right) \times T_{i,t}}{\sigma_{Vi,t} \times \sqrt{T_{i,t}}}$$

$$\sigma_{Vi,t} = \frac{equity_{i,t}}{equity_{i,t} + debt_{i,t}} \times \sigma_{Ei,t} + \frac{debt_{i,t}}{equity_{i,t} + debt_{i,t}} \times (0.05 + 0.25 \times \sigma_{Ei,t}) \quad (1)$$

$$EDF_{i,t} = N(-D_{i,t})$$

where, $equity_{i,t}$ represents the value of the company's stock market in million Iranian Rials obtained from the multiplication of the number of outstanding stocks by closing prices at the end of each year. $debt_{i,t}$ is the sum of current debt and half of long-term debt at the end of each year. $r_{i,t-1}$ stands for the annual return on i stock in the past year and is calculated from the geometric mean of monthly returns in the past year. Monthly returns come from the price change at the beginning and the end of each month using the formula $\ln(p_2/p_1)$. Afik et al. (2012) argued that if, MAX (rf, rt-1) is used instead of ρr (i, t-1) in calculating the DD index, the negative effect of the historical returns is reduced, and the predictive power of the model increases dramatically. $\sigma_{Ei,t}$ denotes the annual fluctuation in the company's stock returns, i.e. the standard deviation of the monthly return on stocks. $\sigma_{Vi,t}$ is the annual fluctuations in the [book] value of a firm's assets in year t. $T_{i,t}$ is considered to be one year. N (...) stands for the cumulative standard normal distribution function.

The above indicator (EDF) is calculated on an annual basis, i.e. based on the end-of-year data of sample companies.

In the current work, stock liquidity was calculated using high-frequency criteria, and, subsequently, considering the collected data, two types of difference in bid-ask price were considered. Higher frequency indices, including effective spread and quoted spread, provide a better and more accurate benchmark for measuring transaction costs (Goyvenko, 2009). Higher values of these two indicators imply higher fluctuations in stock prices. In such cases, the market makers do not have an incentive to make these securities marketable, so the stock liquidity declines (Brogaard et al., 2017). The main indicator of the stock liquidity is effective spread which also takes into account the transaction cost. This index is calculated as the annual relative effective spread. Relative effective spread is measured over one year and is twice the difference between the execution price and the average of the prevailing best bid-ask quote, divided by the average of the prevailing best bid-ask quote and multiplied by one hundred (Equation 2).

$$Effective\ Spread = 2 \times \left(\frac{execution\ price - \left(\frac{best\ bid\ quote + best\ ask\ quote}{2}\right)}{\frac{best\ bid\ quote + best\ ask\ quote}{2}}\right) \times 100 \quad (2)$$

The second indicator of liquidity measurements in this research is quoted spread. This index is calculated as the annual relative quoted spread multiplied by one hundred. Relative quoted spread is the best bid-ask spread divided by the average of the best bid-ask quote and is measured over one year (Equation3).

$$Quoted\ \text{Spread} = \left(\frac{(\text{best } ask \text{ quote} - \text{best bid quote})}{\left(\frac{\text{best } ask \text{ quote} + \text{best bid quote}}{2}\right)}\right) \times 100 \quad (3)$$

As outlined in the theoretical foundations, stock liquidity can affect the corporate default risk through playing roles in informational efficiency in stock pricing and corporate governance. In order to more accurately assess and compare the effect of such mechanisms on the risk of corporate default, they are operationalized in terms of quantitative variables and investigated separately. Following Brogaard et al. (2017), in order to examine the role of stock liquidity in the informational efficiency in stock pricing, the stock return autocorrelation was used. Lower stock return autocorrelations cause the stock pricing process to be closer to random walk, which indicates a higher price efficiency. In other words, lower stock price (return) autocorrelations imply that the stock price reflects the current market conditions, political and economic realities, and trading characteristics. In such a situation, stocks are traded more quickly and easily, and market makers (participant) are more interested in deals. Therefore, the stock price autocorrelation may act as a mirror of stock liquidity (Brogaard et al., 2017). Following Brogaard et al. (2017), in order to quantify the role of liquidity in corporate governance, two indicators [reflecting the corporate governance] were used. The first index is the cumulative percentage of stockholder blocks' ownership (Block) and the second one is the number of stockholder blocks (Nblock). Block variable is defined as the total percentage of stocks held by the institutional/real stockholders which own at least five percent of the company's stock at the end of the financial years (Larcker, 2007). The number of blocks (Nblock) is also calculated as the number of stockholder blocks (Dittmar and Smith, 2007). In the present work, the control variables of Bharath and Shamwy (2008), Fang et al. (2009), and Brogaard et al. (2017) models were used as follows:

- Ln(Equity): The natural logarithm of company's equity at the end of each year.
- Ln(Debt): The natural logarithm of company's debts at the end of each year.
- $1/\sigma_E$: The reversion of stock return volatility for each year. The annual return fluctuation is equal to the standard deviation of monthly stock returns.
- Excess Return: is equal to the difference between annual stock returns and the average return on the market. According to Bharath and Shamwy (2008), the focus on this variable draws our attention to the portion of the return that is not explained by the overall market efficiency.
- Income/Assets: represents the return on company assets.
- Tobin's Q: The ratio of the market value of assets to the book value of assets. Since we do not have the market value of assets in Iran, the variable is figured at the end of each year using the following formula:

$$\frac{(book\ value\ of\ assets - book\ value\ \text{of common}\ equity) + (outstanding\ stocks \times closing\ price)}{book\ value\ of\ assets}$$

The required data and information can be classified as primary and secondary. The secondary data and information are related to theoretical foundations, literature review, and other propositions. To collect this information, archival methods and resources such as books, journals, theses and databases, and documents have been explored. The primary data, including daily, weekly, monthly, and annual bid-ask quoted prices, traded prices, trading volumes, the number and percentage of stockholder blocks, corporate accounting and reporting information, and other information needed to measure the variables have been extracted from TSE publishers at www.codal.ir, Rahavard Novin database, the Library of the Tehran Securities and Exchange Organization, and Tehran Securities Exchange Technology and Management department. Wherever the data and accounting information were not available for a specific year, the average date of the other years was used instead.

4. Empirical Results

The descriptive statistics related to the research variables of the sample members are presented in Table 2. The mean value of default risk representative variable, i.e. EDF, is 0.1095. The minimum and maximum observations of this variable are equal to 0.000014 and 0.6133 respectively, and the standard deviation of this variable is 0.1244. The mean value of liquidity measures, i.e. effective and quoted spreads, is 13.21 and 27.86 respectively with a corresponding standard deviation of 1.94 and 2.04. The standard deviations of EDF, effective spread, and quoted spread suggest that, in general, there is no significant difference in the probability of default risk and stock liquidity among the studied petrochemical and petroleum products companies, that is, we are dealing with a homogenous set of companies. It should be noted that, on average, about 8% of the change in the stock prices of the petrochemical and petroleum products companies in future periods (as a weekly example) could be explained by the corresponding past prices; therefore, stock prices are expected to be an appropriate reflection of the internal and external economic reality in TSE.

Table 2. Summary of descriptive statistics.

Variables	Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis	Observations.
EDF	0.1095	0.1244	0.0000	0.0711	0.6133	2.02	3.89	264
Effective Spread (%)	13.21	1.94	0.7	14.03	89.25	2.37	6.49	264
Quoted Spread (%)	27.86	2.04	0.95	31.04	84.44	3.41	9.63	264
Autocorrelation	0.081	0.09	0.000	0.045	0.537	1.795	4.11	264
Block (%)	64.77	18.14	20.79	68.34	93.26	–0.51	–0.66	264
N-block	9.48	2.95	3.00	9.00	17.00	0.25	–0.20	264
Control Variables								
ln(Equity)	13.70	1.62	9.51	13.45	18.32	0.64	0.66	264
Ln(Debt)	14.20	1.75	10.14	13.87	18.95	0.67	0.61	264
$\frac{1}{\sigma_E}$	0.36	0.4	0.02	0.29	3.22	4.37	25.80	264
Excess Return (%)	0.82	4.19	–8.64	1.38	20.73	0.98	3.89	264
Income/Assets (%)	4.29	17.60	–37.86	1.61	48.02	0.25	0.10	264
Tobin's Q	1.15	1.13	0.00	0.78	5.36	1.40	1.51	264

Regarding the percentage and the number of shareholding blocks, the average of both variables (64.77% and 9.48) is considered to be relatively favorable for the companies under review, and there is a deviation among the total ownership of the blocks of the sample companies (18.14 times the deviation from the standard). This difference also applies to control variables such as return on assets (profitability). Skewness and kurtosis also provide some attributes of variable distribution forms. Given that most of these coefficients are close to a normal case, it seems reasonable to assume that the variables of the research are normal; however, considering the importance of the discussion, this issue is examined separately in the below sections. In this study, panel data have been used to estimate regression models. The advantage of using these data over cross-sectional and time-series data is to facilitate the design of more complex patterns of behavior, to facilitate the assessment of the reliability of variables, to lower coherency between variables, and to estimate parameters more efficiently.

After selecting the type of data, the most common assumption is that the data are normal. If the data have a normal distribution, there is a possibility to use the parametric test. Thus, Kolmogorov-Smirnov test was used at a significance level of 5% to test the normality of the data herein. The results reflected that each of the variables has a normal distribution, and there is no need to use the non-parametric mutation tests. In addition to the normality of variables, the reliability (stationarity) of variables is also one of the most important prerequisites for statistical analysis to avoid spurious regression (Chen et al., 2006). To test the reliability of variables, the unit root test was applied, and the obtained results indicate that variables are stationary at the level of raw data. After confirming the normality and reliability of the variables/indices, the correlation matrix between the independent and dependent variables was compiled according to Table 3, showing the Pearson correlation coefficients. Table 3 presents the correlation matrix of underlying variables.

Table 3. Pearson correlation matrix.

Variables	EDF	Effective Spreads	Quoted Spreads	Autocorrelation	Block	N-block
EDF	1	-	-	-	-	-
Effective Spreads	0.02026	1.00000	-	-	-	-
Quoted Spreads	0.06611	0.05387	1.00000	-	-	-
Autocorrelation	0.04245	0.00784	0.04018	1.00000	-	-
Block	–0.01263	–0.06697	–0.03769	–0.04178	1.00000	-
N-block	–0.00740	–0.03941	–0.07523	0.05852	0.05882	1.00000

Accordingly, at a significant level of 5%, with 95% confidence, there is a positive and significant correlation between stock liquidity measures (effective and quoted spreads) and the risk of default. The correlation coefficients for these variables are 0.02026 and 0.06611 respectively. In relation to the mechanisms of stock liquidity, the coefficients show that there is a positive and significant correlation between the coefficient of correlation between stock price (Autocorrelation) and the risk of default (0.04245). The matrix also reveals a negative correlation between the percentage and the number of block holders (owning more than 5% of the shares) and the company's default risk index. The coefficients of these variables indicate that an increase in the number and percentage of shareholders' blocks correlates with the reduction of the company's default risk.

As stated before estimating the model using the panel data, we need to decide on the appropriate method for applying such data to the estimation. First, it should be clear that there is no need to consider the structure of the panel data (differences or company-specific effects), or the data from different companies can be integrated and used in model estimation. In such a situation, the F-Limer test statistic is used to make a final decision. The results of the F-Limer test in Table 4 reveal that given a P-value lower than 5%, the null hypothesis is rejected; hence, there is no reason to assume the same intercept for various sections in the regression models, and the data must be used in a panel manner. Consequently, Hausman test should be performed to decide on random-effect methods versus fixed-effect methods. The results of the Hausman test (Table 5) show that the null hypothesis based on the random effects is rejected and therefore the regression models along with fixed effects should be used in fitting the model.

Table 4. F-Limer test results.

Regression Models	t-statistics	P-values	Included observations	Results
Hypothesis 1: Effective Spread as Independent Variable	4.881	0.000	264	Panel
Hypothesis 1: Quoted Spread as Independent Variable	4.332	0.005	264	Panel
Hypothesis 2: Autocorrelation as Independent Variable	4.677	0.001	264	Panel
Hypothesis 3: Blocks as Independent Variable	4.912	0.000	264	Panel
Hypothesis 3: N-blocks as Independent Variable	4.796	0.000	264	Panel

Table 5. Hausman test results.

Regression Models	Chi-Square	P-values	Included observations	Results
Hypothesis 1: Effective Spread as Independent Variable	47.895	0.000	264	Fixed effects
Hypothesis 1: Quoted Spread as Independent Variable	39.651	0.006	264	Fixed effects
Hypothesis 2: Autocorrelation as Independent Variable	46.659	0.000	264	Fixed effects
Hypothesis 3: Blocks as Independent Variable	52.004	0.000	264	Fixed effects
Hypothesis 3: N-blocks as Independent Variable	36.457	0.003	264	Fixed effects

The estimation of regression parameters is reliable and worthwhile when, in addition to the normality and reliability of the variables, the classical regression assumptions are in place. The most important assumptions which must be considered in determining the adequacy of the fitted regression model are the normal distribution of error terms (zero mean), lack of collinearity of independent variables, the variance homogeneity of residuals, and lack of residual autocorrelations. Given that the number of observations of each of the independent/dependent variables in hypotheses (6 × 44) is appropriate, the central limit theorem can be used in inferential statistics, and the residual distribution function is approximated to be normal. Furthermore, since the panel data were used in this study and the correlation coefficients are not too high, the collinearity of independent variables will not mortify the models. In the present work, we use the White test at a significant level of $\alpha = 5\%$ to identify and test the variance homogeneity of residuals in the regression model, and the generalized least squares regression model (GLS) is used when this assumption is violated. The results of the White test for all of the fitted models are summarized in Table 6. As it can be seen, the probability of F for all of the hypothesis test models is larger than 5%. Therefore, regarding the 95% confidence level, it can be concluded that the error terms in all of the fitted models have the homogenous variances, so the use of the panel least squares (PLS) regression is valid.

Table 6. The white test results.

Estimated models of H1 testing: effective spreads (independent variable)			
F-statistics	1.90	Probability F	0.071
Observations*-R-squared	14.21	Probability Chi-Squared	0.072
Scaled Explained* Scaled Score	15.22	Probability Chi-Squared	0.055
Estimated models of H1 testing: quoted spreads (independent variable)			
F-statistics	0.481	Probability F	0.083
Observations*-R-squared	4.63	Probability Chi-Squared	0.865
Scaled Explained* Scaled Score	8.15	Probability Chi-Squared	0.518
Estimated models of H2 testing: autocorrelation (independent variable)			
F-statistics	0.551	Probability F	0.065
Observations*-R-squared	4.89	Probability Chi-Squared	0.724
Scaled Explained* Scaled Score	7.01	Probability Chi-Squared	0.364
Estimated models of H3 testing: blocks (independent variable)			
F-statistics	0.852	Probability F	0.055
Observations*-R-squared	4.57	Probability Chi-Squared	0.725
Scaled Explained* Scaled Score	7.66	Probability Chi-Squared	0.435
Estimated models of H3 testing: N-blocks (independent variable)			
F-statistics	0.438	Probability F	0.091
Observations*-R-squared	5.56	Probability Chi-Squared	0.765
Scaled Explained* Scaled Score	4.21	Probability Chi-Squared	0.697

The non-autocorrelations of the residuals as a disturbance of the model are also evaluated after estimating the regression model using Durbin Watson test statistics. Of course, due to the one-year interruption in entering independent and dependent variables into model, this problem is expected to be largely overlooked.

The estimation of regression models and testing of the hypotheses are performed in the following. It should be noted that this research utilizes F-statistic and probability (F-statistic) at a significant level of α = 5% to identify and assess the validity and the whole significance of the regression model. The null hypothesis for F-statistic implies that the regressed model is not valid, and since all of the corresponding Fisher Probabilities (Prob. F) are less than 5%, the validity of models is well approved. To test the first hypothesis, two models were estimated separately. Durbin Watson statistic for the mentioned fitted models (2.22 and 2.25) implies there is no autocorrelation among residuals in all the regressed models. The results of the estimation are tabulated in Table 7 and 8 respectively.

Table 7. Estimated models of H1 testing: effective spreads (independent variable).

Dependent Variable: EDF

Method: Panel Least Squares

Sample: 2011 2016

Periods included: 6

Cross-sections included: 44

Total panel (balanced) observations: 264

Variable	Coefficient	Standard Error	t-Statistic	Probability
Effective Spreads	0.007333	0.001616	4.537748	0.0001
Ln(equity)	–0.005889	0.001603	–3.673737	0.0012
Ln(debt)	0.013456	2.52×10^{-03}	5.333333	0.0001
1/SE	0.003175	0.00108	2.939815	0.0034
Excess Return	–0.000167	7.22×10^{-05}	–2.313019	0.0332
Income/Assets	0.000362	0.000132	2.742424	0.0041
Intercept	0.004495	0.001468	3.061989	0.0032
Model Specification				
R-squared	0.370336			
Adjusted R-squared	0.328951			
F-statistic	3.538372			
Probability (F-statistic)	0.007218			
Durbin-Watson statistic	2.227805			

Table 8. Estimated model for H1 testing: quoted spreads (independent variable).

Dependent Variable: EDF

Method: Panel Least Squares

Sample: 2011 2016

Periods included: 6

Cross-sections included: 44

Total panel (balanced) observations: 264

Variable	Coefficient	Standard Error	t-Statistic	Probability
Quoted Spreads	0.005291	0.001290	4.101550	0.0005
Ln(equity)	–0.001881	0.000536	–3.509328	0.0025
Ln(debt)	0.000937	0.000306	3.062092	0.0301
1/SE	–0.001373	0.000394	–3.484772	0.0045
Excess Return	0.008116	0.001888	4.298729	0.0002
Income/Assets	0.000177	6.14×10^{-05}	2.882736	0.0648
Intercept	0.001301	0.000395	3.293671	0.0081
Model Specification				
R-squared	0.288085			
Adjusted R-squared	0.204146			
F-statistic	3.661694			
Probability (F-statistic)	0.003938			
Durbin-Watson statistic	2.252176			

Regarding Tables 7 and 8, given that the probability value of each of the two models is less than the 5% level of significance, the significance of the specified models is proven. Moreover, the models in question have the predictive power to explain the risk of default. The explained variance, or R-squared, of the models was 0.3703 and 0.2880 respectively, which indicates that on average 37.03 and 28.80% of variations in the dependent variable (the risk of default) are explained by the explanatory variables of the models (independent and control variables); the related coefficients are 0.0073 and 0.0053 respectively. Since the corresponding p-value statistics are less than a significance level of 0.05, there is a positive and significant relationship between these variables and the default risk of petrochemical and petroleum products companies listed on TSE. Therefore, the first hypothesis, which indicates a negative and significant relation between stock liquidity and corporate risk, is confirmed.

To test the second hypothesis, a PLS model was estimated separately. The independent variable of this model was stock price autocorrelations. Durbin Watson statistic of the mentioned fitted model (2.00) denotes that there is no autocorrelation among residuals, which indicates that we can trust on the estimated model results. The results of the estimation are listed in Table 9.

Table 9. Estimated model of H2 testing: autocorrelation (independent variable).

Dependent Variable: EDF

Method: Panel Least Squares

Sample: 2011 2016

Periods included: 6

Cross-sections included: 44

Total panel (balanced) observations: 264

Variable	Coefficient	Standard Error	t-Statistic	Probability
Autocorrelation	0.002902	0.000784	3.701531	0.0104
Ln(equity)	0.000515	0.000145	3.551724	0.0238
Ln(debt)	–0.001018	0.000271	–3.756458	0.0009
1/SE	0.001521	4.98×10^{-04}	3.054217	0.0406
Excess Return	0.005069	0.001409	3.597587	0.0022
Income/Assets	–0.000277	7.29×10^{-05}	–3.799726	0.0322
Tobin's Q	0.005721	0.001457	3.926561	0.0016
Intercept	0.005988	0.001521	3.936884	0.0003
Model Specification				
R-squared	0.186037			
Adjusted R-squared	0.167248			
F-statistic	3.151181			
Probability (F-statistic)	0.001550			
Durbin-Watson statistic	2.004104			

Regarding Table 9, the significance of the specified model is proven. The explained variance, or R-squared, of the model was 0.1860, which implies that on average 18.60 % of variations in the dependent variable (the risk of default) is explained by the explanatory variables of the models (independent and control variables). Accordingly, the related coefficient is 0.0029, and since the corresponding p-value statistics (0.104) is less than a significance level of 0.05, there is a positive and significant relationship between these variables and the default risk of petrochemical and petroleum products companies listed on. Therefore, it can be stated that the second hypothesis is verified.

To test the third hypothesis, the two models were estimated separately. Durbin Watson statistic of the mentioned fitted models (2.24 and 2.03) implies that there is no autocorrelation among residuals in all the regressed models. The results of the estimation are summarized in Tables 10 and 11 respectively.

Table 10. Estimated model of H3 testing: blocks (independent variable).

Dependent Variable: EDF

Method: Panel Least Squares

Sample: 2011 2016

Periods included: 6

Cross-sections included: 44

Total panel (balanced) observations: 264

Variable	Coefficient	Standard Error	t-Statistic	Probability
Blocks	–0.002912	0.000784	–3.714286	0.0126
Ln(equity)	0.000518	0.000145	3.572414	0.0249
Ln(debt)	–0.001207	0.000271	–4.453875	0.0009
1/SE	0.001551	4.98×10^{-04}	3.114458	0.0406
Excess Return	0.005402	0.001409	3.833925	0.0022
Income/Assets	–0.000243	7.29×10^{-05}	–3.333333	0.0314
Tobin's Q	0.005912	0.001457	4.057653	0.0016
Intercept	0.006342	0.001521	4.169625	0.0003
Model Specification				
R-squared	0.258708			
Adjusted R-squared	0.217039			
F-statistic	3.968354			
Probability (F-statistic)	0.000211			
Durbin-Watson statistic	2.240986			

Table 11. Estimated model of H3 testing: N-blocks (independent variable).

Dependent Variable: EDF

Method: Panel Least Squares

Sample: 2011 2016

Periods included: 6

Cross-sections included: 44

Total panel (balanced) observations: 264

Variable	Coefficient	Standard Error	t-Statistic	Probability
Nblocks.	–0.007091	0.001504	–4.714761	0.0002
Ln(equity)	–0.000223	6.81×10^{-05}	–3.274596	0.0021
Ln(debt)	0.000414	0.000107	3.869159	0.0018
1/SE	0.001398	0.000303	4.613861	0.0008

Excess Return	–0.001008	0.000209	–4.822967	0.0005
Income/Assets	–0.000206	8.50×10^{-05}	–2.423529	0.0023
Tobin's Q	0.001704	0.000382	4.460733	0.0006
Intercept	0.004078	0.000891	4.57688	0.0002
Model Specification				
R-squared	0.195342			
Adjusted R-squared	0.186453			
F-statistic	4.185459			
Probability (F-statistic)	0.000108			
Durbin-Watson statistic	2.033178			

Regarding Tables 10 and 11, the models in question have the predictive power to explain the risk of default. The explained variance, or R-squared, of the models was 0.2587 and 0.1953 respectively, which indicates that on average 25.87 and 19.53% of variations in the dependent variable (the risk of default) are explained by the explanatory variables of the models (independent and control variables); the related coefficients are –0.0029 and –0.0071 respectively. Since the corresponding p-value statistics are less than a significance level of 0.05, there is a negative and significant relationship between these variables and the default risk of petrochemical and petroleum products companies listed on TSE. Therefore, the third hypothesis is also confirmed.

Considering that the conditions (explanatory variables) of the estimation models of hypotheses 2 and 3 are the same, through comparing the explanation coefficients obtained for these models, the explanatory power of each of the above mentioned channels can be equated. Therefore, in order to test the fourth hypothesis, we only need to compare the R-squared derived from the third hypothesis with the explanatory power (R-squared) of the second hypothesis testing model. However, in the petrochemical and petroleum products companies listed on TSE, the role of stock liquidity in corporate governance outweighs its role in information efficiency having a higher explanatory power to predict the default risk of these companies; therefore, the forth hypothesis is rejected.

5. Discussion and Conclusions

The study examined the effects of stock liquidity and the corresponding underlying mechanisms on the default risk of petrochemical and petroleum products companies through developing four main hypotheses. Generally speaking, the results show that there is a negative and significant relationship between stock liquidity and default risk in sample companies, that is, an increase in the stock liquidity results in a significant decrease in default risk. Based on the findings of the hypothesis tests, stock liquidity can be effective in reducing the risk of corporate defaults by reducing information asymmetry in the stock pricing process and through playing a role in corporate governance. However, comparison of the results obtained in relation to the above mechanisms reveals that unlike the research conducted in efficient markets, the role of stock liquidity in corporate governance of the sample companies listed on TSE is stronger than its role in the information efficiency in the stock pricing process to explain the default risk. Therefore, except for the fourth hypothesis, all the three remaining hypotheses are confirmed. The results regarding the negative and significant relation between stock liquidity and default risk are consistent with the findings of Brogaard et al. (2015), Vizvari et al. (2016), and Brogaard et al. (2017). The results of this research support the concept of multi-dimensionality of liquidity. However, the results of the fourth hypothesis demonstrate that the role of liquidity in corporate governance of the underlying companies (compared with its role in information efficiency) can better explain the determination of the company's risk of default, which is quite contradictory with the findings of Brogaard et al. (2017). One of the reasons for justifying this contradiction is that the work of Brogaard et al. (2017) was conducted in stock market having a high degree of efficiency, while in TSE, despite efforts aimed at improving transparency, such as the requirement for reporting based on international financial accounting standards, the level of information efficiency has been assessed to be low and in some studies weak or semi-robust (Karimi et al., 2012). Another reason for the rejection of the fourth hypothesis can be attributed to the strong role of governance power in TSE as well as in petrochemical and petroleum products companies. Liquidity facilitates the formation of shareholder blocks. These blocks (institutional and noninstitutional such as TAPIKO, Parsian, Vanaft, Persian Gulf Holding, etc.) can make a significant contribution to the stock prices of underlying companies through methods such as voting by feet, management by trading, adopting various bid-ask positions and, as a monitoring lever, can guide directors to move toward optimal investment decisions. Stockholder blocks also have voting rights and, in some cases, control or significantly influence, which can directly affect corporate investment decisions. Optimal investment decisions increase corporate cash flow and reduce the risk of default.

Regarding the results, it is suggested that real and legal investors should use research findings to avoid investment in investee companies with high levels of default risk. They can consider the stock market liquidity index as an effective factor in the estimation of default risk. The policy makers in the stock market can also devote their best efforts to developing market-making activities in TSE. Developing clear and transparent market-making guidelines, providing information infrastructure, and embedding mechanisms and regulatory bodies in the field of market-making, from the issuance of market-making licenses to market-making implementation, accelerate the liquidity of stock, decrease the default risk of companies, and boost the financial markets. Thinking about measures to reduce transaction costs and about enhancing market transparency through the presentation of transparent financial statements are among short- and medium-term proposed strategies to increase the level of stock liquidity and reduce the probability of the default risk of corporations and result in the prosperity of investment in the capital market. Using two mechanisms to examine the relationship between intuitional variables, EDF, and market-based signals can be considered as the main contribution. As a limitation, the existence of a price fluctuation range (from –5% to +5%) leads to lower prices in the market price range and reduces or even may stop trading. This aspect of stock liquidity refers to the infrastructure of the TSE and should be considered in using the results of the current research because it affects the calculation of bid-ask quoted spreads. Examining the hypotheses of this work for longer periods, across other listed industries, for different company sizes, and for company life cycles, if there are a sufficient number of samples, is recommended to interested researchers.

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