Stock liquidity, stock price crash risk, and foreign ownership

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Abstract

This study examines the impact of stock market liquidity on a stock price crash, using firm data from Borsa Istanbul for the period 2009–2019. The results show that higher stock liquidity increases the likelihood of stock price crashes, but this positive link is not driven by blockholder ownership. The study also investigates the effects of foreign investors, divided between institutional and individual investors, on the relation between liquidity and crash risk. The findings indicate that higher stock liquidity increases the crash risk as the share of foreign institutional investor rises, but this impact is not present with foreign individual participation. Furthermore, the study explores the effects of high-frequency trading and the removal of short-sale restrictions. The results of these analyses suggest that high-frequency trading increases liquidity, which in turn raises the likelihood of a stock price crash, and the removal of short-sale restrictions generally increases the stock price crash risk.

JEL classification: G12; G14; G32

Keywords: Foreign ownership; Stock liquidity; Stock price crash risk

1. Introduction

Stock price crashes, which involve a sudden and dramatic fall in stock prices, have become an increasingly important topic in financial studies because of their effects on investment decisions, risk management, corporate governance, and regulatory practices. Accordingly, the literature is growing about the determinants and consequences of stock price crash risk, reflecting different perspectives. Many of the studies document the relation between managerial incentives to withhold bad news, which creates stock price crash risk, and firm characteristics, including corporate social responsibility (Hunjra et al., 2020; Kim et al., 2014), accounting conservatism (Kim & Zhang, 2016; Kousenidis et al., 2014), corporate tax avoidance (Kim et al., 2011), financial reporting opacity (Hutton et al., 2009; Kim & Zhang, 2014), earnings smoothing (Chen et al., 2017; Khurana et al., 2018), CEO features such as overconfidence (Kim et al., 2016), age (Andreou et al., 2017), and power (Harper et al., 2020). Other studies argue that stock market dynamics and investor behavior, such as investor type (Callen & Fang, 2013; Huang et al., 2020; Kim et al., 2019; Wen et al., 2020), and investor sentiment (Tu et al., 2020; Yin & Tian, 2017), also play an important role in stock price crashes.

A few studies explore the relation between stock liquidity and stock price crash risk (Chang et al., 2017; Zhang et al., 2018). However, to our knowledge, this relationship has been studied in only one emerging market, namely, India (Chauhan et al., 2021). Borsa Istanbul (BIST) is one of the leading emerging equity markets, ranking third in terms of trading value (in US dollars) out of 48 stock exchanges included in the Europe-Africa-Middle East category by the World Federation of Exchanges as of January 2021. It is the
The twelfth-largest stock exchange by market capitalization in that category as of January 2021. Historically, foreign investors have shown considerable interest in the BIST, with an average market capitalization of 64 percent over the period of this study. With the launching of the BISTECH trading platform in November 2015, the BIST has transformed its technology and high-frequency trading (HFT) activity has started in 2016. At the same time, short-selling restrictions are occasionally imposed through an uptick rule. These characteristics make it interesting to examine the liquidity-stock price crash risk relationship in the BIST. This study makes three contributions to the literature as follows. First, it enhances the liquidity-crash risk literature by providing empirical evidence on the BIST, considering all trading firms with the available dataset for 2009–2019. Additionally, it investigates the possible channels that drive this relation for BIST firms, taking into account the blockholder ownership in these firms. The effects of HFT activity and repeals of short-selling restrictions on crash risk in the BIST are also examined by splitting the dataset and applying the difference-in-difference (DID) method, respectively. These analyses offer some answers to the ongoing questions about the effects of HFT and short-selling restrictions from the perspective of the relation between liquidity and crash risk in an emerging stock market.

Second, this study provides evidence as to whether foreign investor participation is a possible channel that influences the relationship between stock liquidity and crash risk, which has not been explored before. Foreign investors prefer liquid equity markets, as they trade more frequently than other investors, suggesting a positive association between foreign ownership and stock liquidity (Dahlquist & Robertsson, 2001). Furthermore, some suggest that foreign ownership can either mitigate the crash risk because of foreigners' good governance skills (Kim et al., 2019) or intensify the crash risk by facilitating the release of firm-specific bad news or through the foreigners' trading behavior (Huang et al., 2020; Vo, 2020). Considering the recent strand of crash risk literature that underlines the role of foreign investors, as well as the impact of liquidity on the formation of foreign ownership in equity markets and the importance of trading by foreign investors in the BIST (Adaoglu & Turan Katircioglu, 2013), this study delves into foreign ownership as a potential channel that affects the association between stock liquidity and crash risk in the BIST.

Third, this study analyzes the impact of foreign investors on the relation between liquidity and crash risk by disaggregating them into foreign institutional and foreign individual investors. Most of the foreigners in emerging equity markets are institutional (Ding et al., 2017; Lee & Ryu, 2019). Chen et al. (2013) argue that foreign institutional ownership significantly increases stock return volatility in emerging markets whereas foreign individual ownership reduces return volatility. They also posit that the volatility-increasing effect of foreign institutional ownership occurs via stock liquidity. In addition, Fan and Fu (2020) show that institutional ownership increases future stock crashes via the heavy selling pressure of an institutional exit. Others claim that institutional ownership decreases the risk of a stock price crash through strong external monitoring (An & Zhang, 2013; Callen & Fang, 2013). Taking these different arguments into account, this study aims to reveal how different categories of foreign investors affect the relationship between stock liquidity and crash risk in the BIST.

The remainder of this paper proceeds as follows. Section 2 reviews the theoretical framework. Section 3 describes the sample and the variables. Section 4 offers the empirical design and findings. Section 5 concludes.

2. Theoretical framework

2.1. Crash risk and liquidity relationship

The stock liquidity can either diminish or exacerbate the crash risk, depending on which channel dominates the relationship. Stock liquidity can reduce the likelihood of crash risk in two ways. The first, cited as governance theory by Chauhan et al. (2017), contends that having more liquid stocks leads to a lower crash risk. In this strand of the literature, Maug (1998) posits that it is less costly to purchase large stakes in liquid stock markets, which enables the easy formation of large shareholders (i.e., blockholders). The blockholders improve corporate governance structures by monitoring and intervening in firm management via informed trading. Furthermore, the existence of blockholders empowers disciplinary trading, thereby leading to more effective managerial efforts thanks to their informational advantages in liquid markets (Edmans, 2009). In addition, as higher liquidity facilitates the threat of blockholders’ exit (i.e., selling their holdings and putting downward pressure on stock prices), the managers, whose compensation depends on share prices, refrain from actions that reduce firm value and are forced to make effective investment decisions (Admati & Pfleiderer, 2009). Accordingly, the probability of the emergence of bad news declines in these circumstances, reducing the risk of future crashes. The second one concerns stock price informativeness, as mentioned in Chauhan et al. (2017). As the level of stock market liquidity rises, the marginal value of information and the integration of private information into share prices increase (Chordia et al., 2008; Holmström & Tirole, 1993). Hence, investors become more informed, and more information is incorporated into prices in more liquid markets, which prevents managers from concealing bad news, thereby reducing crash risk.

However, two theories suggest that stock liquidity can also heighten the likelihood of future stock price crashes. First, short-termism theory indicates a positive correlation between liquidity and crash risk (Chang et al., 2017). Because they face lower trading costs when entering or exiting, more liquid firms might have an ownership structure that consists of smaller shareholders (Norli et al., 2014) or short-term-oriented/transient investors (also including institutional ones) who do

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1 The data come from the Data Analysis Platform, www.vap.org.tr.
not actively monitor firm management and focus on the firms’ short-term performance (Fang et al., 2014; Porter, 1992). Furthermore, higher stock liquidity gives rise to less internal monitoring via decreasing the exit cost of discontented shareholders (Bhide, 1993). In the absence of good monitoring, managers are more likely to hide short-term bad news in order to prevent transient investors from selling their shares. This tendency of managers leads to the accumulation of bad news over time. When all the accumulated firm-related bad news reaches a tipping point and is finally revealed, short-term-focused investors are encouraged to sell their shares, which results in stock price crashes (Chang et al., 2017; Zhang et al., 2018). Moreover, high stock liquidity also eases the exit of transient investors, which also increases the likelihood of a crash by magnifying the ex post stock price reactions to the arrival of bad news (Chang et al., 2017). Second, governance theory, as noted in Chang et al. (2017) argues that blockholders can also contribute to the positive link between liquidity and crash risk. In liquid markets, blockholders can trade aggressively after they obtain private bad news about firms through their informational advantage (Edmans, 2009). The strong share selling by blockholders exacerbates the market response to the release of bad news, hence inducing stock price crashes.

2.2. Foreign investors and the crash risk - liquidity relationship

The liberalization of stock markets and the presence of foreign investors put pressure on companies to disclose information and influence the information environment at the firm level. Foreign investors in emerging markets are generally institutional investors, and they hold large amount of assets (Ozel et al., 2020). They improve the corporate governance practices of local firms because they have effective skills in collecting and processing information about these firms (Kim & Yi, 2015) and effectively manage external monitoring (Beuselinck et al., 2017). Kim et al. (2019) investigate the effects of foreign investors on stock price crash risk. They argue that the existence of foreign investors in emerging markets reduces the local firms’ future stock price crash risk through external monitoring because they induce firm management to improve the quality of financial reporting and annual report tone management. Accordingly, the effective monitoring power of foreigners prevents local managers from withholding bad news, which in turn reduces future stock price crash risk. In terms of the foreign ownership in the liquidity and crash risk relation, as the stocks’ liquidity increases, these stocks are more preferred by foreign investors (Adaoglu & Turan Katircioglu, 2013; Dahlquist & Robertsson, 2001). Higher stock liquidity, accompanied by good external monitoring of foreign investors, reduces the managerial underperformance as well as bad news formation and retention, which altogether diminish future stock price crashes.

Other studies claim that foreign ownership can amplify the risk of future stock crashes. According to Huang et al. (2020), foreign investors are not as informed as domestic investors about local firms, and their intervention in these firms pushes managers to disclose bad news deliberately because continuing to withhold bad news will be costly for managers. In this case, hoarded news from the past and the flood of announcements of recent bad news boost crash risk. Moreover, foreign investors can lower the threshold (tipping point) at which it becomes extremely costly for managers to suppress bad news. In short, foreign participation in local firms facilitates the release of bad news at lower thresholds. When bad news about a highly liquid stock is released all at once, foreign investors can easily desert the firm because they have lower trading costs. Regarding the important role of foreigners in emerging markets, the strong selling pressure resulting from their exit is perceived as a bad signal by other market players, which exacerbates the negative market response to the firm, hence triggering crash risk (Vo, 2020). Furthermore, because higher liquidity facilitates the exit of foreign investors, particularly those with short-term interest in the firm, managers have a tendency to hoard bad news to avoid disappointing them. Doing so might seem to be a solution in the short term, but the release of accumulated bad news inevitably leads to a stock crash in the long run, which supports the short-termism approach cited in Chang et al. (2017) and Vo (2020).

3. Data and variable set

3.1. Sample and data source

This study uses annual data in the final crash risk model, collected from various databases at different frequencies. The stock returns and volume come from the Bloomberg database, whereas the firm-specific variables are obtained from the Finnet 2000+ database. The proportions of investor types (e.g., blockowners and foreign investors) in BIST firms come from data provided by the Central Securities Depository of Turkey. All the firms traded on the BIST are considered; however, the firms with missing variables, and, following Kim et al. (2011), firms with stock return data for less than 26 weeks are excluded from the dataset for the respective year only. Hence, the final sample consists of 2973 firm-year observations, including 364 firms for the years 2009–2019.

3.2. Variables set

3.2.1. Crash risk measures

Following the previous literature (Callen & Fang, 2015; Chen et al., 2001; Kim et al., 2011) this paper employs the most common crash risk measures: the NCSKEW (negative coefficient of skewness) and DUVOL (down-to-up volatility) of firm-specific weekly returns. To obtain the firm specific
weekly returns, first the expanded market model given in Equation (1) is estimated.

\[ R_{it} = \alpha_i + \beta_1 R_{m,t-2} + \beta_2 R_{m,t-1} + \beta_3 R_{m,t} + \beta_4 R_{m,t+1} + \varepsilon_{it} \]  

(1)

where \( R_{it} \) is the weekly return on stock \( i \) in week \( t \), \( R_{m,t} \) is the market return, and \( \varepsilon_{it} \) is the residual return. Then, the firm-specific weekly returns are calculated as \( W_{it} = \ln (1 + \varepsilon_{it}) \).

NCSKEW is calculated as the negative of the third moment of firm-specific weekly returns over the standard deviation of the firm-specific weekly returns raised to the third power for each year and each firm given in Equation (2).

\[ \text{NCSKEW}_{i,T} = - \frac{(n(n-1) \sum W_{it}^3)}{(n-1)(n-2)(\sum W_{it}^2)^{3/2}} \]  

(2)

where \( n \) is the number of observations of firm-specific weekly returns in year \( T \).

DUVOL is the natural logarithm of the ratio of the standard deviation of firm-specific weekly returns on the weeks with firm-specific returns below the annual mean, called down weeks, to the standard deviation of the firm-specific weekly returns on the weeks with firm-specific returns above the annual mean, called up weeks, given in Equation (3).

\[ \text{DUVOL}_{i,T} = \log \left( \frac{(n-1) \sum \text{DOWN} W_{it}^2}{(n-1) \sum \text{UP} W_{it}^2} \right) \]  

(3)

Higher values of both NCSKEW and DUVOL indicate greater crash risk. The only difference is that DUVOL does not involve the third moment and hence is less likely to be overly influenced by extreme weeks (Chen et al., 2001).

3.2.2. Stock liquidity measure

As defined by Kyle (2016), liquidity is an elusive concept, which makes its measurement challenging. Amihud’s (2002) illiquidity (ILLQ) measure is employed to gauge liquidity. This measure depicts how the daily price moves for a given trading volume, which roughly indicates the price impact of trading. It is good at measuring the price impact of trading compared to other liquidity measures, such as effective/realized spreads (Goyenko et al., 2009). Furthermore, unlike the other liquidity measures, it does not necessitate the microstructure data (i.e., intraday data), and it can be useful when there is no stock price change, which can be a concern particularly in emerging markets (Amihud, 2002; Lesmond, 2005). Equation (4) shows Amihud’s (2002) illiquidity measure, which is the average ratio of absolute value of daily returns (ret) to daily volume in Turkish lira (vol) for firm \( i \) on day \( d \) in a given year \( T \). \( D \) stands for the trading days in year \( T \).

\[ \text{ILLQ}_{i,T} = \frac{1}{D_{i,T}} \times \sum_{d} \frac{|\text{RET}_{i,d}|}{\text{VOL}_{i,d}} \]  

(4)

This equation defines the illiquidity of an asset, and lower illiquidity means higher liquidity of a stock or vice versa. Hence, the value of ILLQ is multiplied by \(-1\) to construct the variable for stock liquidity (LIQ) used for interpreting the impact of liquidity on crash risk more conveniently.

3.2.3. Control variables

To isolate the impact of stock liquidity on crash risk from the effects of fixed firm characteristics, a number of control variables are used in line with the crash risk literature.\(^2\) The detrended stock turnover (DTURN) is included in the model as it reflects the heterogeneity in investor views and thus represents an important source of crash risk (Chang et al., 2017; Chauhan et al., 2017; Chen et al., 2001; Kim et al., 2011). Negative coefficient of skewness (NCSKEW) is included to control for the persistence of the crash risk from one period to another (Chang et al., 2017; Chauhan et al., 2017; Chen et al., 2001; Kim et al., 2011; Kim & Zhang, 2016). The standard deviation of weekly returns (SGM) is controlled for in the model because high-volatility stocks are more likely to experience price crashes (Callen & Fang, 2015; Chang et al., 2017; Chen et al., 2001). RET, which represents the average equity return, is used as a control variable, following Chen et al. (2001), who show that firms that have high returns historically are more vulnerable to stock price crashes. As growth stocks are more susceptible to crash risk, the ratio of the price-to-book value (PB) is controlled for in the model (Callen & Fang, 2015; Chang et al., 2017; Chauhan et al., 2017; Kim et al., 2011). The size (SIZE) of the firm, measured by the natural logarithm of total assets, is controlled for, on the assumption that firms of different sizes differ in their vulnerability to crash risk levels (Chauhan et al., 2017; Chen et al., 2001; Kim et al., 2011). Leverage ratio, measured by the ratio of total liabilities over total assets, is used as a control variable (Chang et al., 2017; Hutton et al., 2009; Kim et al., 2011; Kim & Zhang, 2016) because highly leveraged firms might be more prone to stock price declines. Alternatively, Hutton et al. (2009) argue that more stable and less cash-prone firms can incur more debt. ROA, the ratio of net income over total assets, is included in the model to control for profitability (Chang et al., 2017; Kim et al., 2016). The absolute value of discretionary accruals (DACC), which is a measure of earnings management, is estimated using the modified Jones model (Dechow et al., 1995). DACC indicates the quality of financial reporting of the firms, and an increase in DACC is expected to raise crash risk (Fan & Fu, 2020; Kim et al., 2014; Yin & Tian, 2017).

4. Empirical design and results

4.1. Stock liquidity and crash risk: baseline regressions

The baseline regression in Equation (5) is constructed to detect how the stock liquidity in the BIST affects crash risk:

\[ \beta^{\text{ILLQ}}_{it} = \beta^{\text{ILLQ}}_{0} + \beta^{\text{ILLQ}}_{1}x_{it} + \varepsilon_{it} \]  

(5)

\(^2\) See the Supplementary Material, available online. The variables are explained in Table S1. The descriptive statistics and correlation matrix of key variables are in Tables S2 and S3, respectively.
CrashRisk_{t+1,i} = \alpha_0 + \alpha_1 LIQ_{t,i} + \beta X'_{t,i} + \gamma YR_t + \epsilon_{t,i} \tag{5}

where the crash risk proxy denotes both NCSKEW and DUVOL continuous variables for \( t+1 \) year and firm \( i \). Stock liquidity and other control variables (NCSKEW, SIZE, ROA, PB, LEV, DTURN, DACC, RET, and SGM) are represented by \( LIQ \) and \( X' \), respectively, for the year \( t \) and firm \( i \). To consider the year and industry fixed effects, the time dummy variable \( YR \), and industry dummy variable \( IND \) based on sector codes provided by the Public Disclosure Platform are included in the main model. The error term is denoted by \( \epsilon_{t,i} \).

The pooled regression results estimated by ordinary least squares (OLS) are in Table 1. In model 1, the dependent variable is NCSKEW, and the coefficient of liquidity is positive and statistically significant. As an economic interpretation, one standard deviation (std) increase in liquidity leads NCSKEW to rise by 0.054 (0.00108*56.162). In model 2, the coefficient of stock liquidity in the DUVOL model is also positive and statistically significant. A one-std increase in liquidity results in an increase in DUVOL of 0.012 (0.000214*56.162). Both models prove that higher stock liquidity increases the likelihood of stock price crashes on the BIST. These findings are consistent with the empirical results found in other crash-risk models, which indicates that higher liquidity raises the crash risk on the BIST.

Table 1
Baseline regression test results.

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCSKEW_{t+1}</td>
<td>DUVOL_{t+1}</td>
</tr>
<tr>
<td>LIQ_t</td>
<td>0.00108***</td>
<td>0.000214*</td>
</tr>
<tr>
<td></td>
<td>(0.000343)</td>
<td>(0.000114)</td>
</tr>
<tr>
<td>NCSKEW_t</td>
<td>0.146***</td>
<td>0.0570***</td>
</tr>
<tr>
<td></td>
<td>(0.0256)</td>
<td>(0.00856)</td>
</tr>
<tr>
<td>SIZE_t</td>
<td>0.0540***</td>
<td>0.0233***</td>
</tr>
<tr>
<td></td>
<td>(0.0133)</td>
<td>(0.00477)</td>
</tr>
<tr>
<td>ROA_t</td>
<td>-0.000177</td>
<td>0.000194</td>
</tr>
<tr>
<td></td>
<td>(0.00212)</td>
<td>(0.000763)</td>
</tr>
<tr>
<td>PB_t</td>
<td>0.0104</td>
<td>0.00276</td>
</tr>
<tr>
<td></td>
<td>(0.00893)</td>
<td>(0.00306)</td>
</tr>
<tr>
<td>LEV_t</td>
<td>-0.00328***</td>
<td>-0.000968***</td>
</tr>
<tr>
<td></td>
<td>(0.00109)</td>
<td>(0.000385)</td>
</tr>
<tr>
<td>DTURN_t</td>
<td>-0.0000028</td>
<td>-0.000009</td>
</tr>
<tr>
<td></td>
<td>(0.000071)</td>
<td>(0.000039)</td>
</tr>
<tr>
<td>DACC_t</td>
<td>-0.0000184</td>
<td>-0.000913</td>
</tr>
<tr>
<td></td>
<td>(0.0270)</td>
<td>(0.00946)</td>
</tr>
<tr>
<td>RET_t</td>
<td>0.269***</td>
<td>0.110***</td>
</tr>
<tr>
<td></td>
<td>(0.0425)</td>
<td>(0.0152)</td>
</tr>
<tr>
<td>SGM_t</td>
<td>0.925</td>
<td>-0.339</td>
</tr>
<tr>
<td></td>
<td>(0.884)</td>
<td>(0.327)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.412***</td>
<td>-1.601***</td>
</tr>
<tr>
<td></td>
<td>(0.382)</td>
<td>(0.141)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.087</td>
<td>0.076</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

The results of the control variables are largely the same for both models and in line with the literature. Crash risk is positively and significantly related to past stock returns and past negative coefficient of skewness and firm size, but it is negatively and significantly associated with leverage. A positive and significant coefficient of negative skewness shows the persistence of crash risk from one period to another.

4.2. Robustness tests

In this section, several tests are conducted to justify the robustness of the relationship between stock liquidity and crash risk.4

First, the relation between liquidity and crash risk is tested using the variable CRASH, an alternative measure of crash risk. Using the crash definition of Hutton et al. (2009) crash weeks are specified as periods in which a firm-specific weekly return falls 3.09 standard deviations below its average returns over the fiscal year. In this context, CRASH equals 1 if a firm has 1 or more crash weeks over the fiscal year and equals 0 otherwise. Because CRASH is a binary dependent variable, and the model for it can be estimated only by using a logit model, the following tests are carried on with continuous dependent variables (NCSKEW and DUVOL) in the models. These measures are more applicable to and appropriate for further tests. As seen in Panel A in Table 2, the coefficient of stock liquidity is still positive and statistically significant, as found in other crash-risk models, which indicates that higher liquidity raises the crash risk on the BIST.

Second, the baseline regression models might suffer from potential endogeneity problems due to the time-invariant firm-specific omitted variables. To address this concern, the baseline model is re-estimated with a fixed effect model, as in An and Zhang (2013), Callen and Fang (2015), and Chang et al. (2017). In Panel B in Table 2, the fixed effects models’ results for both NCSKEW and DUVOL are presented, and the findings show that higher stock liquidity leads to higher crash risk, which is in line with the results obtained in OLS estimates.

Third, the main model in Equation (5) might also have endogeneity problems because of reverse causality concerns. Although stock liquidity has an impact on the crash risk, there is always a possibility that crash risk could also influence stock liquidity. The changes and reverse changes regressions are estimated by following Aggarwal et al. (2011), Zhang et al. (2018) and Kim et al. (2019) to determine whether reverse causality exists and to address the endogeneity issue. In Table 2, the changes in crash risk are regressed on the change in liquidity in the changes regression in Panel C, whereas the change in liquidity is regressed on the changes in crash risk measures in the reverse changes regression in Panel D. The findings of the reverse changes regressions show that changes in NCSKEW and DUVOL (i.e., changes in crash risk) do not

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4 The results for the control variables, constant term, year and industry-fixed effects are available from the author upon request.
Table 2
Robustness check tests results.

Panel A: Alternative Crash Risk Measure: CRASH

<table>
<thead>
<tr>
<th>Model</th>
<th>CRASH</th>
<th>LIQ,</th>
<th>Constant</th>
<th>Control Variables</th>
<th>Year and Industry Fixed Effects</th>
<th>Pseudo R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td>0.000169*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0.0369</td>
</tr>
</tbody>
</table>

Panel B: Firm Fixed-Effects Model

<table>
<thead>
<tr>
<th>Model</th>
<th>NCSKEW</th>
<th>DUVOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Changes Regression Test

<table>
<thead>
<tr>
<th>Model</th>
<th>ΔNCSKEW</th>
<th>ΔLIQ,</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td></td>
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</table>

Panel D: Reverse Changes Regression Test

<table>
<thead>
<tr>
<th>Model</th>
<th>ΔLIQ,</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
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</table>

Panel E: HFT Off

<table>
<thead>
<tr>
<th>Model</th>
<th>NCSKEW</th>
<th>DUVOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel F: The Repeal of the Uptick Rule

<table>
<thead>
<tr>
<th>Model</th>
<th>CRASH</th>
<th>LIQ,</th>
<th>TREAT</th>
<th>Constant</th>
<th>Control Variables</th>
<th>Year and Industry Fixed Effects</th>
<th>R-squared</th>
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<tbody>
<tr>
<td>(1)</td>
<td></td>
<td>0.000805*</td>
<td>(0.000433)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

significant future stock liquidity, which indicates that stock liquidity is not mainly driven by crash risk. However, increases in liquidity could significantly affect the future crash risk, as seen in Panel C, in which at least one significant result is consistent with other regression results.

Fourth, the dataset starts with the HFT-off period in the BIST and covers the HFT-on period in the past four years. The empirical evidence in the literature regarding the effects of HFT on liquidity is mixed. Many researchers show that HFT improves liquidity in the stock market by lowering the spreads and cost of trading (Hendershot et al., 2011; Hruska & Linnertova, 2015) and increasing the number of trades (Dinh, 2017). Some argue that competition among HFTs increases speculative high-frequency trades, which could adversely affect market liquidity (Breckenfelder, 2020). Against this backdrop, it is important to examine the effects of HFT activity on liquidity. The sample is divided into HFT-off and HFT-on periods to observe the effects of HFT activity on crash risk via liquidity, and the results are in Panel E of Table 2. In the HFT-off period, the effect of liquidity on stock price crash risk is found to be statistically insignificant with inconsistent signs. However, in the HFT-on period, liquidity positively and significantly affects crash risk in the NCSKEW model, which could indicate the increasing effect of liquidity on crash risk due to algorithmic trading.

As a final and further analysis, the effects of short-selling restrictions are analyzed as the period of the study also covers the periods of uptick rule implementation (i.e., short-sale restrictions) on the BIST. The literature shows that the removal of short-sale restrictions could influence the risk of

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5 According to the uptick rule, short selling on a stock can be executed at a price higher than its last traded price. The uptick rule that applies to short selling in the equity market was ended for stocks in the BIST 100 index on February 1, 2013. The uptick rule was applied to stocks in the BIST100 index for two months, between May 9 and July 9, 2018. Then, the uptick rule was suspended before being reapplied on August 14, 2018.
stock price crashes in both positive and negative ways. On the one hand, investors engaged in short sales are mostly sophisticated, and they can monitor firms effectively. As these investors discover firm-related negative news, they can promptly facilitate incorporation of bad news into stock prices via their trading, which in turn prevents the managers from hoarding bad news. Hence, the repeal of short-sale restrictions can reduce the likelihood of crashes due to the monitoring power of short-sale traders (Deng et al., 2020). On the other hand, the removal of short-sale constraints could induce excessive price declines, as uninformed investors run to sell their shares, assuming that declining prices are the result of informed trades’ short selling, depending on the negative news disclosed. Therefore, these excessive stock sales lead to large declines in stock prices, hence, an increase in crash risk (Barlevy & Veronesi, 2003; Ni & Zhu, 2016).

To understand how the repeal of short-selling restrictions affect stock price crashes on the BIST, the main model is enhanced, as in Equation (6) by implementing the DID approach, following Deng et al. (2020). In the enhanced model, the variable treatment (TREAT) takes a value of 1 if the stock is included in the BIST100 index, and 0 for other stocks as a control group. The dummy variable POST equals 1 for the years 2013–2017, in which uptick rule was removed for BIST100 stocks, and 0 for the years before repeal of the restrictions.6 The model also includes the interaction term between the treatment group and the post period, TREAT*POST. Panel F in Table 2 shows that crash risk on the BIST significantly rises in general after the lifting of short-sale restrictions imposed for a long time, because the variable POST has a positive and significant coefficient. However, the coefficient of the interaction term is also found to be positive but statistically insignificant, as the risk-increasing effect of that repeal on BIST100 stocks might also drive down stock prices in the control group, reducing the difference between the treatment and control group stocks.

\[
\text{Crash Risk}_{t+1} = \alpha_0 + \alpha_1 \text{LIQ}_{t+1} + \phi_1 \text{TREAT} + \phi_2 \text{POST} + \phi_3 \text{TREAT} \times \text{POST} + \beta_1 X_{t+1} + \beta_2 \text{IND}_{t+1} + \beta_3 \text{YR}_{t+1} + \epsilon_{t+1}
\]

(6)

4.3. Stock liquidity and crash risk link: which channel matters?

The main findings in the study indicate that a higher level of stock liquidity increases future crash risk on the BIST. However, it is crucial to detect which channels contribute to this positive association between them. In this section, these channels are investigated with respect to the ownership structure of firms.

6 Within the annual data setting, the removal of the uptick rule in 2013 is analyzed in the re-examination of the main model with the DID approach. In this analysis, pre-2013 and 2013–2017 periods are categorized as restriction-on and restriction-off periods, respectively. In 2018, several short-sales restriction periods include both restrictions and removals, making it impossible to reflect them in the annual model.

7 The block ownership percentages come from data provided by the Central Securities Depository of Turkey.
liquidity and a high crash risk, is attributed to transient investors in Chang et al. (2017), whereas the potential channel for this relationship is ascribed to the sudden release of bad news in Zhang et al. (2018).

4.3.2. Foreign ownership and the liquidity-crash risk link

Given the insignificant impact of blockholder ownership on the liquidity—crash risk relationship, and the high share of foreign participation in the BIST, further analyses is needed on the impact of foreign investors on this relationship. The variable for foreign ownership (FRO), measured as the proportion of foreign investors' shares (both individual and institutional investors) in a firm's outstanding total shares and its interaction with stock liquidity (FRO*LIQ) are inserted in the baseline models, and the results are in Table 4. The coefficient of the interaction variable is found to be positive and statistically significant for both crash measures, which implies that the positive association between stock liquidity and crash risk is stronger for firms with higher levels of foreign ownership. In line with the findings of Huang et al. (2020) and Vo (2020), the results confirm that higher foreign ownership by individual leads to higher crash risk. These results might support the short-termism argument (Chang et al., 2017; Vo, 2020) that higher stock liquidity triggers future crash risk via managerial hoarding of bad news due to the exit threat of foreign investors, especially those that are short-term oriented, after the disclosure of bad news. Furthermore, higher stock liquidity also causes future stock crashes due to foreign investors' trading behavior. When bad news arrives, foreigners tend to deliberately sell off highly liquid stocks more easily. Demonstrating the importance of foreign ownership in emerging equity markets, such as the BIST, the strong selling pressure by foreigners is perceived by the market as a bad signal, and local investors are likely to follow the behavior of foreign traders, which can result in stock price crashes (Vo, 2020).

As a further step, the categories of foreign investors trading on the BIST as foreign institutional and foreign individuals are also taken into account in the analysis of foreign influence on the relation between liquidity and crash risk. The foreign investors are mainly institutional investors in emerging equity markets and have large shares of these markets. In addition, in emerging markets, foreign institutional ownership can amplify return volatility, whereas foreign individual ownership reduces it (Chen et al., 2013). At the same time, when bad news is released about the firms, heavy and aggressive selling by institutional investors exacerbates the market response to this negative news, which in turn amplifies future crash risk. In addition, selling pressure is heavier for short-term-oriented institutional investors (Fan & Fu, 2020). The exit of institutional investors plays a large role in shaping the relation between stock liquidity and crash risk (Chang et al., 2017). Higher stock liquidity can intensify heavy selling pressure from foreign institutional investors, especially those focused on the short term, and facilitates a large number of exits, leading to lower stock prices and subsequent stock crashes.

To determine whether foreign institutional investors contribute more to liquidity and crash risk link on the BIST than foreign individual investors, both foreign institutional (FR_INS) and foreign individual (FR_IND) investors, and their interactions with liquidity (FR_INS*LIQ and FR_IND*LIQ) are tested in the augmented main models. As seen in models 1 and 2 in Table 4, an increase in participation by foreign institutional investors significantly raises future crash risk, which is in line with the findings of Fan and Fu (2020). Furthermore, the coefficient of the interaction term of foreign institutional ownership and liquidity is positive in both models, but significant only in model 1. These findings...
might also indicate that the increasing effect of liquidity on crash risk is more pronounced at firms with higher foreign institutional ownership because of their intense selling pressure in domestic equity markets (Fan & Fu, 2020), in which higher stock liquidity expedites their exit. But, in models 3 and 4, the impact of foreign individual investors on future crash risk is negative and statistically insignificant. The coefficient of the interaction term of foreign individual ownership and liquidity is also negative and statistically insignificant. These findings are consistent with the argument made by Chen et al. (2013) that foreign institutional ownership results in higher stock return volatility in domestic equity markets whereas foreign individual ownership reduces it.

5. Conclusion

This study examines the effect of stock liquidity on future stock price crash risk and the channels through which this effect arises, covering 364 firms listed on the BIST for the period 2009–2019. The results show that, as stock liquidity rises, so does the likelihood of future stock crashes on the BIST. As for the channels that drive the relation, first the impact of blockholders is analyzed and the findings do not provide evidence that the positive impact of stock liquidity on crash risk is more salient for firms with higher block ownership. This might support the argument that the trading behaviors of short-term-oriented investors and their impact on managers is a potential mechanism driving the relation between liquidity and crash risk on the BIST. Second, the role of foreign ownership in the relation between stock liquidity and crash risk is analyzed considering the large volume of trading by foreign investors on the BIST. One finding is that foreign investors individually increase future stock crashes. More importantly, stock liquidity significantly increases crash risk as participation by foreign investors in the firm rises. This finding might lend support to short-termism theory, given that managers tend to withhold bad news because of the threat of exit by foreign investors. In addition, although high liquidity makes it easier for foreign investors to sell stocks in the face of bad news, this selling behavior amplifies the negative reaction of other participants to firm-related bad news, causing substantial declines in stock prices and, eventually, stock price crashes. Third, the findings also show that foreign institutional investors play an important role in future stock price crashes on the BIST, and the linkage between stock liquidity and crash risk is also stronger at firms with higher ownership by foreign institutional investors because of their aggressive selling of highly liquid stocks. The relation between stock liquidity and crash risk is also tested for the potential endogeneity problem to look for omitted variables and reverse causality. The results are found to be robust with respect to both concerns. On the other hand, the findings show that HFT activity raises liquidity, causing an increase in stock price crashes. As for short sales, the findings suggest that the lifting of short-sale restrictions after they have been in effect a long time generally triggers a crash risk.

This study highlights the role of stock liquidity and foreign investors in terms of crash risk and offers some references for investors and policy makers, especially in emerging markets. Investors should be vigilant about the rising crash risk from stocks with a high level of liquidity and foreign ownership, particularly those with institutional investors, who can create selling pressure in the market. Regulators should be wary of the unintended consequences of liquidity and foreign investors in emerging markets. Overall, this study does not conclude that stock liquidity is harmful, but it identifies a negative aspect in the form of crash risk, mainly attributable to foreign investors.

Declaration of competing interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bir.2021.06.012.

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