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Idiosyncratic Risk Volatility: Stock Price Informativeness or Price Error?

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Abstract: Research on idiosyncratic volatility in developing countries, particularly Indonesia, is scant. This study is the first to explain idiosyncratic concepts through an information environment approach and an examination of information asymmetry. This study aims to analyze the phenomenon of idiosyncratic risk in Indonesia, whether it is related to price informativeness or price error, by considering the information environment. We identified the information environment based on the liquidity levels and stock liquidity risk. Our research revealed the relationship between information asymmetry in the information environment and idiosyncratic volatility by using a sample of 499 companies listed on the Indonesia Stock Exchange during the period 2017–2019. One thousand, two hundred and twenty-nine (firm_year) observation data were obtained. The dependent variable was idiosyncratic volatility, and the independent variable used an information environment consisting of stock liquidity, liquidity risk, and information asymmetry. The findings of this study are expected to contribute to the literature on idiosyncratic volatility by showing how it can predict the development of the information environment, and how the latter is a consequence of information asymmetry. Moreover, this study should also complement views that are related to the concept of idiosyncratic volatility equivalent to price errors; this research has been carried out in previous studies.

Keywords: liquidity risk; information asymmetry; idiosyncratic risk

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1. Introduction

Research on idiosyncratic volatility in developed countries such as the United States (Campbell et al. 2000; Morck et al. 2000; Sakawa et al. 2021), as well as in developing countries (Li et al. 2004; Noviayanti and Husodo 2018; Foye and Valentincic 2020), has received attention in recent years. This research shows an anomaly in the pricing model (CAPM), which assumes that market risk is the only determinant of return because an investor can diversify company-specific risk (idiosyncratic risk) through portfolio formation. Not all investors can diversify their portfolios due to transaction costs, limited information, and other constraints such as taxes and the need for liquidity (Xu and Malkiel 2005); therefore, investors must pay attention to the overall market and idiosyncratic risks. The study also revealed that institutional investor groups deliberately compile portfolios of assets with high idiosyncratic risks. They do this so that they have the opportunity to receive extraordinarily abnormal returns when information asymmetry occurs (Yang et al. 2020; Wu et al. 2022).

Increasing volatility is associated with several factors, such as high earnings volatility (Hamao et al. 2003; Xu and Malkiel 2003; Wei and Zhang 2005; Vozlyublennaia 2013), company profitability (Fink et al. 2010; Irvine and Pontiff 2009), high stock turnover (Irvine and Pontiff 2009; Vozlyublennaia 2013), and leverage (Wei and Zhang 2005; Vozlyublennaia 2013). In addition to these factors, idiosyncratic volatility is associated with information; however, the basic concept of idiosyncratic volatility is still being debated. On the one hand, it is assumed that idiosyncratic volatility represents a high level

of information transparency (Morck et al. 2000; Durnev et al. 2003; Jin and Myers 2006). On the other hand, idiosyncratic volatility is assumed to be price 'noise' (Hou et al. 2011; Teoh et al. 2011; Mitra 2016; Datta et al. 2017).

The main difference lies in the concept of information transparency. The level of information transparency indicates the quality of the information environment; therefore, it can be said that high information transparency indicates a good information environment, and low information transparency indicates a poor information environment (Mitra 2016). Research by Löffler et al. (2021) shows that the level of information is related to the return that will be received. Based on these concepts, we argue that the information environment approach can be used to explain different concepts relating to idiosyncratic volatility. In particular, this research was conducted in Indonesia, and was characterized by a low level of transparency. This study uses information asymmetry as a factor that affects the relevance of the information environment and the idiosyncratic risk. This research aims to determine whether an idiosyncratic risk is related to price informativeness or price error; therefore, we assume that idiosyncratic volatility is related to information transparency, which is related to a good information environment (Li et al. 2014). However, if it is associated with price noise, idiosyncratic volatility is associated with a bad information environment (Amihud 2002; Kelly 2011; Datta et al. 2017).

The information environment is the information available in the capital market through mandatory and voluntary disclosures (Armstrong et al. 2012; Robin and Wu 2015). Managers have a greater opportunity to benefit from information in situations where the information environment is not transparent (Fakhari and Rezaei Pitenoei 2017). A weak information environment can lead to negative markets, both collectively and individually, as well as minimal participation, increased transaction costs, market dilution, and a decreased trading income. In addition, the weakness of the information environment causes stock prices to fall, sometimes causing total market collapse (Bhattacharya et al. 2013).

Research on the relationship between the information environment and the idiosyncratic risk in developing countries has not been conducted widely, including in Indonesia. Characteristics pertaining to the information environment in Indonesia include the fact that Indonesia has a low level of transparency and a high level of idiosyncratic risk compared with other ASEAN countries (Morck et al. 2000; Foye and Valentincic 2020). This study is expected to contribute to the literature by predicting the development of the information environment in terms of it being a consequence of information asymmetry, and the effect that this has on idiosyncratic volatility. Second, this study provides an additional assessment of the concept of idiosyncratic volatility and its likeness to price errors; this research has been conducted previously. Pricing errors indicate the existence of a non-transparent information environment which prevents investors from properly conducting stock valuations. Decision-makers that have the ability to enforce regulations can make policies encouraging transparency in the information environment (low asymmetry) to ensure stock illiquidity and low liquidity risk. Reducing liquidity risk allows issuers to fund projects while ensuring that the debt is affordable. Moreover, the company can improve its performance so that it has the potential to increase revenues and profits, which have an impact on high stock prices (Tsagkanos and Siriopoulos 2015). The company can take advantage of these opportunities by increasing information transparency. Increased information transparency can encourage the market to be efficient, and thus stock prices can reflect their fair value so that no party has private information that enables it to obtain excessive, abnormal returns.

2. Literature Review and Hypothesis Development

2.1. Information Environment and Idiosyncratic Volatility

Several studies that examine idiosyncratic volatility note how information environments with high idiosyncratic volatility are associated with less informative stock prices and information asymmetry (Krishnaswami and Subramaniam 1999). Idiosyncratic volatility captures high price inefficiencies (Teoh et al. 2011). A high-quality information en-

vironment is associated with low idiosyncratic volatility (Kelly 2011), whereas a poor information environment is characterized by high stock liquidity and liquidity risk. Information asymmetry is associated with idiosyncratic volatility (Mitra 2016). New companies have high idiosyncratic volatility, which decreases over time (Pastor and Pietro 2005). This indicates that idiosyncratic volatility occurs because of the lack of available information. Low return-specific volatility also occurs in countries with high levels of transparency (Bartram et al. 2009).

In contrast to previous research, Morck et al. stated that firms in some countries with good information environments exhibit high idiosyncratic volatility. This is also stated by Jin and Myers who argue that a less transparent information environment has low idiosyncratic volatility. High idiosyncratic volatility reflects high stock price efficiency (Durnev et al. 2003). Research on US companies has also provided evidence to support the view that higher firm-specific return variations indicate more informative stock prices (Bae et al. 2013).

The study by Lee and Liu (2011) helps us to investigate the relationship between price informativeness and idiosyncratic price volatility. The results help reconcile the two abovementioned views; namely, that price volatility either increases or decreases in the presence of price informativeness. Based on these two views, it can be concluded that price inefficiency, lack of price information, and low levels of transparency indicate a poor information environment and vice versa. Based on this description, we argue that idiosyncratic risk is related to price errors; therefore, we use the following hypothesis.

H1. *A poor information environment is associated with high idiosyncratic volatility.*

2.2. Information Asymmetry in the Information Environment That Affects Idiosyncratic Volatility

A company's information environment develops as a consequence of information asymmetry (Beyer et al. 2010). In this case, Bhattacharya et al. revealed that the asymmetric distribution of information can encourage information users to try and access personal information. The reduced transparency of information results in an unequal distribution of information and will therefore be sustainable (Lightfoot and Wisniewski 2014).

Research conducted by Bae et al. showed that idiosyncratic volatility has a stronger positive relationship for companies with high information asymmetry, namely, in conditions where private information is difficult to obtain based on geographical proximity factors. An increase in volatility has the potential to increase the amount of loss for parties that do not obtain information, thus affecting the company's stock price (Habib et al. 2011)

The information risk model in other studies (O'Hara 2003; Easley and O'Hara 2004) shows that returns are positively related to the information asymmetry that occurs due to a lack of public information; this forces investors to rely more on private information. Uninformed traders perceive that they are in a poor information environment because they have fewer assets. This could reduce the price of securities, which at high levels of personal information, and potentially increase information asymmetry and the cost of capital for these firms (Easley and O'Hara 2004). Pastor and Pietro (2005) modeled the relationship between information asymmetry and return volatility in an environment in which investors learn about uncertainty in company profitability as a risk factor that affects investors' perceptions of company profitability and return volatility. Overall, the results indicate that information asymmetry is related to idiosyncratic volatility in a poor information environment; therefore, we use the following hypothesis:

H2. *Information asymmetry strengthens the influence of a poor information environment on idiosyncratic volatility.*

3. Materials and Methods

3.1. Sample

This study used a sample of 499 companies listed on the Indonesia Stock Exchange during the period 2017–2019. One thousand, two hundred and twenty-nine (firm-year)

observation data, based on unbalanced panel data, were obtained. The data collected were daily stock data, the composite stock price index, trading volume, and the closing bid. The daily price was used as the basis for calculating idiosyncratic volatility, stock illiquidity, stock liquidity risk, and information asymmetry. The daily stock price is used in terms of monthly and annual data.

3.2. Variables and Measurements

3.2.1. Idiosyncratic Volatility

The idiosyncratic volatility (σe^2) used in this study is the residual value of the Capital Asset Pricing Model (CAPM) equation:

$$R = \alpha_i + \beta_i\left(R_m - r_f\right) + e_i \quad (1)$$

where R is the return of company i, R_m is the market return (Jakarta Composite Index), and r_f is the risk-free rate (Bank of Indonesia certificate rate). The residual value (e_i) is the daily return variance (which is used in terms of monthly and annual data). The residual value used was based on the residual value (IDVOL σe^2), and the relative IDVOL value, ($\sigma e^2/\sigma^2$) of a robustness test.

3.2.2. Information Environment

The information environment in this study uses two proxies: illiquidity and stock liquidity risk.

- Stock illiquidity (Amihud 2002)
  This variable measures the daily stock-price response as per the rupiah trading volume. Stock illiquidity is calculated based on the ratio of the absolute return to the trading volume (in rupiah).

$$Illiquid = \frac{abs\ return}{volume \times price} \quad (2)$$

  Abs return is the absolute value of the company's daily stock return, the trading volume is the number of shares traded, and price is the daily closing price (Lou and Ronnie 2011). A high stock illiquidity ratio indicates low stock liquidity and high information asymmetry, thus indicating a poor information environment. The relationship between illiquidity and information asymmetry is tested further in Hypothesis 2.
- Liquidity risk
  The liquidity risk (ILLIQRISK) is the standard deviation of the illiquidity equation. The liquidity risk is the co-variation of its returns with unexpected changes in aggregate liquidity (Lou and Ronnie 2011). A high liquidity risk value indicates a poor information environment (Mitra 2016).
- Information Asymmetry
  The information asymmetry variable (SPREAD) was used in this study to determine the quality of the information environment because the development of the information environment is a consequence of information asymmetry (Beyer et al. 2010). Information asymmetry in the information environment indicates a poor information environment. The amount of information asymmetry is calculated based on the following formulation:

$$Spread = \frac{Ask - bid}{mid\ point} \quad (3)$$

  Spread is the value of information asymmetry, *ask* is the daily ask closing price, and *bid* is the bid-closing price. Measurement of each variable in detail can be seen in Table 1.

Table 1. Variables and their measurements.

Variable		Measurement
Idiosyncratic Volatility		
Absolute and relative Idiosyncratic Volatility	IDVOL (σe^2)	Idiosyncratic Volatility based on residual value based on the CAPM equation
Relative Idiosyncratic Volatility	IDVOLrelative ($\sigma e^2/\sigma^2$)	Idiosyncratic Volatility based on the relative residual value
Information Environment		
Stock liquidity (Amihud 2002 Model)	ILLIQUID	Monthly absolute return/trading volume (in rupiah)
Stock liquidity risk	LIQRISK	The standard deviation of the illiquid equation
Information Asymmetry		
Bid-ask spread	SPREAD	Difference between buying and selling prices
Idiosyncratic Determinants		
Book to Market	BM	The ratio of book value equity to market value equity
Leverage	LEV	Debt to asset ratio
Return on assets	ROA	Earnings to assets ratio
Company size	SIZE	Asset log

3.2.3. Control Variable

The control variable used was the determinant of idiosyncratic volatility based on previous research. BM (book to market) is the ratio concerning the book value to market value of equity (Cao et al. 2008; Chun et al. 2008; Bae et al. 2013). The value of BM reflects the company's growth opportunities, which become more abundant with increasing levels of BM; this can explain the increase in idiosyncratic volatility. LEV (leverage) is the ratio of long-term debt to total assets (Chun et al. 2008; Bae et al. 2013). A high leverage ratio in a company indicates an increase in idiosyncratic volatility. ROA (return on assets) is the ratio of net income to assets (Datta et al. 2017). ROA is negatively associated with idiosyncratic risk. Companies with high ROA will publish their complete performance achievements to enhance the quality of information (Soyemi and Olawale 2019; Widianingsih et al. 2022). Improving the quality of financial reporting can reduce the level of idiosyncratic risk. SIZE (log asset) is the size of the company, which is calculated based on the asset log (Mitra 2016). The larger the company, the lower the idiosyncratic volatility.

3.3. Regression Analysis

The tests were conducted using panel data analysis with several stages of testing to determine the consistency of the relationship between the information environment and idiosyncratic volatility.

Hypothesis 1 determines the relationship between illiquidity and stock liquidity risk as a proxy for idiosyncratic volatility in the information environment.

$$\text{IDVOL} = \alpha_0 + \alpha_1\text{ILLIQUIDit} + \alpha_2\text{LIQRISKit} + \alpha_3\text{IEit} + \alpha_4\text{BMit} + \alpha_5\text{LEVit} + \alpha_6\text{ROAit} + \alpha_7\text{SIZEit} + \text{eit} \quad (4a)$$

$$\text{IDVOl}_{\text{relative}} = \alpha_0 + \alpha_1\text{ILLIQUIDit} + \alpha_2\text{LIQRISKit} + \alpha_3\text{IEit} + \alpha_4\text{BMit} + \alpha_5\text{LEVit} + \alpha_6\text{ROAit} + \alpha_7\text{SIZEit} + \text{eit} \quad (4b)$$

To strengthen the results of the analysis that tested Hypothesis 1, Hypothesis 2 testing was carried out to determine the consistency of the information environment's influence on idiosyncratic volatility in the presence of information asymmetry. The formulation used was as follows:

$$IDVOL = \alpha_0 + \alpha_1 SPREADit + \alpha_2 ILLIQUIDit + \alpha_3 LIQRISKit + \alpha_4 IEit + \alpha_5 BMit + \alpha_6 LEVit + \alpha_7 ROAit + \alpha_8 SIZEit + eit \quad (5a)$$

$$IDVOL_{relative} = \alpha_0 + \alpha_1 SPREADit + \alpha_2 ILLIQUIDit + \alpha_3 LIQRISKit + \alpha_4 IEit + \alpha_5 BMit + \alpha_6 LEVit + \alpha_7 ROAit + \alpha_8 SIZEit + eit \quad (5b)$$

4. Results

4.1. Summary Statistics

Table 2 presents descriptive statistics for the variables used. The sample used included 499 companies during the period 2017–2019, and 1229 data (firm-year) were obtained based on unbalanced panel data. Panel A shows idiosyncratic volatility, which was measured based on the residual and relative values of the CAPM regression equation; this was based on daily data, which are used in terms of monthly and annual data. Panel B is an information environment variable consisting of stock illiquidity (ILLIQUID), which shows the daily stock price response to price volume changes. A greater illiquidity ratio indicates low liquidity, which, in turn indicates a bad environment. Similarly, liquidity risk is the standard deviation of the illiquidity equation. Panel C is a bid/ask spread, which is a proxy for information asymmetry. Panel D shows company characteristics, namely, the book-to-market (BM), leverage (LEV), and return on assets (ROA) ratios, and SIZE (company SIZE) as control variables. The skewness spread (information asymmetry) in panel C shows a value of 9640. The skewness value is positive or negative, and it indicates the occurrence of asymmetry (Floros 2011). The kurtosis value shows a value of 170.969; thus, the distribution curve is leptokurtic.

Table 2. Descriptive statistic.

	Observations	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
A. Idiosyncratic volatility								
IDVOL (σe^2)	1229	1.605	1.597	5.506	0.001	0.997	0.536	3.160
IDVOLrelative ($\sigma e^2/\sigma^2$)	1229	−4.093	−2.321	2.346	−55.146	5.64	−3.482	21.299
B. Information environment								
ILLIQUID	1229	7.149	7.183	17.556	3.459	0.957	8.096	105.225
LIQRISK	1229	0.001	0.001	0.105	0	0.004	15.721	332.413
C. Information asymmetry								
SPREAD	1229	−3.228	−3.421	3.063	−8.208	1.693	9.640	170.969
D. Firm characteristics								
BM	1229	0.894	0.8	18.3	−88.9	4.36	−13.991	242.696
LEV	1229	0.191	0.139	3.575	0	0.214	23.617	707.926
ROA	1229	0.029	0.028	1.303	−2.641	0.164	−3.213	80.049
SIZE (Asset = in millions Rupiah)	1229	9,740,000	2,450,000	352,000,000	54,500,000	25,200,000	7.554	82.777

Notes: This table presents descriptive statistics of the variables used. Idiosyncratic volatility as a dependent variable was measured using two measurement residual values, the CAPM equation (IDVOL σe^2) and the relative value (IDVOLrelative $\sigma e^2/\sigma^2$). The independent variable is the information environment consisting of the stock liquidity level (ILLIQUD), liquidity risk (LIQRISK), and information asymmetry variable (SPREAD = bid–ask spread). Company characteristics are control variables consisting of the BM (book to market), LEV (leverage), and ROA (return on assets) ratios, and SIZE (total assets).

Table 3 shows the correlations between the variables that were used in the study. The information environment variable has a significant correlation with idiosyncratic volatility, namely, the illiquidity (ILLIQ) and liquidity risk (LIQRISK) of 0.396 and 0.296, respectively. Information asymmetry proxied by the bid–ask spread is positively correlated with an

idiosyncratic volatility of 0.137. All three show a positive relationship with idiosyncratic volatility, thus indicating that a poor information environment (high ILLIQUID, LIQRISK, and SPREAD) is associated with high idiosyncratic volatility (Kelly 2011). The characteristics of the BM, LEV, ROA, and SIZE companies show a positive relationship with idiosyncratic volatility.

Table 3. Correlations.

	IDVOL	ILLIQUID	LIQRISK	SPREAD	BM	LEV	ROA	SIZE
IDVOL	1000							
ILLIQUID	0.396 ***	1000						
LIQRISK	0.296 ***	0.864 ***	1000					
SPREAD	0.137 ***	0.170 ***	0.083 ***	1000				
BM	0.175 ***	0.104 ***	0.068 ***	0.028 ***	1000			
LEV	0.343 ***	0.278 ***	0.139 ***	0.058 ***	−0.081 ***	1000		
ROA	0.203 ***	0.088 ***	0.0605 ***	0.084 ***	0.078 ***	−0.042	1000	
SIZE	0.550 ***	0.563 ***	0.321 ***	0.182 ***	0.194 ***	0.433 ***	0.181 ***	1000

Notes: The table presents the correlation between variables. *** denotes a significance level of 0.01; the overall correlation between variables is significant at 0.01.

This study tests the data's stationarity with the root test. Table 4 provides the result of the root test. The root test result shows that all variables have significant values at the 1% level; therefore, the root test results imply that this study's data are stationary.

Table 4. The Stationarity Test (Root Test).

Variables	Statistic	Probability *
IDVOL	244.091	0.000
ILLIQUID	209.985	0.000
LIQUIDRISK	206.108	0.000
SPREAD	216.789	0.000
BM	215.794	0.000
LEV	210.752	0.000
SIZE	214.795	0.000
ROA	213.792	0.000

* significance level at 0.01.

4.2. Effect of Information Environment on Idiosyncratic Volatility

The current study applies the fixed effect model to test the hypothesis. The decision to use the fixed effect model is based on the Chow and Hausmann test results which confirm that the fixed effect model is the most appropriate model to test the hypothesis, compared with random effect models. Table 5 provides the result of the Chow test which compares the common and fixed effect models. The results show that each test equation's chi-square probability is 0.000; therefore, the fixed effect model is better than the common effect. Furthermore, the Hausman test is used to determine whether the fixed effect model is better than the random effect model. The chi-square probability test for each equation is 0.000. This result confirms that the fixed effect model is better than the common and random effect models.

Table 6 provides the results of the analysis of environmental influences (ILLIQUID and LIQRISK) on idiosyncratic volatility, based on the residual value (σe^2) in Panel A and the relative value ($\sigma e^2/\sigma^2$) in Panel B, as a robustness test. Panel A shows that ILLIQUID and LIQRISK positively affect idiosyncratic volatility for all models tested separately and together. Illiquidity and liquidity risk have almost the same effect, illiquidity has an impact of 53%, and liquidity risk influences 51% of idiosyncratic risk.

Table 5. Chow and Hausman Tests.

	1	2	3	4	5	6
	Chi-Square	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**
	prob	**prob**	**prob**	**prob**	**prob**	**prob**
Chow—test	1273.883	1249.134	1657.361	1463.090	1548.716	1431.298
	0.000	0.000	0.000	0.000	0.000	0.000
Hausman—test	10.300	28.498	23.834	44.066	11.129	34.671
	0.001	0.000	0.000	0.000	0.004	0.000

Table 6. Information environment and idiosyncratic volatility.

A. IDVOL (σe^2)						
	1	**2**	**3**	**4**	**5**	**6**
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
ILLIQUID	0.457	0.472			0.692	0.721
	14.591 ***	15.490 ***			26.448 ***	25.730 ***
LIQRISK			44.207	39.150	75.976	97.785
			10.591 ***	6.033 ***	22.788 ***	18.533 ***
BM		−0.003		−0.006		−0.006
		−0.177		−0.382		−0.525
LEV		0.150		−0.432		0.107
		0.490		−1.295		0.436
ROA		−0.267		−0.678		−0.054
		−1.273		−2.908 ***		−0.314
SIZE		−0.099		−0.044		−0.076
		−0.760		−0.309		−0.728
Controls	No	Yes	No	Yes	No	Yes
Adj-R^2	0.533	0.596	0.510	0.505	0.728	0.734
F-stat	4.008 ***	4.689 ***	3.728 ***	3.544 ***	7.997 ***	7.861 ***
B IDVOLrelative ($\sigma e^2/\sigma^2$)						
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
ILLIQUID	81.016	91.891	27.566		481.261	472.707
	5.777 ***	5.279 ***	4.817 ***		8.920 ***	7.891 ***
LIQRISK				47.681	123.161	114.379
				5.360 ***	6.933 ***	5.140 ***
BM		0.013		0.012		0.013
		0.595		0.531		0.626
LEV		0.052		0.131		0.090
		0.113		0.287		0.203
ROA		0.472		0.300		0.194
		1.511		0.938		0.628
SIZE		0.014		−0.047		0.030
		0.074		−0.238		0.161
Controls	No	Yes	No	Yes	No	Yes
Adj-R^2	0.871	0.869	0.871	0.870	0.873	0.872
F-stat	88.092 ***	79.822 ***	88.768 ***	81.441 ***	96.733 ***	87.879 ***

Notes: The table shows the comparison of the influence of the information environment (ILLIQUID and LIQRISK) on idiosyncratic volatility, based on the values of IDVOL (σe^2) and IDVOLrelative ($\sigma e^2/\sigma^2$) as robustness tests. Column 2 shows the effect of ILLIQUID, column 4 shows the effect of LIQRISK, and the influence of both is shown in column 6. Columns 3, 5, and 7 are equation configurations, including control variables, to show that the analysis of ILLIQUID and LIQRISK consistently had a positive effect on idiosyncratic volatility. *** denote 0.01 significance levels.

The fact that the increase in illiquidity is associated with an increase in idiosyncratic risk indicates a decrease in the shares traded due to relatively high prices (Lou and Ronnie 2011). It can increase costs and potentially increase idiosyncratic risk. Moreover, liquidity risk as a measure of the sensitivity of stock returns to changes in market liquidity indicates that stocks with a high liquidity risk will be more sensitive to market liquidity; therefore, these stocks are risky (Lou and Ronnie 2011). To strengthen the test, the addition of control variables showed consistent results with regard to the influence of illiquidity and liquidity risk on idiosyncratic risk. This condition indicates that an information environment with high illiquidity and liquidity risk is a poor information environment, and therefore, it can potentially increase idiosyncratic volatility.

Panel B presents the test results based on the relative value of idiosyncratic volatility. The effect of ILLIQUID and LIQRISK is consistent with panel A. Illiquidity and liquidity risk have almost the same effect, with a value of 87%. Panels A and B show that the measurement of idiosyncratic risk using relative values shows better results; therefore, it should not only consider the high level of idiosyncratic risk, but also consider fluctuations in idiosyncratic risk. Thus, we can conclude that Hypothesis 1 proves to be significant. The information environment influences idiosyncratic volatility more than company fundamentals, such as the book-to-market, leverage, and return on assets ratios, and firm size. This result is indicated by the addition of control variables, which show consistent results.

4.3. The Effect of Information Asymmetry in the Information Environment on Idiosyncratic Volatility

Table 7 provides the result of the Chow test, which was carried out to compare the common effect model and the fixed effect model. The results show that each test equation's chi-square probability is 0.000; therefore, the fixed effect model is more appropriate for use than the common effect model. Furthermore, the current study conducted the Hausman test to determine whether the fixed effect model is better than the random effect model. The chi-square probability test for each equation is 0.000; thus, the fixed effect model is better than the common and random effect models.

Table 7. Chow and Hausman Test.

	1	2	3	4	5	6	7	8
	Chi-Square	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**	**Chi-Square**
	prob	**prob**	**prob**	**prob**	**prob**	**prob**	**prob**	**prob**
Chow—test	1624.450	1481.900	1248.798	1181.671	1681.561	1480.202	1481.342	1340.250
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman—test	4.993	13.413	21.191	38.634	25.199	44.555	16.628	34.359
	0.025	0.020	0.000	0.000	0.000	0.000	0.001	0.000

Table 8 shows Hypothesis 2 being tested to establish that the existence of information asymmetry in a poor environment increases idiosyncratic volatility. Information asymmetry, proxied by SPREAD, showed a significant positive effect on the idiosyncratic risk, measuring at 48.9%. The addition of ILLIQUID and LIQRISK led to a significant impact on idiosyncratic risk, increasing it by 58.2%. This result shows that testing Hypothesis 2 strengthened the analysis results that came from testing Hypothesis 1. Panel B presents the test results which are based on the relative value of idiosyncratic volatility. The effect of ILLIQUID, LIQRISK, and SPREAD are consistent with the analysis of panel A. The addition of control variables also shows that the results of the influence of illiquidity, liquidity risk, and spread on idiosyncratic risk are consistent.

Table 8. Information environment, information asymmetry, and idiosyncratic volatility.

	A. IDVOL (σe^2)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
SPREAD	1.555	3.106	1.799	0.082	0.056	0.069	0.064	0.060
	14.960 ***	2.571 **	7.949 ***	2.965 ***	1.872 *	1.826 *	2.325 ***	2.019 ***
ILLIQUID			0.472	0.498			516.708	518.293
			14.857 ***	15.560 ***			12.101 ***	11.462 ***
LIQRISK					44.260	39.164	212.349	214.702
					10.583 ***	6.018 ***	13.444 ***	13.021 ***
BM		0.016		0.020				0.003
		0.507		0.825				0.109
LEV		0.118		0.109				−0.396
		0.319		0.350				−1.215
ROA		−0.635		−0.181				−0.625
		−3.362 ***		−0.863				−2.858 ***
SIZE		−0.124		0.033				−0.068
		−0.781		0.253				−0.495
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Adj-R^2	0.489	0.500	0.559	0.610	0.519	0.515	0.584	0.582
F-stat	3.522 ***	3.514 ***	4.308 ***	4.822 ***	3.820 ***	3.638 ***	4.557 ***	4.395 ***
	B IDVOLrelative ($\sigma e^2/\sigma^2$)							
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
SPREAD	1.566	3.285	0.085	0.081	1.545	0.072	0.062	0.057
	14.840 ***	1.636 *	17.690 ***	2.897 ***	69.536 ***	1.862 ***	2.209 ***	1.915 *
ILLIQUID			0.537	0.512			522.161	524.537
			3.286 ***	15.836 ***			12.074 ***	11.435 ***
LIQRISK					18.001	39.001	214.061	216.707
					4.229 ***	5.915 ***	13.380 ***	12.956 ***
BM		0.013		0.020		−0.007		0.002
		0.410		0.804		−0.405		0.085
LEV		0.110		0.111		−0.454		−0.401
		0.294		0.353		−1.338		−1.213
ROA		−0.644		−0.181		−0.718		−0.636
		−3.359 ***		−0.855		−3.028 ***		−2.867
SIZE		−0.138		0.024		−0.053		−0.078
		−0.852		0.184		−0.363		−0.557
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Adj-R^2	0.474	0.498	0.608	0.606	0.490	0.505	0.563	0.573
F-stat	3.374 ***	3.491 ***	4.948 ***	4.755 ***	3.516 ***	3.544 ***	4.267 ***	4.276 ***

Notes: Results of the analysis of the relationship between information environment, information asymmetry, and idiosyncratic volatility are presented; panel A uses the IDVOL value (σe^2) and panel B uses the relative IDVOL value ($\sigma e^2/\sigma^2$). Column 2 shows the effect of the bid–ask spread (SPREAD), and columns 4 and 6 show the effect of the bid–ask spread in the information environment with ILLIQUID (column 3) and LIQRISK (column 5). Column 8 shows the effect of the combination of the bid–ask spread, ILLIQUID, and LIQRISK. Columns 3, 5, 7, and 9 show the results of the equation analysis by including control variables. ***, **, * denote 0.01, 0.05, and 0.10 significance levels, respectively.

5. Discussion

The results show that information asymmetry indicates that a poor information environment increases idiosyncratic volatility (Hypothesis 2). This also shows that the development of the information environment is a consequence of information asymmetry (Beyer et al. 2010). To strengthen the results of the analysis of Hypotheses 1 and 2, an additional analysis was carried out regarding the consistency of information asymmetry in

a poor information environment, which is related to high idiosyncratic volatility, using the equation:

$$IDVOL = \alpha_0 + \alpha_1 ILLIQUIDit + \alpha_2 LIQRISKit + \alpha_3 ILLIQUID * SPREADit + \alpha_4 LIQRISK * SPREADit + \alpha_5 BMit + \alpha_6 LEVit + \alpha_7 ROAit + \alpha_8 SIZEit + eit \quad (6a)$$

$$IDVOl_{relative} = \alpha_0 + \alpha_1 ILLIQUIDit + \alpha_2 LIQRISKit + \alpha_3 ILLIQUID * SPREADit + \alpha_4 LIQRISK * SPREADit + \alpha_5 BMit + \alpha_6 LEVit + \alpha_7 ROAit + \alpha_8 SIZEit + eit \quad (6b)$$

Table 9 shows the interaction between the information environment and information asymmetry (ILLIQUID * SPREAD and LIQRISK * SPREAD) on idiosyncratic volatility (σe^2) in Panel A, and the relative value is shown ($\sigma e^2 / \sigma^2$) in Panel B. Firms with high asymmetry and high levels of illiquidity are associated with high idiosyncratic volatility (models 1–2). Likewise, firms with high asymmetry and liquidity risk are associated with high idiosyncratic volatility (model 3–4). These results indicate that a poor information environment is associated with high idiosyncratic volatility. This result is reinforced by the analysis of models 5–10 which shows high levels of interaction between information asymmetry and high levels of ILLIQUID and LIQRISK. This condition shows that companies with a high level of asymmetry in a bad environment have an effect that is twice as large as the average on high idiosyncratic volatility. The results show that the level of information transparency can not only be used as an indicator of a bad information environment (Amihud 2002; Mitra 2016), but it can also increase liquidity and liquidity risk.

Table 9. Analysis of Equations (6a) and (6b).

A. IDVOL (σe^2)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
ILLIQUID	0.469	0.490			0.691	0.723	0.678	0.670	0.698	0.722
	14.681 ***	15.504 ***			25.500 ***	24.723 ***	21.17 ***	19.844 ***	25.716 ***	24.715 ***
LIQRISK			62.331	63.705	75.938	97.744	100.082	98.728	73.608	94.064
			10.057 ***	10.253 ***	22.621 ***	18.330 ***	18.911 ***	18.610 ***	21.252 ***	15.998 ***
ILLIQUID_SPREAD	4.120	6.895			1.439	0.532			25.750	19.924
	2.716 **	2.806 ***			2.298 ***	2.075 **			2.450 ***	2.283 **
LIQRISK_SPREAD			0.274	0.269			0.074	0.067	34.328	23.444
			13.203 ***	12.192 ***			3.842 ***	3.253 ***	2.602 ***	2.480 **
BM		−0.002		0.007		−0.005		0.008		−0.005
		−0.140		0.283		−0.433		0.397		−0.428
LEV		0.101		−0.382		0.133		0.103		0.120
		0.338		−1.198		0.535		0.400		0.483
ROA		−0.129		−0.610		−0.050		−0.093		−0.051
		−0.620		−2.869 ***		−0.289		−0.538		−0.294
SIZE		−0.034		0.037		−0.077		−0.014		−0.076
		−0.264		0.276		−0.726		−0.131		−0.725
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adj-R^2	0.559	0.609	0.597	0.593	0.726	0.731	0.739	0.736	0.728	0.731
F-stat	4.311 ***	4.873 ***	4.755 ***	4.554 ***	7.891 ***	7.738 ***	8.184 ***	7.791 ***	7.942 ***	7.740 ***
B IDVOLrelative ($\sigma e^2/\sigma^2$)										
	Coef	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
	t-Stat	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**	**t-Stat**
ILLIQUID	0.512	0.504			0.652	0.740	0.696	0.689	0.842	0.851
	17.126 ***	15.788 ***			22.393 ***	25.096 ***	21.580 ***	20.238 ***	13.431 ***	13.000 ***
LIQRISK			62.386	63.847	47.822	98.903	101.133	99.869	105.558	104.787
			9.926 ***	10.118 ***	13.266 ***	18.408 ***	18.973 ***	18.667 ***	16.240 ***	15.828 ***
ILLIQUID_SPREAD	3.714				2.007	0.689			0.021	0.002
	2.690 **				2.001 **	2.0962 **			2.238 **	2.0249 **

Table 9. *Cont.*

LIQRISK_SPREAD		7.107	0.276	0.272			0.071	0.064	0.036	0.002
		2.824 **	13.149 ***	12.152 ***			3.682 ***	3.105 ***	2.455 **	2.0216 ***
BM		−0.002		0.007		−0.005		0.008		−0.004
		−0.144		0.259		−0.440		0.371		−0.161
LEV		0.099		−0.391		0.133		0.107		−0.273
		0.330		−1.209		0.532		0.413		−0.730
ROA		−0.130		−0.623		−0.049		−0.091		−0.063
		−0.616		−2.883 ***		−0.279		−0.520		−0.220
SIZE		−0.041		0.029		−0.085		−0.024		−0.009
		−0.322		0.211		−0.798		−0.219		−0.068
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adj-R^2	0.605	0.605	0.576	0.584	0.677	0.729	0.729	0.734	0.748	0.753
F-stat	5.009 ***	4.812 ***	4.440 ***	4.421 ***	6.447 ***	7.676 ***	7.824 ***	7.713 ***	7.392 ***	7.345 ***

Notes: The table presents the results of the analysis of Equations (6a) and (6b) to strengthen the results of the analysis in Tables 5–8 by using the interaction variables ILLIQUID * SPREAD and LIQRISK * SPREAD to explain that companies with information asymmetry in bad environments (ILLIQUID and high LIQRISK) are associated with idiosyncratic volatility. ***, ** denote 0.01, 0.05 significance levels, respectively.

6. Conclusions

This study aims to analyze the phenomenon of idiosyncratic risk in Indonesia, and whether it is related to price informativeness or price error, by considering the information environment. Previous research on idiosyncratic volatility provides a contradictory view; therefore, this research is expected to fill the contradictory gap by conducting idiosyncratic volatility analysis through an information environment approach. To explain this approach, two assumptions are used: idiosyncratic volatility is related to information transparency, which indicates a good information environment, and if it is associated with price 'noise', then idiosyncratic volatility is associated with a bad information environment.

The test results show that increased idiosyncratic volatility is associated with a poor information environment, proxied by high levels of illiquidity and stock liquidity risk. This test is also reinforced with the finding that firms with information asymmetry in a poor information environment are associated with increased idiosyncratic volatility.

The findings of this study are expected to contribute to the literature on idiosyncratic volatility by showing how it can predict the development of the information environment, and how the information environment is a consequence of information asymmetry. Moreover, the findings of this study should complement the results of previous studies which find that idiosyncratic volatility equates to price 'errors'. The results of this study are essential for strengthening the argument that idiosyncratic risk is related to price errors. This study only uses illiquidity and liquidity risk as proxies for the information environment so that further research can add other indicators, such as share ownership. Further research can also develop the concept that the information environment is related to the quality of information, such as the quality of financial reporting, to reflect the level of transparency of financial statements.

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