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Price limit bands, risk-return trade-off and asymmetric volatility: Evidence from Tunisian Stock Exchange sectors

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Abstract

This paper explores the impact of imposing various price limit bands on risk-return trade-off and asymmetric volatility on the Tunisian Stock Exchange (TSE). The study applies the EGARCH-M approach during the period spanning from 2 January 2019 to 31 January 2024, covering the periods before, during, and after the COVID-19 era. During the COVID-19 period, the TSE reduced the per-session price limit to protect investors from severe price fluctuations. Despite this protective measure, the results show that higher volatility is compensated by lower returns on all sectors' returns. After the crisis, as a first step, the TSE widened the price limits, but subsequently, it narrowed them. The results show that the shift from the wider price limit regime to the narrow price limits regime structurally modifies volatility for small and large cap sectors.

Keywords

- wider price limits
- narrow price limits
- risk-return trade-off
- asymmetric volatility

JEL codes: G10, G18.

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Introduction

The 1987 financial market disasters sparked considerable discussion about how to keep markets from experiencing such significant changes in the future. Many studies, including (Berkman & Lee, 2002; Deb et al., 2017; Kim et al., 2013; Lee & Kim, 1995) advocate market-breaker mechanisms via price limits and transaction halts to prevent high stock price volatility. Price limits are now used as a safety net on many stock exchange markets around the world, both in developed and emerging markets. In addition, price ranges present a complicated phenomenon that varies from one market to another and may even vary within the same market from one period to another. Thus, investigating price limit bands, risk-return trade-off and volatility has become an attractive preoccupation for policymakers, researchers, and investors.

The impact of price limits on volatility has been the subject of several contributions to the literature. However, despite the large amount of research that has been conducted, there is no clear consensus on the nature of this relationship. Indeed, several studies, such as (Kim & Rhee, 1997; Lee & Kim, 1995; Spiegel & Subrahmanyam, 2000) showed that price limits promote volatility spillover to subsequent trading days. In turn, several studies presented proof that stock prices become more volatile after reaching limits (see, e.g., Berkman & Lee, 2002; Kim et al., 2008; Li et al., 2014). Other studies, however, found that price limits have a general calming effect on investor behaviour because they reduce volatility once the limits are reached (e.g., Deb et al., 2013; Kim et al., 2013; Wan et al., 2015). There are also studies that examined the effects of narrowing and widening price limits on stock market volatility, such as (Wan & Zhang, 2022) on the ChiNext Market of China (Lin & Chiao, 2020), and (Kim, 2001) on the Taiwan financial market, (Seddighi & Yoon, 2018) on the Korean financial exchange market and (Farag, 2013) on the Egyptian, Thai and Korean stock markets.

All the above studies focused on narrowing and widening price limit effects on stock market volatility and paid little regard to the risk-return trade-off and the specific character of the stocks: large-cap or small-cap stocks. In this paper, we remedy this gap in three ways. First, we study the impact of imposing various price limit bands on asymmetric volatility by activity sector. Second, we decompose the data into large-cap or small-cap sectors. Third, studies that examine the connection between price limit bands and the risk-return trade-off have not received enough attention in the literature. To the best of the authors' knowledge, this is the first attempt to address the relationship between price limit bands and risk-return trade-off.

The Tunis Stock Exchange (TSE) imposes daily static and dynamic thresholds. Thresholds limit the price of an order that can be submitted to the TSE. Static thresholds refer to the lower and upper price limits of a security for a given trading day. TSE trading rules initially set a ±6.09% static threshold compared to its previous trading session's closing price. These dynamic thresholds are applied during a continuous session. A 15-minute trading pause would be enforced if the stock price increased or decreased by more than ±3% from its reference price throughout the trading session. When the session re-opens and the stock's price exits the ±4.5% band, trading is halted once again for 15 minutes. When the session restarts, if the stock's price exits the ±6.09% band (static thresholds), trading in this stock is stopped until the end of the day.

The spread of COVID-19 cases in Tunisia prompted the Tunisian Stock Exchange to take measures to protect investors from severe price fluctuations. Indeed, the TSE implemented a new price ceiling mechanism from 18 March to 5 June 2020, in which the static thresholds were reduced to ±3%, meaning that if a stock's price increased or decreased more than ±3% from its starting price throughout the trading session, transactions were stopped until the end of the day. As of 8 June 2020, TSE returned to its usual daily price limits (ceiling and floor) of ±6.09%. On 30 August 2021, the TSE reduced the static and dynamic thresholds again; it set ±6% static thresholds and 2% dynamic thresholds. A 10-minute trading pause was enforced if the stock price increased or decreased by more than ±2% from its reference price throughout the trading session.

The contradictory actions taken by the TSE during and post-COVID-19 period, which consisted in reducing the daily static thresholds from 6.09% to 3% (from 18 March to 5 June 2020), then increasing the daily static thresholds from 3% to 6.09% (from 8 June to 30 August 2021), thereafter decreasing the static thresholds from 6.09% to 6% and decreasing the dynamic thresholds from 3% to 2%% (from 30 August 2021) were the motivation for this paper. The main objective of this paper is, therefore, to understand how alternative price limit bands affect the risk-return trade-off, as well as how changing regulatory rules may affect asymmetric volatility. To investigate the impact of imposing various pricing bands on risk-return trade-off on the Tunisian Stock Exchange (TSE), the study estimates an asymmetric volatility EGARCH-M model during the period from 2 January 2019 to 31 January 2024. We divide the overall period into four sub-periods. The sub-periods are set according to changes in the price limits imposed on the market.

The results are summarized as follows: During the quiet period, under the initial rules-set regime, we find evidence of a positive risk-return relationship for all sectors. The results still show that good news has more impact than bad news. As an exception for financial companies, the findings demonstrate that bad news has a bigger impact on volatility than good news. During the COVID-19 period, despite the protective measures taken by the TSE, the results show that higher volatility is compensated by lower returns. In addition, the study findings demonstrate that the stock market's volatility increased during the COVID-19 period, and we find that bad shocks have more impact than good ones on all sectors' returns. The post-COVID-19 period is divided into two sub-periods, according to the price-limit regime applied. With the wider price limit (WPL) regime, risk-averse investors perceive their investments in small-cap sectors (industrials, consumer services, and basic materials) as relatively riskier compared to large-cap sectors (financial companies and consumer goods). In addition, for large-cap sectors, the results show that positive news has a stronger impact on future volatility than negative news of a similar magnitude. In contrast, for small-cap sectors, negative news has a greater impact on future volatility than positive news. On the other hand, the results show that volatility is extremely high for small-cap sectors compared to large-cap sectors. Thus, under a wider price limit regime, risk-averse investors perceive investments in large-cap sectors as less risky compared to investments in small-cap sectors. The transition to the narrow price limit (NPL) regime radically changes the results. The risk-return relationship becomes weak for large-cap sectors, indicating that under a narrow price limit regime, risk-averse investors perceive their investments in financial companies and consumer goods as relatively riskier compared to the rest of the sub-sectors. Furthermore, the shift from the WPL to the NPL regime structurally modifies volatility for small-cap sectors, suggesting that positive news has a greater effect than negative news. In addition, the volatility of the small-cap sectors decreased within the narrow price limit regime. These implications emphasize the importance of small-cap sectors in attracting investors under the NPL regime.

The paper is organized as follows: Section 1 provides the related literature. Section 2 presents data and methodology. Section 3 provides the empirical results. The final section concludes the paper.

1. Literature review

The emergence of COVID-19 had a deleterious impact on global markets. It is regarded as the world's most catastrophic economic shock (Insaidoo et al., 2021). The disease's emergence harmed the global economy and created uncertainty in global financial markets (Engelhardt et al., 2021). Szczygielski et al. (2021) found that pandemic insecurity had a negative impact on virtually all countries, resulting in lower returns and increased market volatility. Markets became very volatile and unpredictable as a result of the widespread uncertainty about the epidemic and its associated economic disasters (Zhang et al., 2020). Okorie and Lin (2021) found significant fractal contagion on market return and volatility, which supports this finding. Despite the negative effects of the COVID-19 pandemic on global economies and stock exchanges, Fernandez-Perez et al. (2021) demonstrated that culture has a substantial influence on market volatility. They discovered that within the first three weeks after a country's initial COVID-19 case was recorded, stock markets in nations with lower individualism and higher uncertainty avoidance had bigger drops and greater volatility.

During the COVID-19 epidemic, the number of studies on stock market volatility surged dramatically and concerned both developed and developing markets (see, e.g., Alzyadat & Asfoura, 2021; Bora & Basistha, 2021; Chen et al., 2021; Fakhfekh et al., 2021; Lo et al., 2022; Yu et al., 2022). The main findings of these studies show that there has been a substantial shift in volatility during the COVID-19 era.

From a methodological standpoint, the majority of this literature was generated in the time domain using a wide range of time series approaches. Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) techniques are the most popular approaches. Bakry et al. (2022) employed the GJR-GARCH method to analyse the influence of COVID-19 news on stock market volatility in developed and emerging markets. They found major differences between these markets and provided reasons for the differences in terms of country culture and governance quality. Xu (2022) followed Hansen and Huang (2016) and included time-varying factors into the Realized Exponential GARCH method (TV-REGARCH) to investigate the COVID-19 effect on the Canadian Stock Market. The result showed that the COVID-19 pandemic caused a massive rise in market volatility for the Canadian Index. Alzyadat and Asfoura (2021) examined the influence of the COVID-19 epidemic on the stock market in Saudi Arabia. The ARCH model's findings showed that the COVID-19 pandemic had a negative influence on Kingdom of Saudi Arabia (KSA) stock market performance. The results also showed that during the early days of the COVID-19 epidemic, the negative market reaction was considerable. Cepoi (2020) used a panel quantile regression framework and showed asymmetric relationships between stock markets and COVID-19 related news in six developed countries (the USA, UK, Germany, France, Spain and Italy). Just and Echaust (2020) employed a two-regime Markov switching framework in twelve countries, with their findings revealing a significant link between returns and implied volatility.

Another research stream discusses COVID-19's effect on stock markets across sectors. He et al. (2020) employed an event research technique and the market model to investigate Chinese sector industries' returns and tendencies in reaction to COVID-19's emergence. According to this research, the epidemic negatively impacted the transportation, mining, electricity and heating, and environmental industries. On the other hand, the manufacturing, information technology, education, and health-care sectors proved to be resistant to the pandemic. Fakhfekh et al. (2021) examined the volatility oscillations of the Tunisian sectoral stock market indices during the COVID-19 pandemic period, utilizing four GARCH approaches (E-GARCH, FI-GARCH, FIEGARCH and T-GARCH). They concluded that volatility has persisted longer in all series since the COVID-19 pandemic.

As shown above, the financial market volatility response to the COVID-19 outbreak has been extensively researched in the literature. However, studies that consider price limit bands and asymmetric volatility in crisis periods have been overlooked. Kim and Park (2010) established that stock markets with a higher risk of manipulation can benefit from the adoption of price limitations, since they may give uninformed traders more time to engage in price discovery. Farag (2013) explored the consequences of enforcing different price bands on the performance and volatility of equities on the Egyptian, Thai and Korean stock markets. Employing the asymmetric volatility EGARCH and PARCH approaches, the study proved that the transfer from narrow price limits to wider price limits fundamentally affected asymmetric volatility. Farag (2015) examined the impact of setting various price constraints on the overreaction effect on the Egyptian Stock Exchange (EGX) from 1999 to 2010 and found evidence of the overreaction effect on the EGX under different price limit bands.

According to Berkman and Lee (2002), the expansion of price limits enhances long-term volatility and decreases trade volume. Kim et al. (2013) analysed two eras in the Chinese financial equity market, one with and one without price limits. They discovered that price limits are helpful with regard to price restoration and volatility reduction. Seddighi and Yoon (2018) noted that the Korean financial exchange market gains in efficiency when price limits were expanded from 15% to 30%. Lin and Chiao (2020) studied the repercussions of expanding price limits on the Taiwan financial market from 7% to 10%. Their results showed that the event was detrimental to liquidity but beneficial to price discovery. In a more recent study, Wan and Zhang (2022) examined the effect of relaxing the daily price limit on the ChiNext market in China from 10% to 20% and provided proof that widening the daily price limits does not greatly affect price efficiency, but it does considerably increase liquidity and raises return volatility.

Phylaktis et al. (1999) and Kim (2001) focused on narrowing price limit effects on stock market volatility. Considering the information acquired through the price limit system implemented by the Taiwan Stock Exchange, Kim (2001) discovered that when price limits are narrowed, stock market volatility does not decrease. Phylaktis et al. (1999) analysed shares subject to an 8-percent limit, as well as shares subject to a 4-percent restriction on the Athens Stock Exchange and found that volatility is unaffected by price restrictions.

2. Data and empirical methodology

The data includes daily closing price indexes for five main sectors obtained from the TSE database. The sectors studied are as follows: financial companies, consumer goods, industrial companies, consumer services and basic materials. Financial companies contains banks (77.73% of the market capitalisation of the financial index), insurance companies (14.33% of the market capitalisation of the financial index), and financial service companies (7.94% of the market capitalisation of the financial index); the consumer goods sector contains food and beverage companies (84.06% of the market capitalisation of the consumer goods index) and personal and household goods companies (15.94% of the market capitalisation of the consumer goods index);'Industrial' contains only construction and material companies. Consumer services contain only general retail companies; 'Basic materials' contains only basic resource companies.

TSE initially (before 18 March 2020) introduced symmetric ±6.09% price limits for equity prices in relation to the previous trading day's closing price. From 18 March to 5 June 2020, the TSE regulator narrowed the upper and lower limit boundaries to ±3% in order to avoid high price fluctuations that might be caused by the COVID-19 crisis, protect investors, and reduce any potential volatility. As of 8 June 2020, TSE maintained its usual daily price limits (ceiling and floor) of ±6.09%. On 30 August 2021, the TSE reduced the per-session price limit again, setting a ±6% ceiling/floor limit price compared to its previous trading session's closing price. A 10-minute trading pause was enforced if the stock price increased or decreased by more than ±2% from its reference price throughout the trading session.

To analyse the TSE's asymmetric volatility over various price limit band phases, data were collected from 2 January 2019 to 31 January 2024, for a total of 1196 observations. The dataset is divided into four phases. The initial phase from 2 January 2019 to 17 March 2020 represents the quiet period under the initial rules-set regime (a ±6.09% ceiling/floor limit price). The second phase, from 18 March to 5 June 2020, represents the COVID-19 period under the NPL regime (symmetric ±3% price limits per session). The third phase from 8 June 2020 to 19 August 2021 represents the first post-COVID-19 period, under WPL regime (symmetric ±6.09% price limits per session). Lastly, the fourth phase, from 20 August2021, to 31 January 2024, represents the second post-COVID-19 period under the NPL regime (symmetric ±6% price limits per session).

The main sector indexes are converted to their log return series:

$$r_{it} = 100 \cdot \ln\left(\frac{p_{it}}{p_{i(t-1)}}\right) \tag{1}$$

where p_{it} and $p_{i(t-1)}$ represent the sector index price i on days (t) and $(t-1)$, respectively.

In order to determine how alternative price limit bands affect risk-return trade-off and asymmetric volatility, this study applies EGARCH-M estimation. The GARCH-M model performed by Engle et al. (1987) has been widely employed in modelling risk-return trade-off. The traditional GARCH-M (1, 1) model is defined as follows:

$$r_{it} = \mu_0 + \psi \cdot h_{it} + \varepsilon_{it} \quad (2)$$

where r_{it} is the market return, h_{it} is the conditional variance. The error term ε_{it} is supposed to be normally distributed with a zero mean and constant variance.

The ψ coefficient represents the risk-return link, which indicates the required return for taking each unit of risk. A positive value for ψ implies that the market return is higher as the risk level for the market increases. However, a negative value for ψ indicates that the return is lower as the market risk level increases. Chen (2015) stated that a negative value for the risk-return coefficient in the stock market results from less risk-averse investors.

To treat the effect of negative and positive shocks on the conditional variance function, this study applies the Exponential GARCH approach put forward by Nelson (1991). The EGARCH framework has an advantage over other asymmetric GARCH estimation techniques, since there are no non-negativity restrictions that must be placed on the regression coefficients.

The conditional variance (h_{it}), as revealed by Nelson (1991), is as follows:

$$\ln h_{it} = \alpha_0 + \theta \ln h_{i(t-1)} + \omega \left| \frac{\varepsilon_{i(t-1)}}{\sqrt{h_{i(t-1)}}} \right| + \gamma \frac{\varepsilon_{i(t-1)}}{\sqrt{h_{i(t-1)}}} \quad (3)$$

where: ω is the weight given to recent news from the previous period, θ is the effect of past news on volatility at time $t-1$ transferred to time t (volatility persistence).

The γ coefficient distinguishes between the effects of bad and good shocks by defining the asymmetric effect. A negative γ coefficient suggests that negative news has a stronger impact on future volatility than positive news with a similar magnitude. A positive γ coefficient suggests that good news has a greater effect on future volatility than bad news of a similar magnitude.

A dummy variable is added to the conditional mean and variance equation to examine how alternative price limit bands (NPL and WPL) affect risk-return trade-off and asymmetric volatility for each sub-period. The augmented EGARCH-M framework with dummy variables is specified as:

$$r_{it} D = \mu_0 + \psi \cdot h_{it} + \varepsilon_{it} \quad (4)$$

$$\ln h_{it} = \alpha_0 + \theta \ln h_{i(t-1)} + \omega \left| \frac{\varepsilon_{i(t-1)}}{\sqrt{h_{i(t-1)}}} \right| + \gamma \frac{\varepsilon_{i(t-1)}}{\sqrt{h_{i(t-1)}}} + \lambda D \quad (5)$$

The value of the dummy variable D is 1 for the respective band (NPL COVID-19 period, WPL first post-COVID-19 period and NPL second post--COVID-19 period) and 0 otherwise. As proposed by Bora and Basistha (2021), a statistically significant negative dummy variable's coefficient denotes that the stock market's volatility decreased during the specified period. Instead, a statistically significant positive dummy variable's coefficient implies that the volatility of the financial market has increased.

3. Empirical results

Table 1 details the TSE sectors (financial companies, consumer goods, industrial companies, consumer services and basic materials), including the number of listed companies, market capitalisation of each sector (percent of the overall market capitalisation) and trading volume of each sector (percent of the overall market trading volume) as of 31 December 2022. Despite the relatively small number of listed companies (82 listed stocks), the market capitalisation is around 24029 million TND (equivalent to 7691.75 million USD). Financial companies represent more than 52.5% of market capitalisation, while consumer goods account for 29.5%. Together, these two sectors represent 82% of market capitalisation, so they are considered large-cap sectors. Industrial companies, consumer services and basic materials companies combined represent about 17.84% of the market capitalisation. They are considered small-cap sectors.

On the other hand, the greatest trading volume is realized by financial companies (49.35%), followed by consumer goods (25.23%). Industrial companies, consumer services and basic materials companies combined account

Table 1. Tunisian Stock Exchange sectors, 31 December 2022

Sectors	Number of listed companies	Market capitalisation of each sector (% of the overall market capitalisation)	Trading volume of each sector (% of the overall market trading volume)
Financial companies	28	52.57	49.35
Consumer goods	15	29.56	25.23
Industrial companies	13	8.52	13.64
Consumer services	12	5.92	8.26
Basic materials	5	3.4	3.5
Other companies*	9	0.03	0.02

Notes: * 0.03% of market capitalisation comes from other companies (9 companies: 1 oil and gas company, 2 technology companies, 3 health companies, 3 telecommunications companies). These companies belong to other sectors. On TSE, only sectoral indices with a minimum of four companies are published.

Source: TSE website.

for about 25.40% of the trading volume. As a result, trade in large-cap sectors is greater than trade in small-cap sectors.

Table 2 shows the descriptive statistics and the diagnostic tests of sector returns during the full period. Apart from consumer goods and consumer services, each sector generates a positive return. The greatest return is realized by financial companies (0.020), followed by industrial companies (0.008) and basic materials (0.003). Basic materials have the highest volatility (0.911), followed by industrial companies (0.832), consumer goods (0.725), consumer services (0.651) and financial companies (0.521).

Daily returns show high kurtosis for all sectors, indicating that their return series have fat tails and strong peaks. All skewness statistics are close to zero. The Jarque-Bera test results disprove the null hypothesis that the return series are normally distributed.

Table 2. Descriptive statistics of stock return over the whole period

	Financial companies	Consumer goods	Industrial companies	Consumer services	Basic materials
Mean	0.020	–0.010	0.008	–0.003	0.003
Median	0.019	–0.020	–0.009	–0.026	–0.013
Maximum	3.516	3.206	3.599	2.559	3.833
Minimum	–3.988	–5.450	–4.135	–2.895	–5.005
Std. Dev.	0.521	0.725	0.832	0.651	0.911
Skewness	–0.453	–0.253	–0.081	0.147	–0.214
Kurtosis	11.024	8.371	5.552	4.162	5.042
Jarque-Bera	3448***	1539***	345***	76***	230***
ADF	–20.300***	–29.218***	–28.644***	–33.862***	–30.851***
Q(36)	118.600***	97.228***	128.450***	61.860***	84.231***
$Q^2(36)$	353.40***	440.27***	826.54***	657.43***	433.92***
LM-ARCH(24)	236.2***	227.1***	288.5***	62.5***	247.9***
SB	0.171***	0.282***	–0.011	0.018	–1.380E–09***
NSB	–0.153	–0.128	–0.540***	–0.377***	–5.900E–05***
PSB	0.624***	0.159***	0.676**	0.335***	1.900E–05***
JT	28.77***	45.68***	101.52****	63.19***	104.01***

Notes: Std. Dev. is the standard deviation. Q(36) is the Ljung-Box autocorrelation test at the 36th lag. $Q^2(36)$ is the autocorrelation test of squared returns at the 36th lag. LM-ARCH(24) is the Lagrange Multiplier test at the 24th lag.ADF is the augmented Dickey-Fuller test. SB is the sign bias test. NSB is the negative size bias test. PSB is the positive size bias test and JT is the test of the joint hypothesis of SB, NSB and PSB. ***, ** indicate significance at the 1% and 5% levels, respectively.

Source: own work.

The Q statistic shows that autocorrelations up to 36 lags is significantly present. The tabulated Q^2 statistics show that conditional heteroscedasticity is significantly present. As well, LM-ARCH statistics are massively significant, which implies that the time-varying conditional variance is confirmed and supports the use of the GARCH framework. The four Engle and Ng (1993)'s sign bias tests' results point to the existence of asymmetric volatility for all series. Therefore, positive and negative shocks have different impacts on conditional variance and the use of the asymmetric GARCH framework is confirmed.

The empirical findings of the risk-return trend and asymmetric volatility are presented in this part for the four sample periods. To choose the best specification of the asymmetric GARCH model, we tested four GARCH asymmetric models (EGARCH (1,1), GJR-GARCH, NARCH and APARCH). The Akaike Information Criterion (AIC) indicator selects EGARCH (1,1). The Broyden-Fletcher-Goldfarb-Shanno (BFGS) numerical optimisation approach is used to estimate the model. Since the return series are not normally distributed, a generalized error distribution (GED) is suggested based on minimum AIC and maximum log-likelihood criteria.

3.1. Pre-COVID-19 period

Table 3 summarizes the findings of the EGARCH-M (1,1) with the initial rules set regime (a ±6.09% static threshold and a ±3 and 4.5% dynamic thresholds) for the period 2 January 2019 to 17 March 2020. From the mean equation, we notice that the ψ coefficient is positively significant at 1% for all sectors.

Table 3. Estimation results of EGARCH-M model in the pre-COVID-19 period

Variables	Financial companies	Consumer goods	Industrial companies	Consumer services	Basic materials
Mean equation					
μ_0	–5.76E–07***	–0.045***	–0.008***	–5.79E–13	4.68E–06***
Ψ	0.001***	2.036***	1.655*	0.063***	0.051*
Conditional variance					
α_0	–2.055***	–2.429***	–0.417***	–2.955***	–0.668***
Ω	0.933***	0.183***	0.081***	0.251***	0.771***
γ	–0.422***	0.194***	0.069***	0.055***	0.202***
θ	0.923***	0.362***	0.921***	0.882***	0.992***

Note: ***, * indicate significance at the 1%, and 10% levels, respectively.

Source: own work.

The positive risk-return relationship in the TSE market during the quiet period suggests that an increase in return is associated with an increase in risk, and vice versa. These outcomes align with the asset price theory. The findings are similar to those of Refai et al. (2017) for the similar emerging market of Jordan. According to Chiang et al. (2015), the positive risk-return connection is more pronounced during quiet times.

We can see from the variance equation that ω, θ and γ coefficients are all significant, indicating that the constant variance hypothesis is invalid and that sector returns are defined by EGARCH-M asymmetric volatility equations. The results show that the conditional variance for all sectors depends significantly on past innovations and past conditional variance values. In addition, the γ coefficients are significant for all sectors. These findings show that market shocks have an asymmetric influence on sector returns. More precisely, the γ coefficients are positive for consumer goods, industrial companies, consumer services and basic materials, which implies that market upswings have a bigger impact than downturns of the same magnitude. The findings are consistent with those of previous studies, such as Refai et al. (2017) for 17 sub-sectors in the Jordan Market and Refai & Hassan (2018) for the industrial sectors of the Qatar market, suggesting that positive news had a greater effect than negative news. However, the γ coefficient is negatively significant only for financial companies. These findings demonstrate that bad news has a bigger impact on volatility than good news. Such results contradict those of a previous study by Refai et al. (2017) for the emerging market of Jordan.

3.2. During the COVID-19 period

Table 4 provides the effects of switching from the initial rules set regime (a ±6.09% static threshold and a ±3/±4.5% dynamic thresholds) to the NPL regime (a ±3% static threshold) on risk-return trade-off and asymmetric volatility using the EGARCH-M asymmetric volatility model. The empirical evidence shows that the ψ coefficients are negative and significant for financial companies and consumer goods. The results point to a negative and strong risk-return trade-off during the period of a market downturn for large-cap sectors. In contrast, the risk-return interaction is insignificant for small-cap sectors: industrials, consumer services and basic materials. The findings are consistent with previous empirical studies in both developed and emerging markets, which show that higher volatility is compensated for by lower returns during periods of market downturn. For developed markets, Salvador et al. (2014) showed that in eleven European markets, the risk-return interaction was insignificant or negative during the 2008 financial crisis. Ghysels et al. (2014) also discovered similar outcomes for the US Stock Market during the 2008 financial crisis. For emerging markets, Refai et al. (2017) showed a negative risk-return interaction for 15 sub-sectors in the Jordan stock market during the 2008 financial crisis. Typically, investors anticipate a smaller return from equities during these periods because they believe the stocks to be riskier than during quiet trading times.

Table 4. Estimation results of EGARCH-M model during the COVID-19 period

Variables	Financial companies	Consumer goods	Industrial companies	Consumer services	Basic materials
Mean equation					
μ_0	1.62E–08	0.001***	5.85E–11	–5.02E–08	5.50E–10
Ψ	–0.442***	–0.581***	–0.175	1.14E–14	2.01E–10
Conditional variance					
α_0	–10.43***	–3.719***	–16.69***	–8.241***	–7.455***
Ω	0.071***	0.087***	0.043	0.076***	0.283***
γ	–0.067***	–0.023*	–0.065	–0.017***	–0.030***
θ	0.610***	0.392***	0.353***	0.550***	0.437***
λ	8.990***	1.373***	18.61***	2.853***	0.828***

Note: ***, * indicate significance at the 1% and 10% levels, respectively.

Source: own work.

From the variance equation, we observe that the γ coefficients are negative and significant for all sectors (except for industrial companies, it is negative but insignificant), implying that equal-sized negative innovations are more volatile than equal-sized positive innovations. In addition, the dummy variable's coefficients λ are positively significant at the 1-percent level for all sectors, demonstrating that the stock market's volatility increased during the COVID-19 period. This finding is in line with the results of Bora and Basistha (2021) for the Bombay Stock Exchange in India. Fakhfekh et al. (2021) found the same result for the TSE during the COVID-19 period.

3.3. During the post-COVID-19 periods

Tables 5 and 6 report the effects of switching from the WPL regime (±6.09% static threshold and ±3/±4.5% dynamic thresholds) to the NPL regime (±6% static threshold and ±2/±4% dynamic thresholds) on risk-return trade-off and asymmetric volatility using the EGARCH-M asymmetric volatility model. The

Table 5. Estimation results of EGARCH-M model during the first post-COVID-19 period

Variables	Financial companies	Consumer goods	Industrial companies	Consumer services	Basic materials
Mean equation					
μ_0	–0.008***	4.72E–05	–4.97E–08	–1.62E–10	–6.79E–13
Ψ	0.170***	0.054***	0.002	0.007	0.036
Conditional variance					
α_0	–2.763***	–3.616***	–11.465***	–5.796***	–18.605***
Ω	0.065***	0.254***	0.414***	0.055	0.480***
γ	0.008***	0.039*	–0.334***	–0.045	–0.044
θ	0.074***	0.487***	0.526***	0.770***	0.221***
λ	0.932***	0.569***	10.877***	6.126***	18.153***

Note: ***, * indicate significance at the 1%, and 10% levels, respectively.

Source: own work.

Table 6. Estimation results of EGARCH-M model during the second post-COVID-19 period

Variables	Financial companies	Consumer goods	Industrial companies	Consumer services	Basic materials
Mean equation					
μ_0	2.18E–10	–3.13E–09	0.056**	0.108**	1.90E–07**
Ψ	0.003	0.001	0.273**	0.629**	2.11E–06
Conditional variance					
α_0	–18.159***	–18.129***	–1.505***	–1.723***	–1.750***
Ω	0.219***	–0.156***	0.076***	–0.002	0.768***
γ	0.007***	0.152***	0.004	0.028	0.027**
θ	0.276***	0.255***	0.050***	0.017***	0.811***
λ	16.990***	18.194***	0.006	0.008	0.025

Note: ***, ** indicate significance at the 1% and 5% levels, respectively.

Source: own work.

post-crisis outcomes are not identical to those from the previous periods in all of the subsectors. Within the wider price limit regime, we see that the ψ coefficients are positive and significant for large-cap sectors: financial companies and consumer goods. However, they are positive and insignificant for small-cap sectors: industrials, consumer services and basic materials, which implies that the risk-return relationship is weak for small-cap sectors, indicating that within the wider price limit regime, risk-averse investors perceive their investments in industrials, consumer services and basic materials as relatively riskier compared to the rest of the sectors.

On the other hand, the γ coefficients are positive and significant at the 1% level for large-cap sectors, which implies that positive news has a stronger impact on future volatility than negative news of a similar magnitude. For industrial companies, the γ coefficient is negative and significant, which implies that negative news has a stronger impact on future volatility than positive news of a similar magnitude. For consumer services and basic materials, the γ coefficients are negative but insignificant.

We still note that within the wider price limit regime, the dummy variable's coefficients λ for all sectors are positive and significant. In addition, they are extremely high for small-cap sectors (10.877 for industrials, 6.126 for consumer services and 18.153 for basic materials) compared to large-cap sectors (0.932 for financial companies and 0.569 for consumer goods). Farag and Cressy (2012) and Farag (2013) found similar results for small-cap sectors, demonstrating that switching to a WPL band greatly increases volatility. Similarly, this result is in line with that of Wan and Zhang (2022) on the ChiNext market in China. Taking these discoveries into account, under a wider price limit regime, risk-averse investors perceive investments in large-cap sectors as less risky compared to investments in small-cap sectors.

Furthermore, switching from the wider price limit regime to the narrow price limit regime does not have an identical effect on all sectors. The outcomes change radically. Thus, the ψ coefficients become positive and insignificant for large-cap sectors: financial companies and consumer goods. However, they become positive and significant for small-cap sectors such as industrial companies and consumer services, which implies that the risk-return relationship is weak for large-cap sectors, indicating that under a narrow price limit regime, risk-averse investors perceive their investments in financial companies and consumer goods as relatively riskier compared to the rest of the sectors.

The γ coefficients (during the wider limit regime) are negative for small-cap sectors. On the contrary, the γ coefficients (during the narrow limit regime) become positive for small-cap sectors and significant only for basic materials, suggesting that positive news has a stronger effect than negative news. Thus, the adjustment from the WPL to the NPL regime structurally modifies volatility for small-cap sectors. This result is consistent with the study by Farag (2013), who observed that volatility is structurally changed when price limitations are changed on the Thai, Egyptian and Korean Stock Exchanges.

Another notable finding for large-cap sectors includes the increase in dummy variables' coefficients with the NPL regime compared to the WPL regime, implying that the volatility for large-cap sectors increases within a narrow price limit regime. Our results for the large-cap sector are in line with those of Kim (2001), who claimed that when price limits are narrowed, stock market volatility does not decrease. On the contrary, the λ dummy variables' coefficients for small-cap sectors are positive and significant under a wider price limit regime. A change from the WPL to the NPL regime considerably decreases the volatility for small-cap sectors since the λ dummy variable's coefficients become insignificant. Considering these findings, under a narrow price restriction regime, risk-averse investors believe that investments in small-cap sectors provide potential for lower risk than those in large-cap sectors.

Conclusions

Regarding investing strategies and decision-making, it is crucial for investors and policymakers to comprehend the effects of price limits on risk-return trade-off and asymmetric volatility. In light of this, price limits have been widely contested in the stock market literature due to their role in preventing significant market price volatility and for risk management objectives. However, the majority of studies on this topic are limited by the fact that they fail to take into account how different price limit bands protect investors from severe price fluctuations during crisis periods. In this context, we try to analyse this situation by investigating the impact of imposing different price limit bands on risk-return trade-off and asymmetric volatility on the TSE during the period spanning from 2 January 2019 to 31 January 2024, covering the periods of pre-, during, and after the COVID-19 era. In order to investigate the effects of alternative price limit bands (NPL and WPL) on risk-return and asymmetric volatility, as well as the potential effects of switching regulatory rules from (WPL) to (NPL), this study applies the EGARCH-M model. It uses dummy variables to identify each sub-period.

Our results suggest that risk-return trade-off and asymmetric volatility differ between small and large-cap sectors under both NPL and WPL regimes. This was confirmed by conducting tests for the five major sectors on the TSE under the WPL and NPL regimes. During the quiet period, under the initial rules-set regime, we find evidence of a positive risk-return relationship for all sectors, meaning that an increase in return is associated with an increase in risk, and vice versa. The results still show that good news has more impact than bad news. As an exception for financial companies, the findings demonstrate that bad news has a bigger impact on volatility than good news.

During the COVID-19 period, to protect investors from severe price fluctuations, the TSE implemented a new price ceiling mechanism, in which the per-session price limit was reduced to ±3%. Despite this protective measure, the results show that higher volatility is compensated by lower returns. Indeed, investors expect lower returns from stocks during this period, as they believe stocks are riskier than during calm trading periods. In addition, findings demonstrate that the stock market's volatility increased during the COVID-19 period and we find that bad shocks have more impact than good ones on all sectors' returns. It is therefore clear that the protective measures taken were insufficient.

The post-COVID-19 period is divided into two sub-periods, according to the price limit regime applied. With the WPL regime, risk-averse investors perceive their investments in small-cap sectors (industrials, consumer services and basic materials) as relatively riskier compared to large-cap sectors (financial companies and consumer goods). In addition, for large-cap sectors, the results show that positive news has a stronger impact on future volatility than negative news of a similar magnitude. In contrast, for small-cap sectors, negative news has a stronger impact on future volatility than positive ones. On the other hand, the results show that volatility is extremely high for small-cap sectors compared to large-cap sectors. Therefore, under a wider price limit regime, risk-averse investors perceive investments in large-cap sectors as less risky compared to investments in small-cap sectors. The transition to the NPL regime radically changes the results. The risk-return relationship becomes weak for large-cap sectors, indicating that under a narrow price limit regime, risk-averse investors perceive their investments in financial companies and consumer goods as relatively riskier compared to the rest of the sectors.

Furthermore, the shift from the WPL to the NPL regime structurally modifies volatility for small-cap sectors, suggesting that positive news has a stronger effect than negative news. In addition, the volatility of small-cap sectors has decreased within the narrow price limit regime. These implications emphasize the importance of small-cap sectors in attracting investors under the NPL regime.

The findings have ramifications for policymakers. Indeed, since the large-cap and small-cap sectors are not equally impacted by the change in price limits, policymakers must take into account the levels of sector capitalisation when making decisions to adjust price limit bands. The findings provide recommendations for investors. Firstly, under the WPL regime, the risk-return relationship is positively significant only for large-cap sectors and the volatility is extremely high for small-cap sectors compared to large-cap sectors. We recommend investors allocate their capital to large-cap sectors. Secondly, the alteration from the WPL to the NPL regime reinforces the positive risk-return relationship and decreases the volatility effect for small-cap sectors. This result recommends investors allocate their capital to small-cap sectors under the NPL regime. In the case of a change in price limits, investors who want to benefit from a positive risk-return relationship and decrease their portfolio volatility should build a portfolio with the same composition (weights of stocks) of the large-cap sectoral indices, under the WPL regime. However, investors should build a portfolio with the same composition (weights of stocks) of the small-cap sectoral indices, under the NPL regime.

There are two limitations in this study that could be addressed in future research. Firstly, the study focused on aggregated data indexes (sectoral indexes). Future studies could extend the scope of our analysis by considering individual companies to reduce the aggregation bias. Secondly, we conduct our study on the five main sectoral indices, thus overlooking the nine companies that do not belong to any sector. Disaggregating the data by considering each company separately can provide more robust results that take into account all companies in the market.

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