

Circuit breakers and other market safeguards

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1. Executive Summary

Exchanges employ a variety of methods, including market-wide circuit breakers, trading halts on individual instruments, and price limits, to prevent sharp price movements that could affect fair and orderly trading and the integrity of their markets. In particular, circuit breakers are mechanisms that temporarily halt continuous trading or delay an auction as and when excessive volatility disrupts the price discovery function of exchanges.

Circuit breakers re-entered the policy debate in spring 2020 because of the heightened volatility experienced by financial markets in March 2020, at the first peak of the COVID-19 pandemic in Europe, which triggered trading halts in numerous markets worldwide. We expect higher volatility to remain a feature of 2021.

These events have led to a renewed interest in the usefulness and benefits of circuit breakers and in their design. As part of its mandate to enable the resilience and systemic stability of markets, the WFE is conducting a two-part research project to improve our understanding of these tools and contribute to their better design. This paper, Part 1, analyses the findings of a survey of WFE members to examine the kind of circuit breakers and other safeguards that are most prevalent among exchanges today and how they were used during the recent COVID-19 related events. The analysis focuses on the equity markets, covering both cash equities and equity derivatives, and reflects exchanges' views on the topic over the period from June to November 2020, when the survey was conducted.

Key findings

- Exchanges use various tools to safeguard the orderly functioning of markets and to maintain a healthy price discovery process. Although not the only ones, the most prevalent of these safeguards are circuit breakers and price limits, which can be used jointly.
- Circuit breakers are in place in a large majority of exchanges surveyed (86%), although there is some degree of variation in their design or in their calibration, reflecting differences in both the markets themselves and in their respective regulatory regimes.
- Circuit breakers are more prevalent in cash than in derivatives markets (84% vs 67%).
- A large proportion of respondents (67%) confirmed circuit breakers were triggered during March 2020. As a result of these events, some exchanges (30%) have reviewed or are expecting to review their calibration.
- None of the respondents saw coordination of circuit breakers across venues or jurisdictions as a priority.
- The correct calibration of circuit breakers was ranked by participants as the most relevant practical question relating to market safeguards, followed by an assessment of their effectiveness.

2. Introduction

Exchanges from around the world employ a variety of methods to prevent sharp price movements that could generate execution uncertainty, create severe order imbalances, or affect the fair and orderly trading and the integrity of their markets. Sometimes referred to as “volatility control mechanisms” (IOSCO, 2018), these methods range from trading halts (where trading stops for a limited period of time) to ex-ante price bands or limits (where orders may only be accepted or executed within prescribed price thresholds).

Automatic trading halts, commonly known as circuit breakers, trigger a pause in trading when an indicator exceeds a pre-determined threshold. They can apply to the whole market (market-wide circuit breakers) or to individual instruments. They can occur during continuous trading (forcing continuous trading to stop) or during an auction (extending the auction time). When stopping continuous trading, they may allow for a pause before trading resumes (usually through an auction) or they can immediately trigger an auction process (“volatility interruption mechanisms”). The design choices are many, each with different implications on the price formation process.

Circuit breakers were first introduced in the United States at the New York Stock Exchange (NYSE) following Black Monday in 1987 (Brady, 1988; Gomber *et al.*, 2016) as a way to allow a cool-down period in moments of heightened volatility (Ackert, 2012; Subrahmanyam, 2017). Since then, circuit breakers have become widespread in the exchange industry, with their adoption seeing an uptick after the 2008 financial crisis (Gomber *et al.*, 2016).

Circuit breakers serve as a mechanism to provide investors with additional time to pause and evaluate the information that is causing price changes, to reconsider their positions, or to remove any erroneous orders (such as ‘fat-finger’ trades) that might have triggered the interruption. In principle, when trading resumes after a cool-off period, investors should be able to make better-informed trades and reduce order book imbalances, so that the risk of adverse feedback loops is mitigated. It is often the case that circuit breakers are also invoked as a way of reducing volatility or easing the downward pressure on falling prices.¹

In spring 2020, circuit breakers re-entered the policy debate because of the heightened volatility experienced by the financial markets at the first peak of the COVID-19 pandemic which led to circuit breakers being triggered in numerous markets worldwide. For instance, during March 2020, U.S. exchanges experienced four occurrences of market-wide circuit breakers, the Korea Exchange (KRX) saw its market halt twice, and Brasil Bolsa Balcão (B3) six times. Moreover, trading halts on individual instruments surged to record levels. For example, in the United States, according to the quarterly report of the Limit Up-Limit Down (LULD) Plan, equity markets experienced three single-stock halts in January 2020, five halts in February 2020, and about 740 in March 2020.² Price limits were also

¹ However, it is worth remembering the observation, made by Eugene Fama in 1989, that it is a mistake to link (a lack of) volatility with the efficiency of a price formation process: “rational prices are not necessarily less volatile prices, and less volatile prices are not necessarily better than more volatile prices. The appropriate view of the October [1987] price shock depends critically on whether it was a rational response to changes in fundamental values” (Fama, 1989). So, while a reduction in volatility can happen after a circuit breaker is triggered, it may be inaccurate to present a circuit breaker exclusively as a mechanism to reduce volatility.

² Stocks here are the “Tier 1 non-ETPs > \$3.00” according to the LULD plan. These are the stocks in the S&P 500 and Russell 1000 indexes with price greater than \$3.00. The LULD quarterly report is available at <http://www.luldplan.com/studies.html>

triggered on futures on major stock indices during overnight trading and on individual US stocks. Amid the volatile market conditions, several exchanges revised or announced the intention to revise their circuit breaker mechanisms. For example, the Indonesia Stock Exchange (IDX) expanded the two-tier circuit breaker to a three-tier one; the Athens Stock Exchange (ATHEX) extended the trading halt period from two minutes to ten minutes; and the New York Stock Exchange (NYSE) announced an industry review of the circuit breakers.³

These events have led to a renewed interest in the design of circuit breakers and their impact across markets.

With these considerations in mind, WFE Research surveyed the WFE members and affiliates to understand what kind of circuit breakers are most prevalent among exchanges, whether there are broad regional trends or differences, and what jurisdictions had a circuit breaker triggered during the recent COVID-19 crisis. This survey focused on the equity markets, covering both cash equities and equity derivatives markets.

Based on the survey responses, we analyse the various circuit breaker mechanisms implemented globally and the core policy considerations related to their implementation. Markets implement circuit breakers in various ways: they may be structured for different types of trading sessions (e.g., continuous trading session or opening/closing auctions), may have distinct triggering points and cool-off periods, may be triggered by different types of indicators (e.g., price changes, volumes), and may depend on the market segment or the time of the day.⁴ We believe that providing a detailed analysis of the multiple types of circuit breakers will contribute to understanding how they operate and what we can expect from them.

3. An integrated program for protecting markets

A well-functioning exchange is one that facilitates price discovery, maximises the incorporation of new information in the value of financial instruments, and operates in a fair and transparent way. This foundation allows market participants to make informed choices when placing their orders, confident that executed trades will be cleared and settled.

Many events have the potential to temporarily affect one or more of these attributes. An erroneous trade can send misleading signals, precipitating a fall in prices that undermines the price discovery process and generates an imbalance in the order book. Unexpected and impactful events, such as a natural disaster affecting a firm or an industrial sector, may lead to spikes in volatility, while investors reassess their views about the prospects. Even when events develop over a longer timeframe, as in the case of the recent COVID-19 pandemic, the accumulation of bad news, the increase of uncertainty, or a negative investor sentiment may lead to such spikes in volatility.

An increase in volatility is not necessarily a bad thing. It may be consubstantial with an efficient price discovery process and correctly reflect a change in market conditions (see Footnote 1). However, sharp and sudden increases in volatility, such as the ones where traders need to react under time

³ <https://www.ft.com/content/ba48ca62-2802-42b5-97a6-1abdd950de8b>

⁴ For a comprehensive review of the different types of circuit breakers across markets, see WFE Research's 2016 report "Circuit Breakers – A Survey among International Trading Venues", <https://www.world-exchanges.org/our-work/articles/wfe-survey-circuit-breakers>

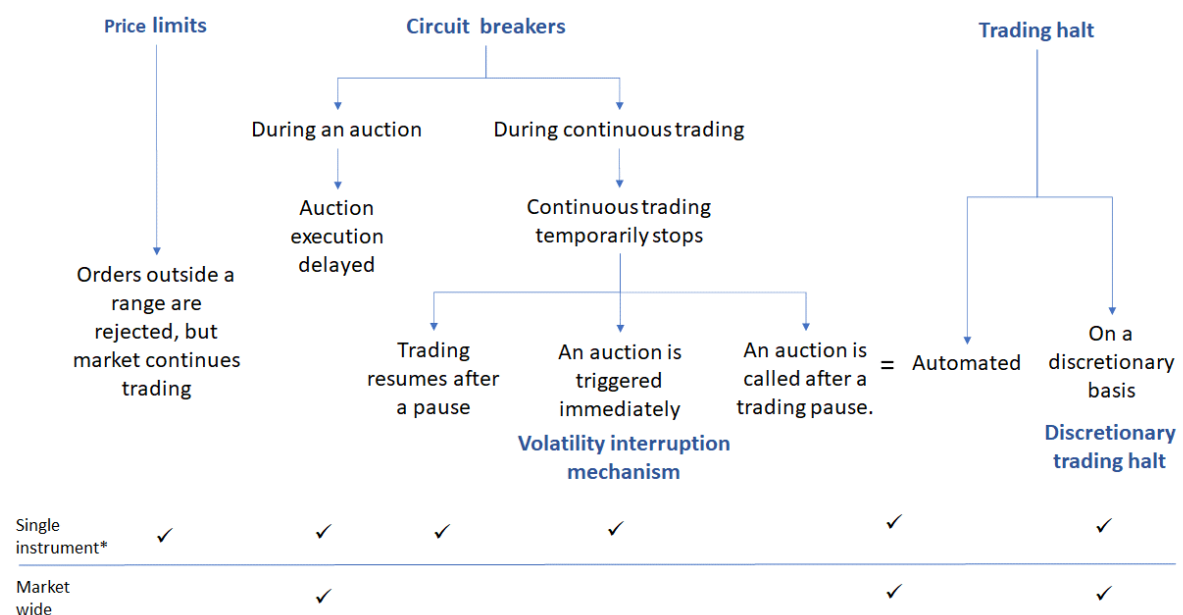
pressure and without necessarily having the capacity to fully assess all the available information, have the potential to disrupt the orderly functioning of markets.

In other words, when thinking about volatility, it is useful to distinguish between the volatility derived from the diffusion process that typically underlies the evolution of prices and the volatility produced by a jump process. From an orderly-market perspective, we should mostly care about the latter one but acknowledging that there may be circumstances where a jump in volatility is part of an efficient price discovery process. The role of exchanges is to provide an environment in which the integrity of the price formation process is guaranteed by rules and provisions, including situations where high volatility is the valid result of the efficient incorporation of new information.

Exchanges employ various methods to control jump-induced volatility, preventing sharp price movements that could generate execution uncertainty and severe order imbalances, or affect the fair and orderly trading and the integrity of their markets. These methods range from trading halts, where trading stops for a limited period, to ex-ante price bands or limits, where orders may only be accepted or executed within prescribed price thresholds. In many cases, more than one of these “volatility control mechanisms” is employed.

In the next section we briefly review some the safety mechanisms used by exchanges (**Figure 1**).

Figure 1: Some of the safeguards used by exchanges to maintain an orderly market⁵



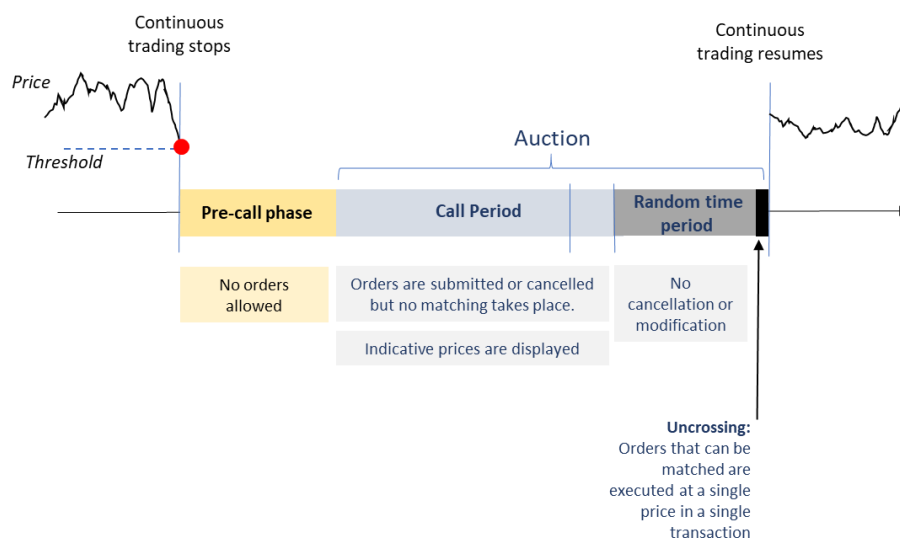
*In the case of derivatives, this includes a set of contracts with the same underlying asset.

⁵ For simplicity we do not include in the figure some hybrid designs. Hong Kong Exchange, for example, has a slightly different design for its volatility safeguard which has some similarity with dynamically triggered volatility interruption in Europe but where trading does not stop, and is rather only constrained within a certain price band within the cool-off period, as in a price limit.

3.1 Circuit breakers

In this paper, a circuit breaker is defined as *a mechanism that temporarily stops continuous trading in one or more securities or contracts, or delays an auction execution, as a result of a market variable exceeding some pre-defined thresholds*. The market variable is often (but not always) the next executable price. The rules of the mechanism are known in advance and applied automatically, in contrast to “discretionary trading halts”, in which the exchange or the regulator may decide to stop trading when facing imminent important news or announcements, for example. Once the circuit breaker is triggered, a fixed period passes before continuous trading can resume, usually through an auction process (**Figure 2**).

Figure 2: A stylized representation of a circuit breaker during continuous trading



The figure illustrates the different elements that may be involved in a circuit breaker. In some cases, like volatility interruption mechanisms, there is no pre-call phase and the trading halt directly leads to an auction. In other cases, like the LULD, there is a 15-second monitoring period and there is no auction, but only a 5-minute pause. In all cases, continuous trading and order execution stops for a certain period.

It is worth noting that, while this definition of circuit breakers is consistent with a large part of the academic and regulatory literature (e.g., Gomber et al., 2013; FCA, 2017; IOSCO, 2018; Guillaumie et al., 2020), it deviates from other studies in which price limits are included as a type of circuit breaker (e.g., Gomber et al., 2016).⁶ Price limits (or “price bands”) allow order submission but only within a certain range of prices—individual orders with prices outside of those limits are rejected but orders with prices within the limits are accepted.⁷ While price limits are also part of the exchanges’ toolkit to maintain orderly markets, they have different implications for the price discovery process. We

⁶ Including price limits as a type of circuit breaker was also the approach taken in the Brady Report (the report produced by the Brady Commission to investigate the causes of the 1987 crash in the US markets).

⁷ MiFID II regulation for EU trading venues, for example, requires trading venues to have in place procedures “to reject orders that exceed pre-determined volume and price thresholds or are clearly erroneous” (Art. 48, par. 4).

therefore consider price limits and circuit breakers as different types of “volatility control mechanisms” (IOSCO, 2018) or “volatility safeguards” (Guillaumie et al., 2020),⁸ as **Figure 1** illustrates.

The distinction we make between a circuit breaker and a price limit also adds some precision to the language. The term circuit breaker was borrowed from the electrical jargon:⁹ an *electric* circuit breaker temporarily disconnects the installation from the main supply to prevent any damage to the installation itself or to the appliances connected to it; it is triggered automatically when the electric current crosses a threshold, and it can be triggered by a variety of conditions: overheating, current overload, or imbalances between the outgoing and incoming current, among others. There is a clear analogy with market circuit breakers. Instead, price limits do not stop trading but only prevent extreme prices entering the order book and would therefore be more akin to “surge suppression devices” which are mechanisms that do not disconnect the current but only manage its peaks, preventing their propagation through the circuit.

Because of their prevalence across markets, two cases of single-instrument circuit breakers deserve special mention: Limit Up-Limit Down and volatility interruption mechanisms.

3.2 Limit Up-Limit Down (LULD)

In May 2012, the U.S. SEC introduced, on a provisional basis, the Limit Up-Limit Down (LULD) plan to prevent trades in National Market System (NMS) securities from occurring outside of specified price bands. The LULD plan became a permanent rule in the U.S. in April 2019 (File No. 4-631 of the NMS Plan). The LULD bands are set at a percentage level (5% for Tier 1 Securities with price higher than \$3.00 and higher level for the remaining stocks) above and below the average reference price of the security over the immediately preceding five-minute period. If trades breach the specified price bands and trading is unable to revert within the band after 15 seconds, there would be a five-minute trading pause similar to the one triggered by a single-stock circuit breaker.¹⁰ As such, LULD is a single-stock circuit breaker where the triggering mechanism is defined by an order price dynamic collar.

3.3 Volatility interruption mechanisms

Many exchanges report using “volatility interruption mechanisms”, in which continuous trading is stopped and switched to a call auction. While under a trading halt the execution of trades is suspended altogether, the volatility interruption mechanism allows for continuous price discovery while continuous trading is halted. Under our definition, the volatility interruption mechanism is a specific type of circuit breaker. In fact, they can be seen as a limit case of a circuit breaker, in which the trading

⁸ The name “volatility control mechanism” is unfortunate, since what triggers a circuit breaker is often a downside change in price, which is not a good proxy for volatility. Moreover, circuit breakers can also be triggered by other variables. It would be more adequate to consider these mechanisms as *orderly market safeguards*.

⁹ The electrical analogy was in the mind of the legislators and experts appointed to analyze the 1987 Crash: “The tidal wave of selling in October 19 had effects on both the New York and Chicago Exchanges that were similar in all essential respects to those that afflict an electric power utility when all its customers turn their air conditioners at once. The demand for service then exceeds the system’s capacity to supply it at normal cost and a variety of formal and informal rationing and “peak-load pricing” mechanisms come into play” (Miller et al., 1989).

¹⁰ Tier 1 comprises all securities in the S&P 500, the Russell 1000 and select Exchange Traded Products (ETPs). The LULD Plan applies during regular trading hours of 9:30 am - 4:00 pm. For more information, see <http://www.luldplan.com/index.html>.

halt directly triggers an auction process (i.e., without a pre-call phase). The inclusion of volatility interruptions as a circuit breaker is consistent with the approach set out in IOSCO, for example, where volatility control mechanisms are grouped according to whether they lead to a trading halt or not (IOSCO, 2018).

However, the usage of the term is not standardised. Some exchanges report volatility interruption mechanisms as being different from a circuit breaker. Some academic studies also consider these two mechanisms distinct and see the volatility interruptions as a price limit. In other cases, volatility interruption mechanisms are seen as synonymous with an individual instrument circuit breaker (for example, in Kwon *et al.*, 2018).¹¹

3.4 Parameters for a taxonomy

Circuit breakers can be implemented in different ways. In this analysis, we distinguish them across the following dimensions:

Market-wide vs individual instrument circuit breakers

In terms of scope, circuit breakers can be divided into those that simultaneously affect all instruments in a market (**market-wide circuit breakers**) and those that affect only individual instruments (**single-instrument circuit breakers**). In the case of derivative markets, “single instrument” refers to a set of contracts with the same underlying instrument. Market-wide circuit breakers are typically triggered by excessive price movements of an index, and single-instrument circuit breakers are triggered by price movements of the individual instrument. While market-wide circuit breakers tend to be triggered only exceptionally, single-instrument circuit breakers may be triggered frequently.¹²

Continuous trading vs auction circuit breakers

On a typical trading day, the continuous trading session may open or close (or both) with an auction. There may also be additional auctions scheduled intraday. In the continuous trading session, marketable orders can be executed, resulting in transactions. In contrast, as illustrated in **Figure 2**, an auction session includes a Call phase, where exchanges collect orders submitted by buyers and sellers and then calculate and display the indicative prices. No order execution takes place during the Call phase. After the Call phase ends, traders can no longer modify the orders. Meanwhile, the exchange determines the auction price (usually the price with the most volume) and, to conclude the auction, executes all trades at that price in a single transaction (“uncrossing”). The end of the Call phase is often determined randomly to discourage price manipulation.

Circuit breakers can take place during continuous trading hours or during auctions, but their effect is different: while a circuit breaker during continuous trading leads to a trading halt for a given period and/or a direct switch to an auction, a circuit breaker during an auction extends the auction period.

¹¹ While there is some divergence between industry definitions, there seems to be a wider terminology gap between the industry and academia. This divergence is important to bear in mind when comparing results across studies.

¹² For example, from January 2014 to June 2015, there were 20,349 instances of individual circuit breakers being triggered at the London Stock Exchange across all securities (FCA, 2017).

Reference variable

Circuit breakers are commonly triggered by price movements. The reference can be the price itself or a function of it (e.g., a volume-weighted, average price). However, Moser (1990) notes that trading halts can also be triggered by order imbalances (to protect the interests of market makers in specialist markets) or by excessive volume (to protect the back-office against an overload of operations).

Static or dynamic thresholds

While exchanges set thresholds according to different methodologies, two broader groups can be identified:

- **Static thresholds** refer to a fixed reference variable in the past, typically the previous day's closing price, the current day's opening price, or the most recent auction price.
- **Dynamic thresholds** refer to a reference variable that changes through the trading day. It could be, for example, the price of the last transaction or a function of the most recent trading prices (e.g., a moving average).

Each of these thresholds captures a different aspect of market dynamics. While the static thresholds are useful to capture large incremental changes during the day, the dynamic ones are focused on capturing sudden changes (for example, those resulting from a fat-finger error). Exchanges often use a combination of both static and dynamic thresholds.

Duration of the trading halt

The length of the trading halt differs across exchanges and can range from a few seconds to the rest of the trading day. Exchanges can adjust the length of trading halts depending on the sharpness of the price movement, with longer halts associated with more marked swings. The duration also varies across market segments or depending on the time of the day (for example, as the close of the trading day approaches, circuit breakers may halt trading for the rest of the day).

Coordination of circuit breakers across venues or jurisdictions

Since the same stock can be traded across different venues and jurisdictions, and can underlie the price of derivative products, some markets lend themselves to establishing a certain level of coordination. In other cases, this may not be desirable since, for example, the reasons for a circuit breaker being triggered in one venue, may not apply in another, even for the same stock.

Information disclosure

The provision of information before and during the triggering of a circuit breaker is intentional and intended to elicit participants' behaviour that facilitates orderly trading and price discovery. Exchanges may send triggered circuit breaker flags to market participants, together with an indication of when the auction will begin, so that market participants can act accordingly. There may also be divergence on whether thresholds are disclosed or not. In its survey of the EU markets, ESMA reports that, out of 22 platforms that use circuit breakers, a third disclose their circuit breaker thresholds (Guillaumie et al., 2020).

4. Related research

Since the introduction of the circuit breakers after the 1987 stock-market crash, academics and regulators have studied the benefits of circuit breakers and their impact on trading behaviour, liquidity, price formation and volatility. Broadly speaking, there have been three ways of approaching the question:¹³

- Theoretical analysis: Using theoretical market microstructure models to examine how information shocks affect liquidity, price formation or agents' behaviour in the presence of circuit breakers.
- Empirical analysis: Econometric event studies to test the impact of circuit breakers on trading patterns and market variables (e.g., volatility and liquidity), using historical data.
- Experimental analysis: Simulating a market to analyse the impact of circuit breakers in a controlled environment.

Although the conclusions are mixed and far from definitive, some results seem to prevail:

Circuit breakers can achieve an improvement in market quality, such as a reduction in volatility, an increase in liquidity, or a more efficient price discovery process. However, circuit breakers often do not have any significant impact on prices (they may delay but do not stop a fall in prices), which is consistent with the fact that circuit breakers are not designed to affect prices.

A series of theoretical papers show that circuit breakers can reduce trading risks when the market becomes volatile. For example, the Greenwald and Stein (1991) model predicts that value buyers leave the market reluctantly when they are unsure about the execution price of their orders, and circuit breakers can reduce such a transactional risk and bring back value buyers. The Kodres and O'Brien (1994) model reasons that investors may be deterred from trading due to the potential price change between the trading decision time and the time of order execution, and circuit breakers can reduce such implementation risk. However, other papers suggest that, by affecting trading behaviour, circuit breakers are likely to entail a perverse cost in terms of increased price variability or migration of trading volume, even when they are not triggered (Subrahmanyam, 1994).

Empirical contributions on circuit breakers mainly focus on the single-stock price limits instead of the market-wide trading halts, as the latter have been rarely triggered prior to the recent COVID-19 pandemic and also because assessing the effect of a market-wide circuit breaker may be more challenging. In sum, the empirical literature has not been able to draw a definite conclusion on the effects of circuit breakers on market quality. On the one hand, several studies have pointed to the benefits of circuit breakers. Corwin and Lipson (2000) find an increase in order submission and cancellation during the NYSE single-stock trading halts. They also find that a large proportion of the limit order book at the reopening is composed of orders submitted during the halt, although the depth near the quotes is unusually low. The authors further document that the market-clearing price at the reopen is a good predictor of future prices, suggesting that price formation takes place during trading halts. Goldstein (2015) studies the U.S. market during the period from 1988 to 1999 and concludes that circuit breakers led to a small but statistically significant decline in intraday equity market volatility, and suggests that, to a limited extent, they contributed to reducing the transmission of

¹³ While there is also an extensive literature about price limits, we limit our review to circuit breakers, which are the focus of the paper. For a survey about the price limit literature, we refer to Sifat and Mohamad (2018).

volatility from the futures to the primary market. In a study of 24 security markets, Aitken *et al.* (2015) find that circuit breakers reduce the vulnerability of the exchange to trade-based ramping market manipulation at the close.

On the other hand, some papers find that circuit breakers also have drawbacks and can deteriorate market quality. Studying the European market, Guillaume *et al.* (2020) show that circuit breakers can reduce volatility and improve price discovery, but at the same time increase bid-ask spreads. Studying the trading halts observed at the NYSE in 1988, Lee *et al.* (1994) find that circuit breakers increase halted stocks' volatility during the next trading day. Also using U.S. data, Santoni and Liu (1993) find evidence which is not consistent with the hypothesis that adoption of circuit breaker rules reduces the conditional variance of stock returns. Wang *et al.* (2019) study the January 2016 market-wide trading halts in the Chinese market and find that circuit breakers do not stop security prices from falling, and volatility remains the same.

Circuit breakers may generate a “magnet effect”, where trading and volatility increases as traders anticipate the triggering of a circuit breaker.

Researchers have attributed part of the previously mentioned market quality deteriorating effects of the circuit breakers to the “magnet effect”, which is first discussed in Subrahmanyam (1994). This hypothesis suggests that traders will rush to close their position quickly before the circuit breakers halt trading, fearing the lack of trading when the market halts. This “magnet effect” is first empirically documented by Goldstein and Kavajecz (2004) in the NYSE market during the turbulent October 1997 events (triggered by a crisis in the Asian markets)¹⁴ and then is also studied in the Asian markets (Nath, 2003; Yan Du *et al.*, 2009; Wong *et al.*, 2009; Wang *et al.*, 2019b). Using data from the Egyptian Stock Exchange, Tooma (2011) provides evidence of the existence of a magnet effect for price limits and of its economic significance.

There may be spillover effects. For example, a circuit breaker may move volatility across markets when traders move their trades to another market in anticipation of a circuit breaker being triggered.

Traders invest in a portfolio of securities and across various markets. In studying the circuit breakers in single-stock trading halts, several researchers find that there are volatility and volume spillovers from halted stocks to non-halted stocks. However, they cannot agree on whether the spillover effects improve or deteriorate the market conditions in the non-halted stocks. Nath (2005) and Cui and Gozluklu (2016) find an increase in volatility in the non-halted stocks, whereas Brugler *et al.* (2018) document a decrease in volatility.

When trading halts in regulated markets, traders may carry their trades to alternative venues, such as OTC venues and dark pools. Empirical research shows that off-main venue trading during main venue circuit breakers exhibits an increase in volatility (Fabozzi and Ma, 1988), increase in transaction costs (Chakrabarty *et al.*, 2011), and a weakened price discovery process (Gomber *et al.*, 2012). Recent studies in the European market suggest that there is no spillover between the halted main venue and not halted alternative venues (Clapham *et al.*, 2017 and FCA, 2017). The authors find that the main participants of the alternative venues, high-frequency traders, leave the market during trading halts. The alternative venues, including dark pools and non-lit venues, rely heavily on main venue market data (e.g., mid-point prices).

¹⁴ See, for example: <https://www.cnbc.com/2017/10/27/20-years-ago-friday-this-unprecedented-trading-curb-kicked-in.html>

Although circuit breakers only temporarily halt trading, they may also exhibit time-lag effects, and the effects of circuit breakers may spill over and extend to subsequent days. Kim and Rhee (1997) study the single-stock circuit breakers in the Tokyo Stock Exchange and find that the increase in volatility can persist up to one week after a trading halt is triggered.

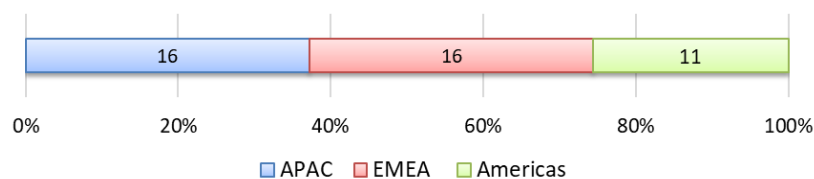
As, according to the literature, the evidence on the benefits of circuit breakers is not unambiguous; at the WFE we aim to conduct more applied research on the topic to shed light on the benefits of circuit breakers (or otherwise), exploiting the recent and widely spread trading halts triggered during the COVID-19 crisis in Europe.

5. The survey

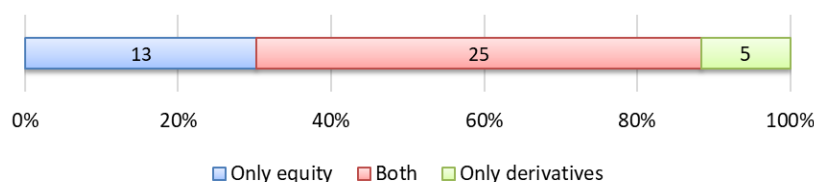
The survey was conducted among the WFE members and affiliates between June 2nd and November 30th, 2020, covering exchanges across the Americas, Asia-Pacific (APAC), and the Europe, Middle East and Africa (EMEA) regions (**Figure 3.A**). A total of 43 venues answered the questionnaire (see Annex 1 for the list of respondents).

Figure 3: Number of respondents per region and type of market

A: Distribution by region



B: Types of markets



The survey focused on cash equity and equity derivatives markets. Five respondents were derivatives-only exchanges (**Figure 3.B**). Commodities were not included because of the different nature of their markets. They will be the subject for a separate study.

Globally, exchanges reported close coordination with regulators and other key stakeholders to develop circuit breakers and other safety mechanisms designed to maintain the fair and orderly operation of markets during periods of extreme volatility while not impeding price discovery. For instance, the Stock Exchange of Thailand and the Philippine Stock Exchange coordinated with local regulator and incorporated a new three-level circuit breaker system in April 2020 and May 2020, respectively. In many cases, exchanges have a regulatory obligation to design methods to control excessive price movements which are optimised for unique aspects of their market and market participants. Less common is mandated coordination of circuit breakers across exchanges in a particular jurisdiction. Such coordination may not always be viable or even desirable, as the conditions

causing a circuit breaker being triggered in one venue may be completely unrelated to the orderly trading in another venue

Most exchanges reported having multiple safety mechanisms at their disposal. More than half of the responding exchanges (54%) reported using market-wide circuit breakers. All exchanges reported having one or more mechanisms to interrupt or constrain normal trading of individual stocks and certain derivatives contracts, in response to extreme price movement. In some cases, daily price limits served as a backstop to other safety mechanisms. While exchanges generally reported a variety of safety mechanisms, the survey revealed certain regional tendencies in the approaches taken by exchanges or regulators to manage an orderly and efficient market. There were also differences in the approaches used by exchanges to manage extreme price movement between cash equity and equity derivatives markets.

In the following sections, we summarise the main results of the survey.

5.1 Circuit breakers across cash and derivatives markets

Most of the responding exchanges (24 out of 43) operate both cash equities and derivatives markets; 14 operate cash equities markets only, and five operate derivatives markets only (see Annex 1 for details). Exchanges generally recognise a connection between the trading of securities and related derivatives and employ safeguards to control extreme price movements in both markets. With regards to the links between cash and derivatives safeguards, exchanges reported a variety of approaches across jurisdictions.

Some derivatives markets do not use mechanisms that directly apply to individual derivatives contracts. Rather, trading is stopped when there is a halt or an interruption in the underlying security. In the U.S., for example, all derivatives trading is halted during the market-wide circuit breaker in the cash equity market. Also, a security futures contract stops trading when the underlying stock is subject to a Limit Up-Limit Down halt. The Taipei Exchange and the Taiwan Stock Exchange use similar mechanisms.

Another approach taken by exchange operators is to use the same type of safety mechanism in both their cash equities and derivatives markets, although not explicitly linking the trading of the derivative contracts to the trading interruption in the underlying security. For example, Deutsche Börse Group uses the volatility interruptions on both Xetra for individual equities and Eurex for actively traded futures contracts.¹⁵ Yet, the reference prices used to trigger a volatility interruption in a derivatives contract are independent of pricing in the cash market. Also, Deutsche Börse calibrates its mechanisms differently in each market. Xetra uses both static and dynamic reference prices to trigger a volatility interruption. In contrast, Eurex uses two different dynamic reference measures based on a shorter (5-second) and a longer (15-second) price window and no static reference. In Eurex, price thresholds for futures are set on a contract-by-contract basis and options are not subject to volatility interruptions.

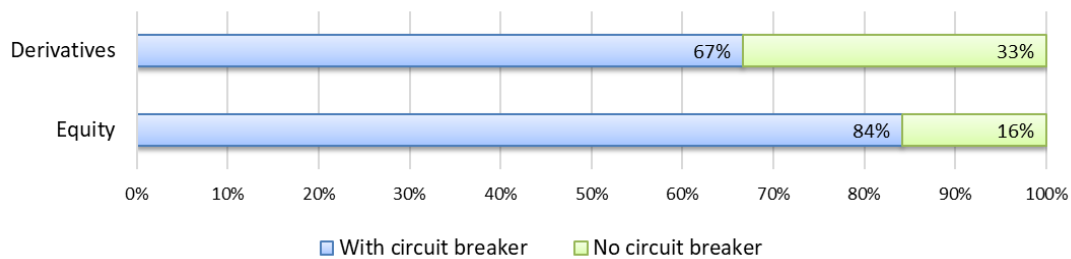
The third approach used by derivatives exchanges is price limits, which are not considered circuit breakers according to our definition (see section 3.1). Derivatives exchanges reported using price limits either as a backstop to other safety mechanisms or as the sole tool to control extreme price movements. Generally, price limits result in the rejection of aggressively priced orders (i.e., outside of

¹⁵ Xetra is a trading venue for cash securities, bonds, and ETFs, operated by the Frankfurt Exchange (Frankfurter Wertpapierbörse). Listed derivatives are traded in Eurex. They are both part of the Deutsche Börse Group.

a prescribed price band), but trading within the price band is still allowed. They may include a “cool-off” period after which the price bands are reset. The cool-off period could last for a few minutes up to the entire day.

It is worth noting that cash markets are more likely to have circuit breakers, compared with derivatives markets. Around 67% of the derivative markets in the survey use circuit breakers, compared with 84% in the spot markets (**Figure 4**). The individual cases are reported in **Annex 2**.

Figure 4: Markets with circuit breakers.



When looking at the presence of market-wide or single-instrument circuit breakers, we see that from those exchanges that reported using circuit breakers in the spot markets, 45% reported using both types while 15% have solely market-wide circuit breakers (**Figure 5.A**). In the case of derivatives exchanges using circuit breakers, most of them (57%) rely only on single-instrument tools (**Figure 5.B**). As we will discuss in the next section, these results are in part a consequence of differences in regulations across regions, as hinted in **Figure 5.C**.

5.2 Differences by region

Different regions have implemented circuit breakers and other safeguards in different ways, attending to their market characteristics and different regulatory requirements. While in EMEA and APAC having only single-instrument circuit breakers is common, in Americas having both market-wide and single instrument is more frequent. (**Figure 5.C**).

Americas

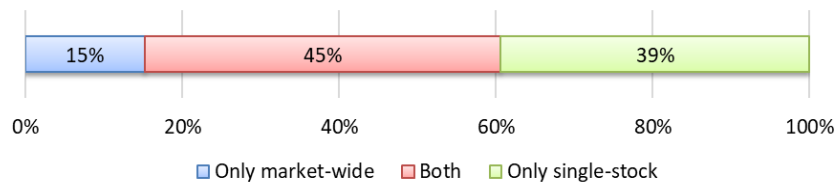
U.S. exchanges are part of the National Market System (“NMS”) that effectively links all markets under a consistent set of regulations and a common price reporting facility. All U.S. exchanges that trade equities and equity derivatives are subject to market-wide circuit breakers that are triggered when the S&P 500 Index declines 7%, 13% and 20% from its previous closing level. Level 1 (7%) and Level 2 (13%) circuit breakers result in 15-minute trading halts for all stocks and ETFs, as well as for all equity derivative products. A Level 3 (20%) circuit breaker results in a halt for the remainder of the day.

Single-stock circuit breakers are coordinated across all U.S. markets under the Limit Up-Limit Down (LULD) Plan. LULD halts are triggered when the price of an individual stock or ETF rises or falls outside of a dynamic range based on an average of the last 5 minutes of trading and does not trade inside that range within 15 seconds. Following a 5-minute “pause,” trading resumes with an auction on the primary listing exchange. U.S. exchanges also reported a variety of additional tools other than regulatory halts designed to smooth anomalous price swings in individual equity securities. For example, the Nasdaq Stock Market checks for overly “aggressive” orders and modifies prices to the

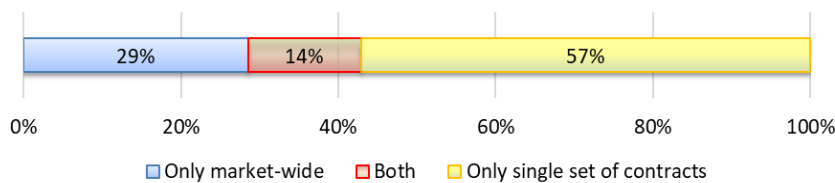
then-current LULD allowable price band. A Securities Information Processor, or “SIP” consolidates data from all exchanges and notifies market participants when LULD halts are triggered.

Figure 5: Market-wide vs single-instrument circuit breakers

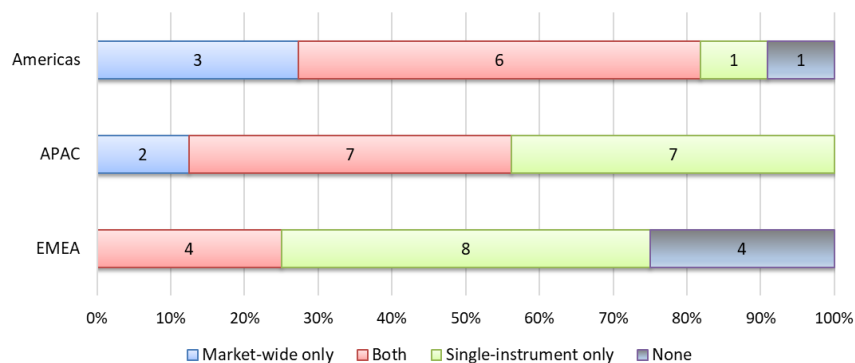
A: Spot markets*



B: Derivative markets*



C. By regions



*Percentages are estimated relative to respondents with a circuit breaker. Individual percentages may not add to 100% due to rounding.

From the eight other non-US responding exchanges, five use market-wide circuit breakers that are triggered by movement in the domestic market benchmark index. However, the TMX Group reported using the SPTSX Composite on U.S. holidays and the S&P 500 Index as their benchmark on all other trading days. Canada, Mexico, and Brazil all used a 3-tier system of market-wide halts consistent with the U.S. exchanges, with each halt lasting from 15 to 60 minutes and ultimately the remainder of the day. These exchanges also used volatility interruptions for individual stocks and ETFs. However, volatility interruptions in the Bolsa Mexicana de Valores (BMV) uses a combination of static and dynamic thresholds where orders outside dynamic limits switch to a call auction, while orders outside static limits cause a halt. If the call auction price is outside of a static reference price based on the opening stock price, the stock is halted for an undetermined period.

The responding exchanges in the region tended to halt trading in derivatives when continuous trading in related underlying securities halted, either due to a market-wide or single-stock circuit breakers or due to volatility interruptions.

EMEA Region - Europe

The safeguard mechanisms used by European exchanges are aligned with the MiFID II and equivalent regulatory frameworks.¹⁶ MiFID II requires regulated markets to implement price limits, that are, “procedures and arrangements to reject orders that exceed pre-determined volume and price thresholds or are clearly erroneous” (Art 48(4)). It also states that regulated markets should be able to “temporarily halt or constrain trading if there is a significant price movement in a financial instrument on that market or a related market during a short period” (Art 48(5)). Importantly, Article 48(13) mandated ESMA to create guidelines for the implementation of circuit breakers, and these were issued in April 2017 (ESMA, 2017) following a consultation. This framework ensures that circuit breakers in ESMA jurisdictions are broadly harmonized, leaving individual markets the necessary leeway to tailor the calibration to their needs, in the spirit of ESMA's consultation paper (ESMA, 2016).^{17,18}

In contrast to the U.S., in Europe we do not find market-wide or index-linked circuit breakers. Rather, the European exchanges have single-instrument circuit breakers, typically of the volatility interruption type. While individual exchanges may use different names for these mechanisms, they share common features, including the use of both dynamic and static reference prices as a trigger. Dynamic reference prices are based on either the last traded security price or a moving average of prices. In contrast, the static reference price is usually based on the most recent auction price for that security, which would typically be the regular opening or closing auction.

Under MiFID II, exchanges have discretion as to how conservative the thresholds could be. They can establish the thresholds for the upper and lower bounds by stock or by group of stocks, as well as the time limit to complete a call auction. For example, Deutsche Börse uses random durations for auctions triggered by their volatility interruptions, while Bolsas y Mercados Españoles (BME)'s “volatility auctions” last for 5 minutes and then trading commences randomly during the next 30 seconds.

¹⁶ The Swiss and UK exchanges are not subject to MiFID II. Swiss exchanges are subject to the Swiss Federal Act on Financial Market Infrastructures and Market Conduct in Securities and Derivatives Trading (“FinMIA”). FinMIA is intended as the Swiss equivalent to [MiFID II](#). While UK exchanges are no longer subject to MiFID II, they still were at the time of the survey.

¹⁷ In the consultation paper, ESMA (2016), at points 23 and following, noted that a variety of circuit breaker mechanisms were present among ESMA-compliant jurisdictions, attributable to the difficulty of defining “volatility” across different jurisdictions, whether volatility is always detrimental and what are tolerable levels of volatility in a market. In point 25 ESMA notes that: “it is difficult to provide one-size-fits-all answers to those questions and believes that it is important to leverage, where appropriate, on the trading venues' expertise and on their knowledge of the financial instruments traded on them”. As a consequence, “in ESMA's view, the proposed Guidelines should therefore be sufficiently broad so as to encompass all types of trading halts and avoid recommending specific and quantitative parameters while being sufficiently precise to ensure a certain degree of harmonisation and provide useful guiding principle to European venues” (Point 26).

¹⁸ A “trading halt” in MiFID II coincides with what we here consider a circuit breaker; in particular, it includes volatility interruption mechanisms.

SIX Swiss Exchange is subject to FinMIA,¹⁹ which, similar to MiFID II, grants exchanges in Switzerland respective discretion regarding thresholds. SIX Swiss Exchange reported relatively tight price thresholds ($\pm 1.5\%$ to $\pm 2\%$) and included a further trading stop if the price continues to deviate by 10% from the reference price.

In our survey, European exchanges reported using similar principles in establishing trading safeguards in their equity and derivatives markets, but some, such as Deutsche Börse, use different parameters and calibrating measures in related instruments. Unlike their U.S. counterparts, the European exchanges participating in the survey do not halt trading in their derivatives markets due to halts or volatility interruptions in the related cash markets.

EMEA Region – Middle East & Africa

Three of the eight responding exchanges in the Middle East and Africa reported using market-wide circuit breakers based on extreme price changes of a broad-market benchmark index. The Tel Aviv Stock Exchange (TASE), The Egyptian Exchange (EGX), and the Boursa Kuwait (BK) indicated the use of market-wide circuit breakers triggered by downward movement in their respective broad market indexes. Each exchange reported using at least two tiers that, when triggered, result in trading halts that range from 15 to 30 minutes, and a halt for the remainder of the day if the final tier is breached. For EGX, a board decision was taken for the market-wide circuit breaker to be applied only for market declines as of 23 March 2020. In other words, market-wide circuit breakers changed from being symmetrical to non-symmetrical after reviewing the WFE study on circuit breakers (Gomber et al., 2016) which indicated that some advanced markets do apply non-symmetrical market-wide circuit breakers.

Seven exchanges use volatility interruption mechanisms to mitigate excessive price movement in individual stocks. The volatility interruption mechanisms used by the exchanges in Middle East and Africa are similar to those used by the European exchanges; that is, continuous trading shifts to a call auction when certain price bands are breached. Exchanges reported using both dynamic and static reference prices to trigger their respective control mechanisms. The duration of the call auctions varies by exchanges but ranges from 2 to 10 minutes, and longer for smaller and less liquid stocks.

For the derivatives market safeguard mechanisms, only the Tel Aviv Stock Exchange reported using both market wide circuit breakers and volatility interruptions mechanisms.

Asia-Pacific Region

Exchanges in the Asia-Pacific region reported a variety of mechanisms to ensure the orderly operation of their markets. Nine out of sixteen responding exchanges in the region reported using market-wide circuit breakers tied to their local broad market index. For example, trading on the Korea Exchange (KRX) halts for 20 minutes when the KOSPI Index drops by 8% and then by 15%. Trading is halted for the remainder of the day if the index drops by 20%.

All sixteen responding exchanges reported one or more mechanisms to control extreme price movements in individual stocks. Volatility interruptions, similar to those used by exchanges in other regions, were most reported. The three exchanges in Taiwan (Taiwan Stock Exchange (TWSE), Taipei Exchange (TPEX), and Taiwan Futures Exchange (TAIFEX)) use a coordinated set of circuit breakers and other safety mechanisms. TWSE and TPEX trigger volatility interruptions when stock prices move up

¹⁹ See footnote 16.

or down 3.5% relative to a dynamic reference price—a 5-minute moving average of trade prices. Additionally, these exchanges have a daily price limit of $\pm 10\%$. Derivatives trading on TAIFEX halts whenever the related underlying security halts on TSX or TPEX. Index futures on TAIFEX are subject to a daily limit of 10%.

Some Asia-Pacific exchanges employed a form of price limits as the primary safeguard mechanism instead of circuit breakers or trading pauses. The Indonesia Stock Exchange uses volume limits, in addition to price limits; these volume limits are mainly for preventing “fat finger” errors in an order entry rather than for avoiding the accumulation of orders during a volatile period. Hong Kong Exchanges & Clearing (HKEX) and the Singapore Exchange (SGX) use “Volatility Control Mechanisms” (“VCM”) that trigger a “cool-off” period when stock price thresholds are breached. A price threshold is determined relative to a dynamic reference price; for example, the price of the stock 5 minutes earlier. When a VCM is triggered, stock orders outside of a specified price band are rejected, but trading can take place within the band during a 5-minute cool-off period after which price limits may be reset and trading will continue with the new limits in place. HKEX currently allows only one VCM per stock in each of the morning and afternoon trading sessions. When normal trading resumes after the “cool-off” period, HKEX stops monitoring the same security for potential VCM threshold breaches, whereas SGX may trigger multiple VCMs during a trading day.²⁰

The Australian Securities Exchange (ASX) uses circuit breakers in its derivatives market and a form of price limits in its cash equity market. The “Extreme Trading Range” (ETR) mechanism triggers a 2-minute pause when a contract trades outside of a range relative to a static reference price – the first trade of the day. The reference price is reset based on the trade price resulting from the re-opening auction. On the other hand, ASX uses the “Anomalous Order Threshold” (AOT) mechanism for cash equity trading. The AOT will reject aggressive orders that are 10% or more outside the AOT reference price, which is a dynamic price updated approximately once per minute. The AOT mechanism does not apply to derivatives trading.

5.3 Auction vs continuous trading

The survey asked the respondents to provide information about circuit breaker rules during opening/closing auctions and continuous trading session.

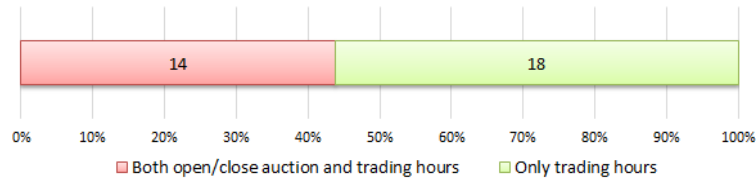
Out of the 32 exchanges with circuit breakers in their equity market, 14 (44%) have circuit breakers implemented during the opening/closing auction session in addition to the continuous trading session (**Figure 6**). Among these exchanges, five implement the same circuit breaker rules in the opening/closing session as in the regular trading session. Seven exchanges opt to implement different rules in the auction session, emphasising the differences between the trading sessions. Some exchanges have more flexible circuit breaker trigger conditions for the auction sessions, as the market can experience bigger movements and higher volume during these sessions. For example, Japan Exchange Group (JPX) allows order execution outside the Special Quote Parameter range (the JPX equivalent of the circuit breaker price range) during closing auctions under certain conditions.²¹

²⁰ As part of enhancements to its Volatility Control Mechanism (VCM), HKEX will further allow multiple VCM triggers. This is tentatively scheduled for 2021.

²¹ See the section on improvement of trading rules at <https://www.jpjx.co.jp/english/systems/equities-trading/01.html>

Figure 6: Differences in time of implementation and rules for circuit breakers in equity markets

A: Types of circuit breakers used during the trading day



B: Differences in rules between open/close auction and trading hours

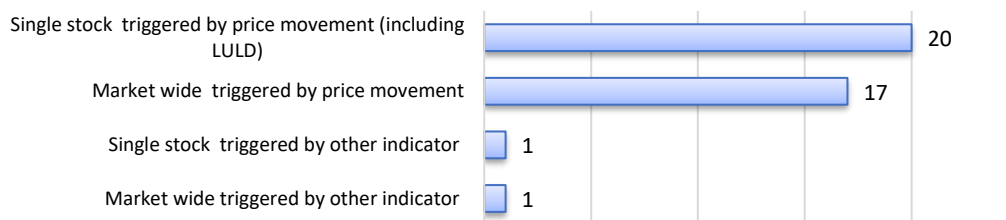


5.4 Reference variable

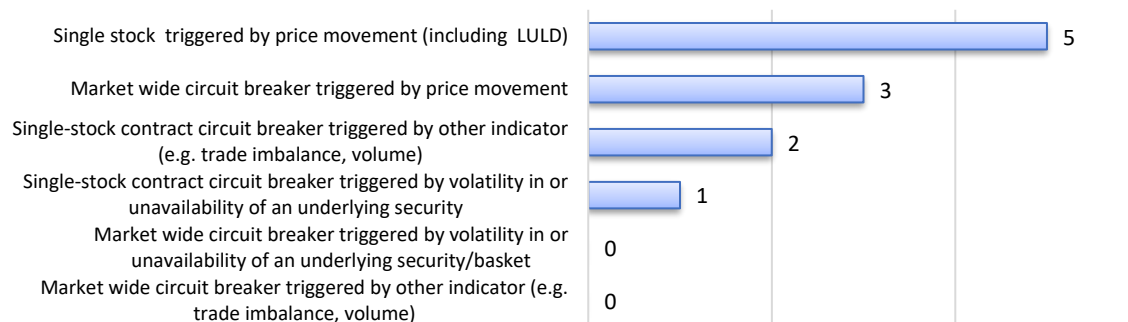
Although circuit breakers are commonly triggered by price movements, Moser (1990) observed that they could also be triggered by other market variables. In the survey, however, all respondents indicated that, for the equity markets, they use price movements as the trigger for their market-wide circuit breakers and this is also the case for single-stock circuit breakers (**Figure 7**). Brasil Bolsa Balcão (B3), reported using an additional reference parameter – the average traded quantity - as a circuit breaker trigger. In the case of derivatives, while most circuit breakers are triggered by price movements, there were also examples of the reference variable being a volume-weighted average price or a volatility estimate.

Figure 7: What kinds of circuit breakers do you have in your market?

A: Equity markets



B. Derivatives markets



When looking at the instrument that is used as the reference to trigger a market-wide circuit breaker, it is usually a domestic market equity benchmark, although this is not always the case. The TMX Group, for example, uses the U.S. market benchmark, the S&P500, as their reference when both U.S. and Canadian markets are open.

5.5 Dynamic vs static reference prices

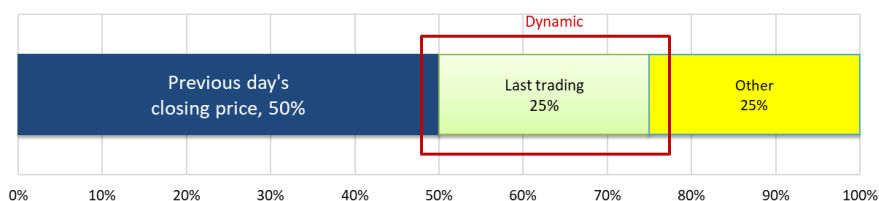
Another important aspect is whether the reference price is based on a static reference (i.e., the last closing price or the last auction price) or a dynamic reference (i.e., the last trading price or a moving average). While the latter case focuses on large sudden changes, the former focuses on the incremental magnitude of the change. The survey showed the choice between dynamic and static varies between market wide and single instrument, but also between derivatives and cash markets.

Figure 8: How the reference price is calculated for market-wide circuit breakers.

A: Equity markets



B: Derivative markets



Market-wide

In our survey, we found that almost all equity market-wide circuit breakers are static and rely on the previous day's closing price as the reference. Of the 23 exchanges that reported using market-wide circuit breakers in their equity markets, only 16% of respondents use dynamic thresholds (**Figure 8.A**). In the case of derivatives, dynamic thresholds are more common, at least 25% of the total (**Figure 8.B**).

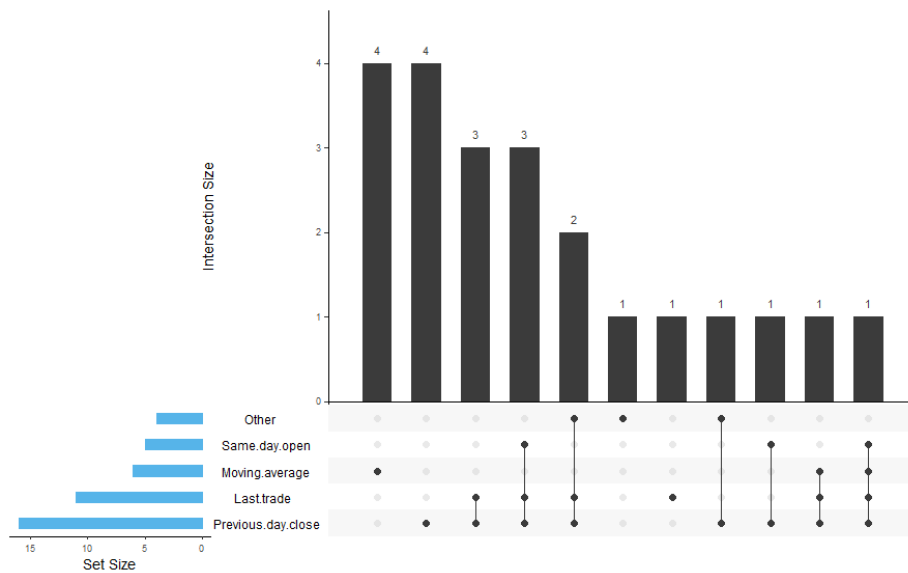
Single-instrument

In the case of single instrument circuit breakers, around 50% of the respondents use static references (previous closing or same day opening price). It is worth noting that several exchanges have both dynamic and static references, in different combinations. For example, the Tel Aviv Stock Exchange (TASE) and Johannesburg Stock Exchange (JSE), among others, implement both static and dynamic references for their single-stock halting mechanism. Also, Bolsa Mexicana de Valores (BMV) uses a static fluctuation band for the single-stock circuit breakers and uses a dynamic fluctuation band for the single-stock volatility interruption. In **Figure 9** we show this multiplicity of approaches by tracking the exchanges where there is an intersection in the use of different references. In the case of equities, seven exchanges reported using 3 or more references (**Figure 9.A**). For derivatives, it is less common to use more than one reference and only one exchange reported using three (**Figure 9.B**).

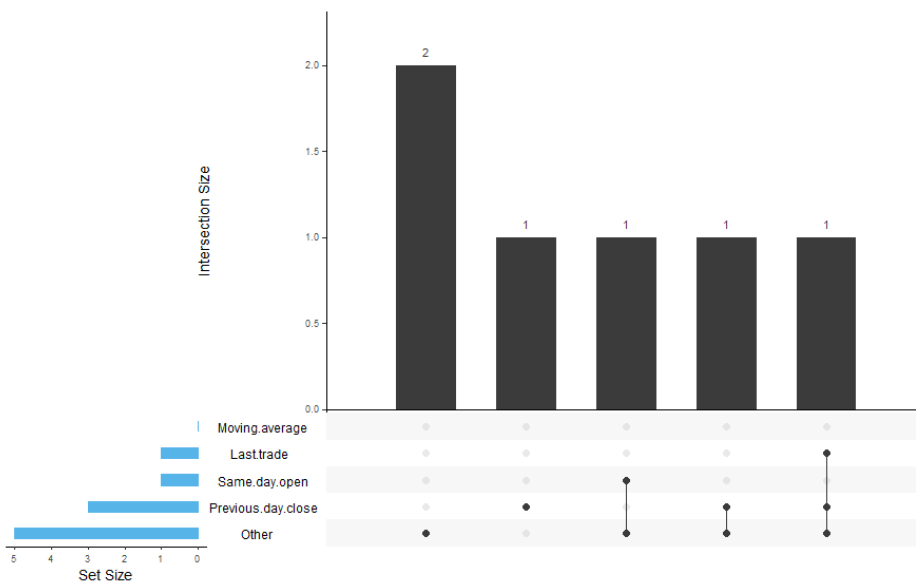
The Korea Stock Exchange (KRX) has dynamic and static volatility interruption mechanisms. The two types of volatility interruption differ in the threshold level, cover distinct instruments, and depend on the time when they apply: the thresholds for invoking dynamic volatility interruptions for constituent stocks in the KOSPI 200 index are 2% (closing call auction), 3% (continuous trading); and 4% (closing call auction), 6% (continuous trading) for all other KOSPI-and KOSDAQ-listed stocks. Such volatility interruptions are effective during the continuous trading session, closing call auction and after-hours trading, but not during the opening call auction. In contrast, the static volatility interruption applies to all stocks on the KOSPI and KOSDAQ market and is effective during the opening and closing call auction and continuous trading session, but not during after-hours trading (Kwon *et al.*, 2018).

Figure 9: How the reference price is calculated for single instrument circuit breakers

A: Equity markets



B: Derivative markets



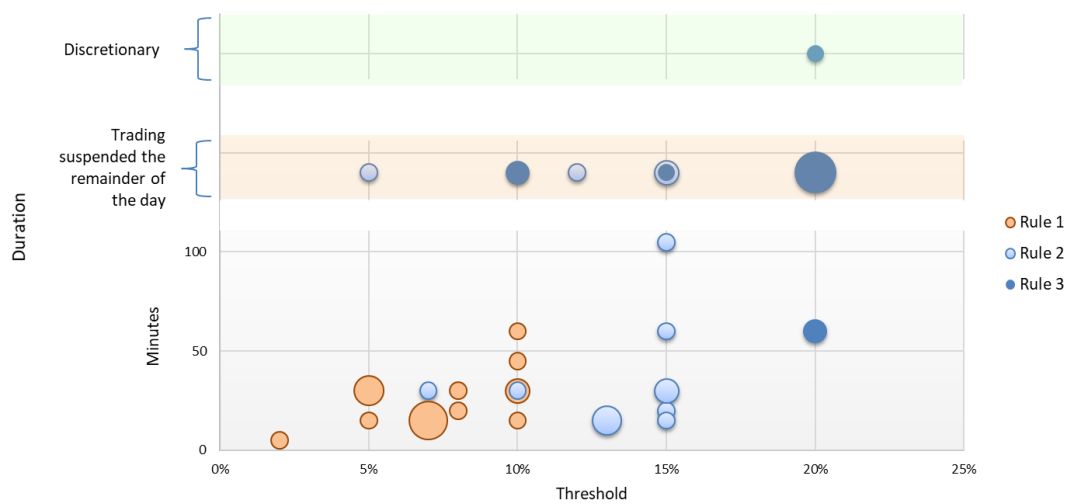
5.6 Thresholds and duration

The duration of a trading halt is directly proportional to the level of the threshold, with exchanges usually defining a set of two or three rules (“tiers”) indicating the duration associated with each threshold. For instance, a level one threshold would only allow for a small variation with respect to the reference price and, if reached, it would trigger a short trading halt period. Higher-level thresholds would require more significant deviation from the reference price and would halt trading for longer. In many cases, the duration will also vary with the time of the day: for example, the same threshold may trigger halts of different duration depending on whether the event happens before or after a certain time of the trading day. While exchanges follow similar patterns, the responses show a diversity of individual calibrations.

Market-wide

In the case of market-wide circuit breakers, the responses showed that, while the initial thresholds vary between 2% and 10% of the reference price, they can trigger halts that vary from a few minutes to a whole hour (Figure 10). A simple inspection of the first level of thresholds suggests a significant linear correlation between the level of the threshold and the duration of the halt. However, in the case the second and third rules, the correlation weakens, with some lower thresholds attracting higher durations and vice-versa. For example, North American exchanges halt the trading for the rest of the day if the index falls by 20% with respect to the previous day’s closing price, whereas trading will halt with smaller declines on the Tel Aviv Stock Exchange (12%) and Boursa Kuwait (10%). The Colombo Stock Exchange will suspend trading for the rest of the day if the 5% trigger is reached on or after 2pm.

Figure 10: Market-wide circuit breaker rules in equity markets: thresholds and duration.



The figure represents the different combinations reported of level of threshold and duration of the trading halt for circuit breakers used during continuous trading. The area of the bubbles is proportional to the number of respondents: it varies from 1 (the smallest) to 5 (the largest). Some of these thresholds are also dependent of the time of the day. “Rules” 1, 2 and 3 refer to the sequence of thresholds and corresponding durations that the exchange uses to define how circuit breakers are applied. Rule 1 is the first to apply.

In the case of derivative markets, no exchange reported having a market-wide circuit breaker operating in isolation, that is, without reference to the cash market. In the case of the US., for example,

derivative market-wide circuit breakers are triggered as a consequence of circuit breakers being triggered on the cash market.

Single instrument

The differences stand out when we compare threshold-duration pairs across single-stock circuit breakers. The reason is that the single-stock circuit breakers rules often depend on additional variables: the market segments (for example, small-cap, mid-cap, and large-cap), the share unit price, whether the stocks are constituents to an index, or the time of the day. They may also depend on additional parameters (e.g., increment in trading). While single-stock circuit breakers tend to have lower thresholds and shorter durations compared with the market-wide case, in some cases the higher thresholds may lead to stopping trading on that instrument for the rest of the day or for an unspecified time.

In the case of individual derivative contracts there is also a variety of approaches. Some markets apply 7%, 13% and 20% thresholds with 2 minutes halt. Japan Exchange Group reported a 10-minute trading pause with static thresholds and a 30-second pause with dynamic thresholds that vary per contract.²² In the Shenzhen Stock Exchange, if the intraday trading price of a contract moves by 50% or more above or below the latest reference price and the absolute value of such movement reaches or exceeds ten times the tick size, the contract will enter a 3-minute auction session, after which continuous trading will resume.

With regards to volatility interruption mechanisms, four respondents indicated that they have volatility interruptions in addition to regular trading halts in their equity markets. Another four respondents also said that volatility interruptions are what they consider a circuit breaker, and do not have trading halts. These numbers suggest that volatility interruptions are a common volatility control mechanism among exchanges. In fact, volatility interruptions *are* circuit breakers in many jurisdictions that do not have outright trading halts. This is the case, for example, of European exchanges such as Athens Stock Exchange, Bolsas y Mercados Españoles, Deutsche Börse, London Stock Exchange, and SIX Swiss Exchange, but also of Johannesburg Stock Exchange and Shenzhen Stock Exchange.

According to the survey respondents, volatility interruptions typically use dynamic reference prices. The Korea Exchange, for example, reports that a volatility interruption is triggered when the bid/ask prices deviate more than $\pm 16\%$ from the last execution price, and they also employ a static volatility interruption, triggered when the bid/ask prices deviate more than $\pm 10\%$ from the last call auction price. The Tel-Aviv Stock Exchange reports that a volatility interruption is triggered if prices fall outside of differentiated thresholds depending on stock categorisation and index inclusion. Bolsa Mexicana de Valores reports the use of both dynamic threshold ($\pm 5\%$ with respect to the average trading price over the last two minutes) and static threshold ($\pm 15\%$ with respect to the last closing price). If the security price moves beyond either of these two thresholds, the trading of such a security switches from continuous trading to a call auction. The auction lasts for 5 minutes in the case of a dynamic threshold breach, while a static threshold induced auction does not have a specific duration. Moreover, if the allocation price of the auction (used to calculate further dynamic limits) is higher than the static threshold, then BMV halts the trading of such security.

²² See <https://www.jpex.co.jp/english/derivatives/rules/price-limit-cb/index.html>, and <https://www.jpex.co.jp/english/derivatives/rules/price-range/index.html>.

At the Johannesburg Stock Exchange (JSE), volatility interruptions during continuous trading are triggered by changes in a dynamic reference price. Every trading day, the closing prices are carried over to the next day and are used as a dynamic reference price before opening. The price determined during the opening auction sets the new dynamic reference price, which is then updated after each trade.

In November 2020, the Saudi Stock Exchange (Tadawul) introduced volatility interruptions on the Main Market for the first three days of trading of newly listed securities, and on the Nomu-Parallel Market for all listed securities on a continuous basis. When the security price reaches a $\pm 10\%$ static price limit, the exchange halts continuous trading and switches to a 5-minute call auction, and the auction price will become the new reference price. Volatility interruptions can be triggered more than once during a trading session.²³

5.7 Other control mechanisms reported

Trading halts and volatility interruptions are not the only mechanisms that exchanges use as safeguards to mitigate extreme price movements. Exchanges widely implement other additional mechanisms, such as **price limits**, to control price volatility.

The WFE survey explicitly asked the respondents to indicate whether they have price limits or other price volatility control mechanisms in their exchange. We present a summary of their responses.

Price limits

Out of the full set of respondents, 29 (67%) indicated that they have price limits in addition to regular trading halts or volatility interruptions in their equity markets, suggesting that this is a widely used volatility control mechanism.

Exchanges provided additional information about how price limits in equity markets work. With a few exceptions (reported below), price limits work in a similar way across exchanges; that is, during regular trading hours, the trading system allows only orders with bid or ask prices that are within a price range centred around a reference price, typically the previous day's closing price or the same day's opening price. Price ranges are typically calculated as a percentage of the reference price and vary depending on the exchange and on the price level. The reported percentage might be as little as 5%, and as much as 35%, with the most common setup being closer to 10%. Only one exchange reported setting price limits in absolute values (as opposed to as a percentage) based on the previous day's closing price.

Two exchanges reported having differentiated thresholds depending on their market segments, with less conservative thresholds for small-cap stocks/low liquidity segments. One of these two respondents also has a differentiated price limit for the closing session.

Exchanges report applying price limits not only to stocks but to all instruments listed on the stock market. One exchange, for example, has a standard $\pm 10\%$ price limit rule calculated over the previous day's closing price, which applies to stocks, ETPs and other instruments. They report having a more complicated set of rules for warrants, depending on what the warrant's underlying is.

The Australian Securities Exchange uses the "Anomalous Order Thresholds" (AOTs) mechanism, which calculates reference prices and limits for all ASX securities. The AOT Reference Price is a dynamic price

²³ The Nomu-Parallel Market is an alternative equity market with lighter listing requirements catered for smaller companies.

updated approximately every minute. The AOT will reject aggressive orders that are 10 per cent or more outside this reference price.²⁴

Two stock exchanges with derivatives markets report having price limits on the derivatives market but not on the spot market. On both exchanges, price thresholds are set based on the type of contract.

Other mechanisms

Out of the full set of respondents, 12 exchanges (28%) reported that they have alternative mechanisms to limit price volatility. As they all differ from each other, we will comment on some of these individual mechanisms.

The Indonesia Stock Exchange has volume limits; that is, they reject orders if volumes in a single order are more than five million shares or more than 5% of listed shares (whichever is smaller).

The Johannesburg Stock Exchange flags reported bilateral transactions that are far away from the reference price. Flags are made available to market surveillance, traders, compliance desks and clearing members.

Nasdaq has a set of additional mechanisms in place, namely:

- Pre-set credit checks on market participants.
- Reject duplicate orders above a certain parameter.
- Reject orders above maximum order share size pre-set at a Market Participant Identifier (MPID) level: Firms can set a maximum allowable order size on their sessions; it is a firm maximum share value limit on a session level and not on a security level.
- Limit routing to price levels greater than a set percentage away from National Best Bid and Offer (NBBO) at entry: On entry, Nasdaq enforces a fat finger check where orders that are entered >10% away from the NBBO will be rejected. On orders that are accepted and eligible for routing they allow an order to sweep prices up to 5% away from the NBBO at entry. Orders will be cancelled back to firms once they hit the 5% price levels.

Cboe Global Markets also has several additional mechanisms, namely:²⁵

- Auction collars: limiting the auction price to a specified distance from the final reference price.
- Elimination of market order imbalances prior to emerging from regulatory halts.

SIX Swiss exchanges also reports having additional mechanisms, namely:

- Throttles: aiming to reduce or restrict unusual order traffic with the aim to limit disorderly conditions
- Suspension: Exchanges also have discretion to suspend or restrict trading temporarily if there are significant price movements

The Kazakhstan Stock Exchange (KASE) reports that their Committee on Market Risk has the ability to amend the parameters of the circuit breaker in a moment of heightened volatility as an alternative volatility control mechanism.²⁶

²⁴ The exchange notes however that different limits are applied to securities below \$2.35.

²⁵ More detail can be found at www.luldplan.com.

²⁶ KASE has price limits and volatility interruption mechanisms.

These responses suggest that some exchanges consider the discretionary intervention of the national regulator/regulatory body as a mechanism to keep price volatility under control. It also represents exchanges' willingness to take additional actions as necessary to adapt to changing market conditions and extreme volatility.

6. Coordination between circuit breakers

One of the aspects that we were interested in is the coordination of circuit breakers across venues, across trading times, and across jurisdictions. Coordination between the cash and the derivatives markets, for example, would mean that trading in a derivative is halted if the underlying instrument on the cash market of the exchange is affected by a circuit breaker. The survey asked the respondents to indicate whether they thought additional coordination was needed in any of these areas. The responses reflected how different markets may require different approaches, as discussed in more detail below.

Coordination between circuit breakers during continuous trading and at the auction

When asked about coordinating rules and procedures between circuit breakers during the opening or closing auctions and circuit breakers during trading hours, most respondents did not see the need for additional coordination, mainly because circumstances are different--during an auction, there is time to react, while during continuous trading there is no such time. Also, bigger moves in the opening and closing auctions need different (typically wider) thresholds triggers.

Coordination across jurisdictions

Coordination across jurisdictions received mixed responses. On the one hand, some exchanges are favourable to it to avoid creating arbitrage opportunities (albeit minimal) when there is dual listing between markets. However, most of the respondents were of the view that each trading venue should be allowed to implement the most suitable type of volatility control for their markets, depending on the unique circumstances, market practices, and trading mechanisms prevailing in each market. Coordination was seen as unfeasible or inappropriate not only because the cause of the interruption in one venue may not be present in another venue, but also because markets' rules and characteristics can vary substantially across jurisdictions, and therefore a one-size-fits-all approach would not be adequate. In addition, the operational costs, IT investment, and the increase in human resources, required to ensure coordination would not always justify the potential benefits and it would be particularly onerous for small trading venues.

Coordination between venues (spot and derivatives markets)

When asked about the need for coordination between spot and derivatives markets, respondents also had very different views reflecting, again, the different characteristics across markets. Those in favour argued that coordination ensures that interdependent markets function properly with up-to-date reference prices and avoids disruption.

Those against argued that, since derivatives prices usually precede related spot market movements, coordination could create a false imbalance between the markets. On the other hand, there are concerns that, because of their different nature, these instruments should be treated independently to minimise market interruptions. If the circuit breaker has been triggered for a given instrument, it

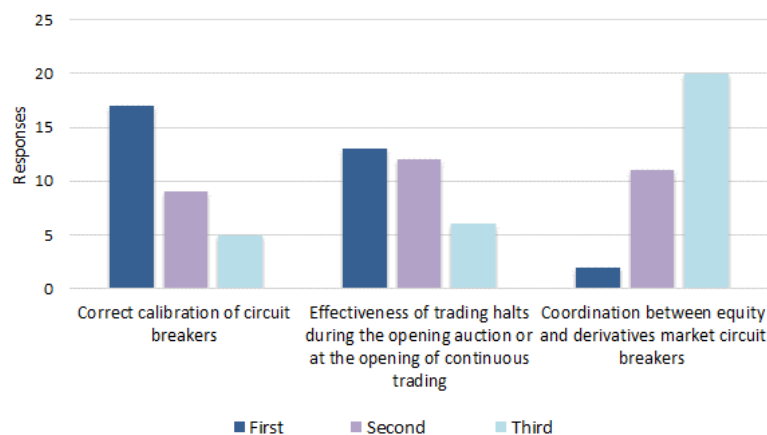
does not necessarily mean that a volatility control mechanism should be triggered for its linked instruments as the latter may be trading normally or at different volatility levels.

7. Circuit breaker performance during COVID-19

During the first wave of the COVID-19 pandemic in Europe (March 2020), when volatility peaked, many market-wide circuit breakers were triggered around the world. The majority were activated in the weeks from the 9th of March to the 19th of March, although in the APAC region, circuit breakers were still being triggered during the last week of March.

These events were exceptional. In the U.S., for example, market-wide circuit breakers had only been triggered twice after they were introduced after the 1987 crash. The fact that they are so rarely triggered means that there has been little opportunity to test their calibration or to assess their impact (contrary to single-instrument circuit breakers, which occur much more frequently). While in most cases circuit breakers operated as expected and markets resumed normally, the recent events offer an opportunity to better understand how they interact with the market dynamics and to address any concerns that may be identified. This will be the object of a separate study.

Figure 11: Ranking of topics in order of policy importance, in the light of the recent COVID-19 events



The bars show the number of responses on the ranking of the relevant policy topics in the order of their importance (First: most important - Third: least important).

In the survey, a total of 29 exchanges reported a circuit breaker was triggered as a consequence of COVID-19 events. When asked to rank three topics – effectiveness of the opening auction, calibration of circuit breakers and coordination across venues – in order of policy importance in the light of the recent COVID-19 events, 17 exchanges ranked the correct calibration of circuit breakers as the most important topic, as several respondents adjusted their circuit breaker mechanisms amid the volatile market environment during the COVID-19 pandemic. Moreover, 13 exchanges ranked the

effectiveness of trading halts during the opening auction as the second most important topic. This interest in the circuit breakers during opening auction is linked to the higher volatility and larger volumes which are frequently observed during auctions. Lastly, exchanges expressed lower interest in the coordination of circuit breakers between the equity and the derivatives markets (**Figure 11**).

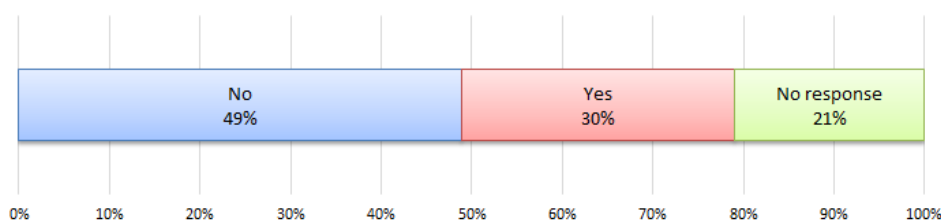
Eleven exchanges reported having recalibrated their circuit breakers during the pandemic or as a consequence of it. These changes included

- Changes to the thresholds. For example, increasing them from two levels (10% and 15%) to three (5%, 10% and 15%), or tightening them (from 10% to 5%)
- Extending the duration of the halting period (from 2 to 10 minutes, for example).
- Removing the upward limit of a circuit breaker.

In addition, four exchanges are considering changes to their circuit breakers as a result of Covid-19 events. This includes changes to the reference price (from last-day’s close to opening price) or increasing the gap percent of change between the triggering thresholds.

In summary, almost a third of respondents have recalibrated their circuit breakers or are considering making changes to them in the future as a consequence of the Covid-19 events in March (**Figure 12**).

Figure 12: Exchanges that have recalibrated their circuit breakers or are considering doing so because of COVID-19



8. Conclusions

During the period of heightened volatility faced by financial market globally at the peak of the COVID-19 pandemic in Europe, many markets worldwide triggered volatility control mechanisms that halt trading activity, commonly known as circuit breakers. These events sparked renewed debate on the topic, calling for an assessment of their effectiveness. This report aims to provide an updated picture of circuit breakers designs across different jurisdictions worldwide and to serve as a reference for researchers and practitioners alike.

There are various lessons to be learned from the WFE survey.

The first is that exchanges implement a variety of rules and mechanisms (there is no “one size fits all solution”) but broad regional trends can be found, especially in regions where a large number of exchanges fall under the same regulatory umbrella (such as the United States or Europe).

While market-wide circuit breakers (i.e., trading halts of the whole market triggered by a sharp price movement in an index) are the norm in the Americas, in Europe single-instrument volatility interruptions (i.e., a mechanism that switch from continuous trading in an individual stock to a call auction) are most prevalent. The Asia-Pacific region, where no harmonised capital market regulation is present, sees instead a variety of different mechanisms and rules.

Finally, it must be noted that exchanges also routinely implement other volatility control mechanisms that do not imply trading halts. The most common is price limits; that is, the outright rejection of orders whose price falls outside a given threshold. Price limits are often introduced in conjunction with trading halts and volatility interruptions, and work as a backstop for the latter. Several exchanges also report having mechanisms that are jurisdiction-specific and cannot be bucketed in any broader category.

Further WFE research will focus on assessing the effectiveness of circuit breakers as a volatility control mechanism, examining the recent volatility-related events triggered by the COVID-19 crisis in Europe> We will use this report as a compass to steer the direction of investigation on the topic.

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Annex I: 2020 Survey Participants

Region	Exchange	Reported circuit breakers	
		Cash equities	Equity Derivatives
Americas	Barbados Stock Exchange	x	
	B3	x	
	Bolsa de Valores de Colombia	x	x
	Bolsa de Valores de Lima	x	
	Bolsa Mexicana de Valores	x	
	Cboe	x	x
	CME*		x
	Matba Rofex		x
	Nasdaq U.S.	x	
	Panama Stock Exchange		
TMX Group	x	x	
APAC	Australian Securities Exchange		x
	Bursa Malaysia	x	x
	Colombo Stock Exchange	x	
	Hong Kong Exchanges and Clearing	x	x
	Indonesia Stock Exchange	x	
	Japan Exchange Group	x	x
	Korea Exchange	x	
	National Stock Exchange of India	x	x
	Nepal Stock Exchange	x	
	Philippine Stock Exchange	x	
	Shenzhen Stock Exchange		x
	Singapore Stock Exchange	x	x
	Stock Exchange of Thailand	x	x
	Taipei Exchange	x	
	Taiwan Futures Exchange (TAIFEX)		x
Taiwan Stock Exchange	x		
EMEA	Aquis Exchange**		
	Athens Stock Exchange	x	x
	Bolsas y Mercados Espanoles (BME)	x	
	Borsa Istanbul	x	x
	Boursa Kuwait	x	
	Bourse Regionale des Valeurs Mobilières	x	
	Deutsche Börse	x	x
	Dubai Gold & Commodities Exchange		
	Egyptian Exchange	x	
	Johannesburg Stock Exchange	x	x
	Kazakhstan Stock Exchange		
	London Stock Exchange	x	
	Saint Petersburg International Mercantile Exchange		
	Saudi Stock Exchange (Tadawul)		
	SIX Swiss Exchange	x	x
Tel-Aviv Stock Exchange	x	x	
Total	43	32	20

*The exchange did not provide complete information in the survey. Information is completed from the exchange's website.

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