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The impact of circuit breakers on market outcomes

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1. Objective

As we are all very well aware, market swings in recent times have been quite dramatic. Policymakers, practitioners, and academics are all concerned about the uncertainty reflected in prices. Price movements that are unrelated to economic fundamentals impede the ability of the market to allocate capital efficiently. Recently, ambiguity about the role of computer trading has exacerbated the alarm. While automation reduces the cost of transactions, it also makes decisions mechanically, without the benefit of human judgment. Mandated trading interruptions, or circuit breakers, have been proposed as one method of moderating extreme, unwarranted market price movements. The purpose of a circuit breaker is to calm the market, thereby building investor confidence and trust in the financial market.

This impact assessment focuses on how trading halts can be implemented and the resulting influence on market outcomes. Three forms of circuit breakers are currently in place or proposed in the United States: the market-wide circuit breaker, the single-stock circuit breaker, and the limit up-limit down trading halt, often referred to as a price limit rule. When triggered by a large movement in a stock price index, a market-wide breaker shuts down all trading. A single-stock circuit breaker is similar in concept but computes the trading threshold and imposes the interruption on an individual stock. Finally, the limit up-limit down mechanism prohibits trade in a security outside upper and lower bounds, though trade of the stock can continue within the limits. After providing some background, the following section further describes mandated trading interruptions and reviews insights offered by academic research.

2. Background

2.1. Historical perspective on circuit breaker rules

Regulators of securities markets around the world strive to promote the integrity of markets. In the U.S. the mission of the Securities and Exchange Commission (SEC) “is to protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation.” Not only do we want to provide investors with a fair playing field, but we also want efficient markets that allow firms to generate capital which, in turn, encourages growth and a healthy economy.

We think of market efficiency along two dimensions. First, a market is operationally efficient if transactions can be completed quickly, accurately, and at low cost. The securities exchanges have designed computer systems to promote operational efficiency and ensure that buyers and sellers receive the best price. Second, a market is informationally efficient if information is quickly reflected in trading prices. The Internet and media rapidly report news about firms so that securities are more likely to trade at fair value, facilitating the efficient allocation of capital.

A large number of academic studies have examined the efficiency of markets. In general, markets are thought to be operationally efficient but there are some glaring discrepancies. For example, in recent months several technical problems have been experienced at the London Stock Exchange (LSE), which have halted trading (Grant, 2011). Trading interruptions like this are frustrating to traders but, perhaps even more importantly, interfere with the price discovery process. Of even greater concern are market disruptions such as the one that occurred on May 6, 2010 in the U.S. A severe sudden drop in stock prices and subsequent recovery all within a short 20-minute time period left markets and regulators reeling. Over 300 securities traded at

prices that fell 60% or more in mere moments (Report of the Staffs of the CFTC and SEC, 2010). It seemed clear that this “flash crash” was not caused by a shift in underlying fundamentals, but rather by an extreme, temporary loss in liquidity.

Liquidity and market depth are qualities of a market that are important for the efficient processing of orders. Liquidity is the ability to sell a security with speed and ease at a fair price. A market is deep if buy and sell orders exist above and below the price at which a security is trading so that a large order will not significantly impact the price. On May 6, 2010 a mutual fund complex placed a large order to sell stock index futures contracts using an automated execution algorithm. Markets that day were already volatile due to the European debt crisis. Buy-side orders could not keep pace with the mass of selling and traders began withdrawing liquidity and market depth fell. Volatility spilled over to the equity markets where buyers and sellers could not identify trading interest. Prices as low as one cent and as high as $100,000 were observed and, just as quickly, prices reverted to normalcy.

Though a market-wide circuit breaker rule was in effect at the time, a halt was not triggered during the flash crash. The Securities and Exchange Commission (SEC) put in place a market-wide circuit breaker rule in the U.S. the year following the 1987 market crash in an effort to protect investors in the event of a future extreme market adjustment. A circuit breaker rule was advocated by the members of the Brady Commission who believed that these mechanisms “cushion the impact of market movements, which would otherwise damage market infrastructures” (Presidential Task Force on Market Mechanisms, 1988, page 66). As Table 1 indicates (see end of this section), the market-wide circuit breaker rule passed in 1987 was widened in 1997.

Recently, updates to the market-wide circuit breaker rule in the U.S. have been proposed because the breaker has been triggered only one time (October 27, 1997) when the Dow Jones Industrial Average (DJIA) fell 554 points or 7.2 percent. The current rule computes the trigger based on the DJIA whereas the proposed rule will compute thresholds using the Standard and Poor’s 500 stock index (S&P 500). The S&P 500 is a broader-based index and is the underlying basis for many widely used derivative products. In addition, the new rule will re-compute trigger points daily, rather than monthly as with the current rule. Halt times will shorten and time frames will be simplified. Halts will be triggered sooner at declines of 7%, 15%, and 20%, as compared to the current triggers of 10%, 20%, and 30%. See Table 1 for a summary of past, current, and proposed market-wide circuit breaker rules.

At the time of the flash crash, no single-stock circuit breakers were in place in the U.S. However, price limits in futures markets have been in place for some contracts for many years. For example, trading in corn futures is prohibited at prices more than $0.40 per bushel from the previous day’s closing price at the CME Group, a leading derivatives exchange in Chicago. In addition, a wide variety of circuit breaker rules have been imposed on individual stocks around the world. At the London Stock Exchange, for example, automated trading halts are triggered when prices fall or rise a specified percentage. The defined percentages range from 5% to 25% depending on the liquidity of the particular stock.

Table 1. History of market-wide circuit breakers in U.S. equities

First circuit breaker implemented in October 1988: The original circuit breakers were triggered when the DJIA fell a given number of points	
250 point drop	Trading halt for one hour
400 point drop	Trading halt for two hours if additional 150 point drop after trading resumes
Circuit breakers widened in January 1997	
350 point drop	Trading halt for 30 minutes
550 point drop	Trading halt for one hour if additional 200 point drop after trading resumes
Current circuit breaker rule adopted in April 1998: Trigger levels are fixed quarterly based on the average closing level of the DJIA the previous month	
10% drop	Halt trading for one hour if before 2:00 p.m. Halt trading for 30 minutes if between 2:00 and 2:30 p.m. No halt in trading if after 2:30 p.m.
20% drop	Halt trading for 2 hours if before 1:00 p.m. Halt trading for 1 hour if between 1:00 and 2:00 p.m. Close the market for the day if after 2:00 p.m.
30% drop	Close the market for the day
Circuit breaker rule proposed in September 2011: Trigger levels are recalculated daily based on the S&P 500	
7% drop	Halt trading for 15 minutes between 9:30–3:25 Trading halted only once a day based on this trigger level No halt in trading if after 3:25 p.m.
13% drop	Halt trading for 15 minutes between 9:30–3:25 Trading halted only once a day based on this trigger level No halt in trading if after 3:25 p.m.
20% drop	Close the market for the day

2.2. Theoretical evidence

Opponents of a circuit-breaker rule contend that mandated trading halts interrupt the natural movement of security prices and introduce unnecessary and artificial barriers. The theoretical evidence on the efficacy of market-wide circuit breakers in equity markets is limited. In Subrahmanyam's (1994, 1995) theoretical models circuit breakers can be detrimental. He argues that circuit breakers may have the perverse effect of increasing price variability by forcing agents to advance their trades before trading is halted, a so-called "magnet effect." Furthermore, with two markets, volatility increases and liquidity decreases when a circuit breaker is triggered in the more liquid market. Subrahmanyam (1997) also suggests that informed traders may reduce their trading in anticipation of a trading halt resulting in higher trading costs for small investors.

Other theoretical evidence suggests that circuit breakers can be beneficial. A circuit break rule may temper unwarranted price increases as it provides a "cooling off period." For example, in Greenwald and Stein (1991), mandated halts can play a useful role in reducing transactions risk, the risk that arises due to uncertainty about execution price. When a very large volume shock hits a market, transactional risk rises sharply. When current prices fail to accurately represent information, a circuit breaker may encourage buyers and sellers to submit orders. While Greenwald and Stein model behavior for a single stock their findings are suggestive of outcomes for a market-wide circuit breaker. As they note, "(t)he basic purpose of any circuit breaker should be to reduce transactional risk in an effort to stimulate value-buyer responsiveness" (1991, page 458).

Other theoretical models of circuit breakers also indicate there are benefits and costs to a price limit rule. A price limit may prevent extreme price changes due to speculation, give traders time to acquire and assimilate information in a fast-moving market, and, particularly in futures markets where margin requirements can be considerable, reduce the daily potential loss. In their model, Kodres and O'Brien (1994) find that price limits promote the sharing of risk in markets when price shocks arrive before traders can execute desired trades. An additional potential benefit is proposed by Westerhoff (2003) who argues that if investors are prone to chase trends, price limits can reduce price deviations from fundamental values. However, Kim and Sweeney (2002) conclude that price limits can slow the dissemination of information and hinder market efficiency. Another recent model suggests that price limits lower information quality but also lower the bid-ask spread, thus improving liquidity (Anshuman and Subrahmanyam, 1999). Thus, as Anshuman and Subrahmanyam's model suggests, the theoretical literature indicates that judgment is required in considering the appropriateness of any trading halt rule as the costs and benefits in each particular market conditions must be weighed.

2.3. Archival empirical evidence

As with the theoretical literature, the empirical literature relating to market-wide circuit breakers is limited, probably by the fact that the breaker has only been triggered once in the U.S. In addition, archival studies of the effects of circuit breakers face numerous empirical challenges because security prices and associated volatility change for many reasons, including macroeconomic factors and investor sentiment. Though the current market-wide circuit breaker rule has been activated only once, research suggests that extreme market movements are not unlikely (Bakshi and Madan, 1999; Booth and Broussard, 1998).

Despite the challenges, some empirical research has provided insight. Lauterbach and Ben-Zion (1993) examine the experience of the Tel-Aviv Stock Exchange during the 1987 market

break. Trading halts seemed to smooth the price adjustment but did not stop an overall decline in the market. In addition, Lauterbach and Ben-Zion concluded that the trading halt may have helped minimize order imbalances. In contrast, Santoni and Liu (1993) conclude that a market-wide trading halt fails to moderate volatility. Focusing on the 1997 market crash, Goldstein and Kavajecz (2004) examine trading behavior and conclude that the cost of supplying liquidity became so high that market participants opted for floor trading, thus withdrawing depth from the order book. Goldstein and Kavajecz caution that markets with electronic order books are open to extreme losses of liquidity in periods with high volatility. In 1997 traders attempted to advance transactions in anticipation of the trading halt and during the halt, they curbed order placement. Importantly, Goldstein and Kavajecz conclude that the uncertainty associated with a closed market exceeds the uncertainty that accompanies an open market in times of decline.

Related empirical research examines whether other forms of trading restrictions (e.g., firm-specific trading halts and price limits) affect price volatility and market efficiencies. Firm-specific trading halts may be called due to order imbalances or significant news releases, whereas price limits, commonly used in futures markets, restrict trading outside upper and lower price bands. Again the results are not definitive. Some argue that trading restrictions reduce volatility (Ma, Rao, and Sears, 1989a;1989b), others conclude that volatility increases (Lee, Ready, Seguin (1994)), and still others find little long run effect on market outcomes (Overdahl and McMillan, 1998).

A number of researchers have looked internationally to provide insight into the effects of trading interruptions. The evidence on how individual stock and futures price limits impact market efficiency is mixed. Some international research suggests that price limits fail to moderate, or even increase, volatility, For example, Kim (2001) investigates the stock price experience in Thailand and reports that more restrictive price limits fail to moderate volatility. In a study of initial public offerings in Taiwan, Yang (2003) finds that a price limit rule leads to higher volatility on days subsequent to a limit hit. Henke and Voronkov (2005) also report that interruptions triggered by price limits lead to excess volatility on subsequent trading days. Henke and Voronkova's study is particularly interesting because they study the Warsaw Stock Exchange which is organized as a call market. Because the call institution gives investors time to reflect, a trading interruption does not serve the purpose of allowing a cooling off period. Others report that limits fail to moderate volatility in agricultural and stock-index futures markets (Martens and Steenbeek, 2001; Veld-Merkoulova, 2003)

The weight of the evidence suggests that price limits fail to contain volatility and some researchers also conclude that price limits impede price discovery. While Yang (2003) does not find evidence of delayed price discovery in Taiwan, Chan, Kim, and Rhee (2005) report that price limits impose significant costs in terms of price informativeness using stock data from Kuala Lumpur. Consistent with Chan, Kim, and Rhee (2005), Yoon (1994) presents empirical evidence that prices "overshoot" fundamental values in the presence of a circuit breaker rule using data for Korean stocks.

Other researchers examine whether price limits act as magnets, drawing price away from fundamental value, as hypothesized by Subrahmanyam (1994, 1995), For treasury bond futures, Arak and Cook (1997) conclude that the price limit is not a magnet, but rather has a calming effect in the market. Abad and Pascual (2007) and Berkman and Steenbeek (1998) find no magnet effect for stocks traded on the Spanish Stock Exchange or Nikkei futures traded on the Osaka Securities Exchange and the Singapore International Monetary Exchange,

respectively. However, some recent evidence reported by Hsieh, Kim, and Yang (2009) and Tooma (2011) supports a gravitational effect in price limits for Taiwan and Egypt, respectively.

Still other studies have compared outcomes under alternative rules. For example, Kim, Yague, and Yang (2008) compare the performance of trading halts and price limits on the Spanish Stock Exchange. They report that liquidity increases after halts but falls when a price limit is triggered. In contrast, Coursey and Dyl (1990) argue that price adjustment is more efficient when trading is unconstrained and, further, trading suspensions lead to greater losses than interruptions triggered by price limits.

Unfortunately, the archival literature does not paint a clear picture of the role of trading halts in markets (Harris, 1998; Kim and Yang, 2004). This ambiguity may arise from the various types of mechanisms, differences in rule specifications across international markets, diversity in theoretical assumptions and empirical measures, and difficulty in control for confounding events in empirical studies. While the evidence, though not without exception, indicates that circuit breakers impede price discovery and fail to moderate volatility, the theoretical literature suggests that benefits may arise. Though volatility may be empirically associated with a trading interruption, the halt may reduce transactional risk and provide a cooling off period.

2.4. Experimental evidence

An experimental method can provide insight because it allows us to examine behavior under alternative market structures (e.g., in the presence and absence of circuit breakers), an examination that cannot be conducted with naturally occurring markets. Research by Isaac and Plott (1981) and Smith and Williams (1981) indicates that price controls impact the bidding behavior of buyers and sellers. More recent research by Ackert, Church, and Jayaraman (2001) focuses specifically on market-wide circuit breakers. In their experiment, they compare behavior in markets with asymmetric information across three regulatory regimes: market closure, temporary halt, and no interruption. With market closure, no transactions were permitted for the remainder of a trading period when the circuit breaker was triggered, whereas with temporary halts, market activity was interrupted and trading resumed after a rest period. Finally, with no interruptions, traders transacted at any price during the trading period.

The results reported by Ackert, Church, and Jayaraman suggest that deviations from the expected price are not affected by the presence of circuit breakers. What drives price deviations from fundamental value is information in the market. Analysis of trading behavior suggested that when a trading interruption was imminent, trading activity accelerated, consistent with Subrahmanyam's magnet effect. Ackert, Church, and Jayaraman conclude that although a circuit breaker rule has the unintended consequence of accelerating trade, the price discovery process is not impeded. Because trading may be interrupted, market participants rationally attempt to effect trades before a breaker is triggered. While no real downside risk to a circuit breaker rule is suggested, the benefit is also not apparent. When there is private information in the market, a circuit breaker is *never* triggered when it should not be. Thus a circuit breaker rule does not prevent unwarranted price movements but may (temporarily) prevent price from moving toward fundamental value.

In a second experimental study of market-wide circuit break rules, Ackert, Church, and Jayaraman (2005) examined whether market-wide trading halts play a useful role in moderating unwarranted price movements in periods *without* private information. In the absence of private information all trade is uninformative but some traders may erroneously infer otherwise. If some mistakenly believe that there is private information in the market, they

may mimic others' trading behavior causing prices to move away from fundamental value. In an uncertain environment it is not surprising that people might follow the decisions of others.

Theoretical models consider behavior when decisions are made sequentially and decision makers infer information from previous behavior (Bikhchandani and Sharma, 2000). An individual's expectation may not be consistent with private information (Ackert, Church, Ely, 2008). Importantly, individuals may rationally follow others' decisions, even though previous decisions are not necessarily based on superior private information. For example, it is optimal for a decision maker to ignore private information and follow the behavior of others in an information cascade in which predictions follow those announced earlier in time (Bikhchandani, Hirshleifer, and Welch, 1992; Welch, 1992). Although ignoring private information can be rational, inefficient outcomes can also result (Avery and Zemsky, 1998; Banerjee, 1992). Notably, when decisions are based on incorrect private information, subsequent decisions may be sub-optimal.

Camerer and Weigelt (1991) provide evidence of mimicking behavior which they refer to as "information mirages." Their experimental data suggests that in some instances individuals overreact to uninformative trades. In addition to the price-path dependence reported by Camerer and Weigelt, Anderson and Holt (1997) conducted experiments in which subjects made sequential, public predictions and report evidence of cascades. With an information mirage or cascade, a circuit breaker rule could have the beneficial effect of mitigating unwarranted price movements. If no traders are informed, asset prices should not deviate from an uninformed expectation. As in naturally occurring markets, uninformed traders do not know whether others' actions reflect informed or uninformed trade, and they may incorrectly conjecture that price signals are informative. If traders mistakenly believe that others' trading behavior reflects private information, circuit breakers may moderate price deviations from fundamental value. In this case, circuit breakers protect against large, non-information-based price movements because the trading halt provides time for traders to evaluate information.

Ackert, Church, and Jayaraman's second experiment included two circuit breaker rules: market closure and temporary halt. While the temporary halt could provide for a cooling-off period it could, alternatively, exacerbate price deviations. A temporary halt could give traders time for introspection, time in which they dwell on irrelevant or unimportant information which, in turn, reinforces beliefs that others possess private information (e.g., Tordesillas and Chaiken, 1999). The results of this study suggest that circuit breakers fail to temper unwarranted price movements. In fact, breakers that trigger a temporary halt appeared to have a detrimental effect. The data suggested that with a temporary halt, price moves away from fundamental value in periods without private information. Unlike their earlier experimental examination of circuit breakers, here there was no evidence that trade was accelerated in anticipation of a trading halt. With uncertainty about private information, a circuit breaker rule seemed to play no useful role in the experimental asset markets. Note that while a circuit breaker rule provided a cooling off period, in this design there was no opportunity for buyers and sellers to submit bids. Thus, price discovery and recovery of liquidity were limited during trading interruptions.

Taken together the theoretical, archival, and experimental research on circuit breaker rules seem to lead to more questions about the efficacy of the rules, and the implied course of action seems murky. The theoretical and empirical models are based critically on assumptions about the behavior of market participants and the structure of the market. Thus, a great deal of judgment is required when basing a decision on this literature. In the following sections, the

costs and benefits of each approach, as indicated by the literature, are discussed and policy recommendations are presented.

3. Risk assessment

3.1. Market-wide circuit breaker

Proponents contend that trading halts moderate unwarranted price movements. Others, however, suggest that circuit breakers may actually produce a magnet effect, whereby prices move even farther from underlying fundamentals. Though a market-wide circuit breaker has been in place in the U.S. since 1988, little consensus has been reached in the literature on whether this rule is beneficial. What risks do security markets face without a market-wide circuit breaker in place?

The landscape has changed dramatically since the circuit breaker rule was adopted in 1987. During the market break in 1987 600 *million* NYSE shares were processed. On May 6, 2010, over 10.3 *billion* NYSE shares were processed, and that total is only for the NYSE (Schapiro, 2010). The current market-wide circuit breaker was not triggered during the flash crash. As in the market break in October 1997, the cost of supplying liquidity became high so that traders stopped supplying liquidity (Goldstein and Kavajecz, 2004). It appears that the market-wide circuit breaker is not providing the protection to market participants that we might hope for.

In considering the risks it is important to understand the potential sources of volatility. A key goal is to prevent unwarranted price changes. Security valuations sometimes seem to be completely at odds with any realistic expectation. This is nothing new as history is replete with examples. Consider the Dutch tulip mania in the 1600s during which bulbs traded at extremely high prices, with the market eventually crashing. More goods than one household would typically own and acres of land were traded for single tulip bulbs (Mackay, 1841). Clearly rampant speculation played a role in the rise of this speculative bubble as gambling took hold. The dot.com bubble that led to a market adjustment in 2000 is potentially another example of a speculative bubble. As early as 1996 Federal Reserve Chairman Alan Greenspan cautioned that “irrational exuberance” had taken hold in markets. Behavioral finance expert Robert Shiller argues that the recent experience in the housing market also suggested a bubble in housing prices (Shiller, 2000). Notice that in all these cases, prices had been rising for quite some time, possibly away from the levels warranted by economic fundamentals, but the downward price adjustment was typically swift. If the adjustment is a correction for mispricing and the volatility created moves prices toward better valuations, perhaps this volatility is not so bad for the economy. A market-wide circuit-breaker rule can do nothing to prevent the long price-run up, which is the real cause for concern.

One problem is that there is not necessarily consensus on whether the level of the market is appropriate at any given time. Investor sentiment can have a pervasive impact in a market (Barberis, Shleifer, and Vishny, 1998). In some cases, a price adjustment may not move price toward true valuations if trades are based on misinformation. It is sometimes argued in a frothy market that rational traders may realize they are paying too much for an asset, but if someone else will pay even more, the transaction is warranted. But, do these traders know when to get out? History and academic studies show us over and over again that people are just not very good at predicting a downturn (Ackert, Charupat, Church, and Deaves, 2006). Furthermore, in extreme situations, the ability of smart traders to take advantage of mispricing is limited because prices could move even farther from fundamental values (Shleifer and Vishny, 1997; De Long, Shliefer, Summers, and Waldman, 1990). Market crashes can follow from differences

in investor opinion. In Hong and Stein's (2003) model we observe large price corrections without significant fundamental information. In their model short sales constraints keep bearish investors out of the market so that prices fail to reflect their private information. If the market declines, the bearish investors become the marginal traders.

As Shiller (2000, page 225) notes, a relatively short market closing (e.g., one hour) may not have much impact on a large price adjustment. Though the rest gives traders time to cool off, we really have little evidence on how traders react. In 1997, the only time the market-wide breaker was triggered, we saw the market correct after the crash. We don't know if the market would have corrected without the trading interruption. Shiller contemplates whether a price correction with no interference from regulators would have actually bred more investor confidence in the functioning of markets, as compared to a correction following a mandated trading halt.

We do know that dramatic changes are usually attention-grabbing. Media coverage attracts investors (Barber and Odean, 2008) who tend to overreact to unexpected news (De Bondt and Thaler, 1985). As discussed previously, traders may herd or follow the behavior of others. This mimicry can be rational or irrational and could result from news or misinformation. Investor sentiment can have a lasting effect on market valuations, which is problematic if the sentiment is based on misinformation.

The primary risk we face without a market-wide circuit breaker in place is the risk of a significant market adjustment that is unwarranted based on economic fundamentals. If investors overreact and the downturn is prolonged, firms may suffer from an inability to raise needed capital. However, if a price adjustment is a correction, a trading halt likely postpones the inevitable.

3.2. Single-stock halt mechanisms

There are two types of halt mechanisms for individual stocks currently in place or proposed: the single-stock circuit breaker and the limit up-limit down trading halt. The single-stock halt mechanisms target liquidity lapses in individual stocks. The primary difference between the two tools is that trading can continue between the price bands for the limit up-limit down mechanism, whereas trading stops with the circuit breaker.

As discussed previously, the academic evidence on the efficacy of circuit breakers and price limits is inconclusive. Of course investor sentiment can have a marked impact on pricing for an individual security, just as with the overall market. If trades are based on misinformation, prices will diverge from fundamental value. In addition, there is a risk of contagion across securities and markets if investors follow the decisions of the misinformed.

In addition to liquidity lapses in individual stocks, a data entry error could have a strong, even if short-lived, impact on a market. News reports in the wake of the May 6, 2010 break often speculated whether a data entry error was the source of the rapid decline in security prices, but no such error came to light. But, some anecdotal evidence suggests that a trading halt can be effective in such circumstances. For example, in London on August 24, 2010 the prices of five stocks took sudden dives (Jeffs, 2010). The LSE trading halt rule was triggered because price limits were breached and trading was suspended for five minutes. In an "automatic execution suspension period" a trading suspension is called and the market re-opens after an auction. When trading resumed on August 24, prices returned to normal levels. Speculation on the cause of the crash was a "fat finger" trade or data entry error.

In the investigation called into the events of May 6, 2010, the role of algorithmic trading was examined. In their report the joint staffs of the Commodity Futures Trading Commission (CFTC) and SEC concluded that automated execution algorithms can deplete liquidity and lead to extreme market movements (September 30, 2010). Furthermore, as demonstrated by the market pause that day on the index futures markets at the Chicago Mercantile Exchange (CME), a trading halt can encourage orderly markets. A large sell order at the CME is thought to have started the entire event but after a trading pause was triggered, the futures market settled down. No such mechanism existed in the equity markets which continued to decline. The conclusion was that the pause gave traders time to reevaluate their strategies and reset parameters in their algorithms.

Some argue that high speed trading actually reduces volatility (Bunge, 2011), and there is support for this argument in the academic literature. Hendershott, Jones, and Menkveld (2011) conclude that algorithmic trading has enhanced the liquidity of markets and increased the informativeness of price quotes, particularly for large capitalization stocks. Algorithmic trading takes many forms and may account for as much as 73% of U.S. trading volume. The increase in algorithmic trading has posed challenges for exchanges whose infrastructures must be upgraded and for regulators who monitor the markets. In testimony to the U.S. Congress, SEC Chairman Mary L. Schapiro notes that “(o)ne of the challenges that we face in recreating the events of May 6 is the reality that the technologies used for market oversight and surveillance have not kept pace with the technology and trading patterns of the rapidly evolving and expanding securities markets” (Schapiro, 2010). While Hendershott, Jones, and Menkveld’s evidence provides support for the view that algorithmic trading enhances markets, more investigation is warranted. This study focuses on a period with generally rising stock prices and the situation could change drastically in a downturn as on May 6, 2010. We have seen that there are extreme liquidity losses in periods of market stress. Depending on the parameters, algorithmic programs may cause additional order imbalances.

The primary risk we face without single-stock halt mechanism is the risk of a significant price adjustment that is unwarranted based on economic fundamentals. An unwarranted adjustment could be caused by (1) misinformation and herding behavior, (2) a computer error, or (3) high-speed trading algorithms. As with a market-wide adjustment, if a price change is a correction, a trading halt simply postpones the inevitable.

4. Options

As mentioned previously, three forms of circuit breakers are currently in place or proposed in the United States: the market-wide circuit breaker, the single-stock circuit breaker, and the limit up-limit down trading halt. The current rule in place is a market-wide circuit breaker that shuts down all trading when triggered by a large movement in a stock price index. Because the breaker has been triggered only once in 1997, modifications of the market-wide rule are being considered. The current rule computes the triggers monthly based on the DJIA whereas the proposed rule will compute thresholds daily based on the S&P 500. Halts will be triggered sooner at declines of 7%, 15%, and 20%, as compared to the current triggers of 10%, 20%, and 30%.

In addition to updates to the market-wide rule, U.S. regulators added single-stock circuit breakers on June 10, 2010 in response to the flash crash. A single-stock circuit breaker is similar in concept to the market-wide halt but computes the trading threshold and imposes the interruption on an individual stock. If a stock is traded at a price 10% higher or lower than the

price five minutes prior, trading is halted for a five-minute “pause.” The 10% price band is wider for small capitalization and penny stocks. When a pause is called for on a listing market, other markets are notified and all trading in the security is halted. Orders placed before a pause is called remain on the book but can be cancelled, if so desired.

On April 5, 2011 several exchanges and the Financial Industry Regulatory Authority (FINRA), an independent securities regulator in the U.S., proposed an up-limit down mechanism to replace the single-stock circuit breaker. With the proposal, trading outside upper and lower bounds is prevented, though trade in the stock can continue within the limits. Lower and upper price bands are reported to the public throughout the trading day. If bids and offers are outside of the limit band the security enters a “limit state” during which the exchange would disseminate the best bid or offer with a flag that indicates it is a limit state quotation, and thus not executable. The limit state holds for 15 seconds. If there are no trades within the limits in the 15-second limit state, the security enters a five-minute trading pause.

5. Costs, risks and benefits

5.1. Market-wide circuit breaker

It is important to remember that the intent of the market-wide circuit breaker rule was *not* to prevent price changes that are due to fundamental information. According to the SEC “the market-wide circuit breakers were not intended to prevent markets from adjusting to new price levels; rather, they provide for a speed bump for extremely rapid market declines” (SEC Release No. 34–65427, page 4).

A circuit breaker that is triggered imposes costs on the economy because trade stops. The primary cost of a market-wide trading interruption is the loss of price discovery when markets are closed. Traders may suffer as they cannot complete desired transactions. In the U.S. a halt has been initiated only one time since 1987. An observer might wonder why the thresholds are set so widely that trading is so rarely halted. The width of the thresholds reflects the large cost if markets are closed unnecessarily. If the market correction follows frothy pricing, we do not want to impede the process. If, however, the market is overreacting due to herd-type reaction to misinformation, allowing a break so that market participants can reevaluate the landscape is prudent. In either case, an interruption gives the exchange and market participants time to catch up after a large volume shock.

A loss of liquidity is a serious problem associated with market adjustments as orders tend to be one-sided. Note that a market-wide circuit breaker rule can help address liquidity problems arising in individual stocks if buyers and sellers are encouraged to submit prices. Efforts by exchanges to ensure the flow of information to traders during a trading interruption will enhance the market’s ability to recover.

If a market-wide breaker is not properly designed there is the risk that other markets are impacted detrimentally. Coordination across markets is critical. With a stock circuit breaker, derivatives traders need to be aware of how cross-market restrictions affect their positions. In the U.S., trading in derivatives is also halted when the equity market is closed. Furthermore, stocks can trade at multiple exchanges and on alternative platforms, with some orders being internalized or traded away from an exchange. Regulations need to be simple and easy to implement in these cases so that market participants fully understand the implications.

5.2. Single-stock circuit breaker and limit up-limit down mechanism

The purpose of a single-stock trading halt is to alleviate temporary liquidity lapses. While we do not have concrete evidence that the limit up-limit down mechanism effectively promotes liquidity, the tool has desirable properties. It is critical that traders quickly understand the situation when a strong price move is observed and leaving the market open facilitates the flow of information. A data entry error will not close the market and participants will see that the market is not compromised as they can continue to transact within the price bands.

One concern related to a limit up-limit down rule might be that implementation is difficult with all the interconnections across equity and derivatives markets. The preliminary evidence we have suggests that a limit up-limit down mechanism is operational. Comments from the profession are generally supportive (www.sec.gov.comments/4–631.shtml; Mathisson, 2010). Furthermore, similar mechanisms have been useful during downturns in futures markets and in international equity markets, including at the LSE.

6. Future

The technological aspects of trading pose a great challenge going forward. Monitoring must keep pace with technology. Those in private pursuit of profit clearly have the advantage here over those striving to ensure the public interest. When human judgment is replaced by an algorithm, unexpected outcomes can result, such as the events of May 6, 2010.

Some efforts are being made to develop technologies to use high speed computing to develop indicators of market stress (Bethel, Leinweber, Rubel, and Wu, 2011). In theory these indicators will be useful to regulators who hope for early signs of market stress. It is too early to comment on whether these efforts will be fruitful.

7. Summary and recommendation

Theoretical and empirical research have examined the role of a trading halt rule in markets but no consensus has developed. The goal of mandated trading interruptions is to moderate unwarranted volatility and shore up lapses in liquidity. Costs include the inability to complete trades and interruption of the price discovery process. Benefits include time for market participants to cool off and, depending on the design of the rule, submit offers to promote the flow of information.

History has shown us that price movements do not always reflect changes in economic fundamentals. The recent financial crisis and attention-grabbing events like those on May 6, 2010 shake investors' faith in financial markets. A widely set circuit breaker rule, accompanied by clear information regarding how the rule is triggered and a mechanism to promote the dissemination of price information during a trading interruption, will bolster confidence in the market.

While the single-stock circuit breaker also has the potential to promote liquidity, the limit up-limit down mechanism appears superior because it does not interrupt trading unnecessarily when there is no sharp change in fundamentals. Traders can continue to transact at prices within the price limits bands even if an extreme price is observed. For example, if incorrect order data is recorded, or a high speed algorithmic program initiates trade, the price bands will put the brakes on erroneous trades and short-term liquidity gaps. If traders become unduly

pessimistic, fundamental traders will not be so quick to leave the market as they have more information about price execution.

A world with no impediments to trade is optimal if all traders are rational, do not make errors, and are able to develop algorithms that incorporate all possible contingencies. Since we do not live in such a world, safeguards like a market circuit breaker rule with wide thresholds and a limit up-limit down mechanism are prudent.

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