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Stock market circuit breakers

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1. Objective

Rapidly falling prices may exacerbate panic amongst investors and cause price-contingent orders to become unfairly stale. Large price swings may create execution uncertainty, which may cause investors to simply refrain from trading. Circuit breakers that allow a cool-down period and a batching of trades can mitigate this problem. Further, that extreme order imbalances during rapid market movements might create disruption, so that closing the market briefly, letting orders accumulate and then batching them upon the re-opening may lead to better quality execution prices and thus lower volatility.

2. Background

Exchanges across the world use a number of impediments to trade. These include price-triggered circuit breakers, discretionary trading halts, and price limits. Circuit breakers are usually triggered when prices cross certain pre-established boundaries and cause markets to halt trading for a pre-determined period of time. Discretionary trading halts are tools used by exchange officials to shut down trading whenever there is a significant trade imbalance or an important news announcement is imminent. Price limits preclude trade at prices outside of established boundaries, though trade within those boundaries may continue to take place. Price-triggered breakers and trading halts are mostly used in equity markets, whereas price limits are commonly found on derivatives markets. While price limits and discretionary trading halts have been in existence for decades, circuit breakers are a comparatively new policy tool. In this paper, I focus on price-triggered halts, with allusion from time to time to other impediments as well.

It may be argued that circuit breakers came into prominent focus after the market crash on October 19, 1987, when the US market dropped by more than 20%. After that event, the Brady Report (1988) suggested that rapidly falling prices may exacerbate panic amongst investors and cause limit orders to become unfairly stale. It was also suggested that large price swings may create execution uncertainty, which may cause investors to simply refrain from trading. Circuit breakers that allow a cool-down period and a batching of trades can mitigate this problem. Thus, one rationale for circuit breakers was to allow market-clearing participants to get some breathing room and calm them in moments of panic. Furthermore, a second reason for breakers is that extreme order imbalances during rapid market movements might create disruption and letting orders accumulate and then batching them may lead to better quality execution prices and thus lower volatility.

The NYSE first implemented market-wide circuit breakers in October 1988. The trigger point was set at 250 points. Currently, the levels are as follows. The halt for a 10% decline in DJIA is one hour if it occurs before 2 p.m., for 30 minutes between 2 and 2:30, but no halts after 2:30. The halt for a 20% decline is two hours if before 1 p.m., and one hour between 1 p.m. and 2 p.m., and market closure for the rest of the day after 2 p.m. If the market declines by 30%, trading does not occur for the remainder of the day.

We will now review the theory and evidence on the efficacy and impact of circuit breakers. Importantly, circuit breakers may affect prices even if they are not triggered. However, since they are triggered so rarely, at the present moment, it challenging to test for their efficacy with any degree of reliability.

A first issue is that the existence of a circuit breaker may affect decisions of investors prior to the triggering of the breaker. Subrahmanyam (1994) demonstrates the “magnet effect.” Thus, as the price nears the limit, investors anxious about being denied the opportunity to trade will advance their trades in time, thus increasing price volatility. Also, if the breaker is triggered based on moves in one market, investors will simply move their trades to substitute markets and transfer volatility to those markets.

Financial markets are populated by both informed and uninformed investors. Informed investors play a valuable role in markets by allowing prices to accurately reflect information about cash flows that, in turn, allows other investors to make sounder investment decisions. For example, if adverse information is reflected in prices by way of informed selling, this may signal uninformed investors to desist from investing heavily in a stock, which is optimal. However, the flip side of informed trading is that it makes markets less liquid as market makers, concerned about losing money to informed traders, widen the bid-ask spread. Informed investors, faced with perishable information, might be tempted to submit a large one-time order to lock in prices. In the presence of a circuit breaker, Subrahmanyam (1997) argues that they might be concerned that their large trades might trigger the breaker. In this case, they would simply reduce their order sizes which would increase the bid-ask spread for small orders. This might end up harming retail investors, who typically submit smaller orders than large institutions.

In contrast to the previous work that illustrates potential costs of circuit breakers, the models of Greenwald and Stein (1991) and Kodres and O’Brien (1994) address possible benefits of circuit breakers. These authors argue that when noise trades move prices, informed traders become concerned about execution price uncertainty and tend to withdraw. Circuit breakers improve market performance and pricing efficiency by allowing the batching of orders and improving liquidity. A breaker may also decrease volatility because it allows for more time for traders to react. Thus, in falling markets traders may get hit with margin calls. Without a halt traders may be caught by surprise and may not be able to satisfy their margin calls. This, in turn, may cause brokers to suspect an impending default and trade to prevent losses by way of orders that limit losses. Since such orders automatically trigger selling when prices reach a certain exogenous bound, they may lead to an even more one-sided market during periods where prices are falling. A halt that allows for a breather and matches orders after resumption of trade may allow for more time for margin calls to be fulfilled. This may allow for restored broker confidence, reduced stop-loss selling, and thus restoration of a two-sided market. This may lead to greater liquidity and reduced volatility.

With regard to whether reducing volatility should be a policy goal at all, Fama (1989) points out the obvious that rational pricing does not imply lower volatility, so that pricing processes with lower volatility are not necessarily superior to pricing processes with higher volatility. That is, as long as price volatility emanates from rational shifts in beliefs about fundamental values, high volatility per se is not undesirable for the economy. Price limits are avowedly imposed to reduce “excessive” volatility, but Fama (1989) points out the difficulty of ascertaining what is “excessive.” Indeed, Fama (1989) asserts that price limits may serve no purpose other than to delay the discovery of the true price. Even though price limits can stop large rises or drops on a given day, on subsequent days, the price will inevitably converge to true values, albeit more slowly.

There is very limited evidence on the efficacy of circuit breakers. Goldstein and Kavajecz

(2004) consider an episode on October 27, 1997, when circuit breakers were triggered. They find that circuit breakers cause a paucity of liquidity on the day following the circuit breaker, because limit order traders are loath to resubmit previous days' expired orders. This causes a lack of depth in the limit order book. The phenomenon is particularly prevalent in firms with high trading activity. This evidence is at odds with the notion that circuit breakers calm down markets and increase market liquidity. Likely this happens because market participants are still recovering on the next day from a complete inability to trade, which is a psychologically significant event.

Since circuit breakers are rarely triggered, experimental studies are one way to investigate likely impacts of these impediments to trade. Ackert, Church, and Jayaraman (2001) conduct such an experiment to focus on the effects of NYSE-type market-wide breakers. They find that circuit breakers cause agents to speed up their trading activity as the price approaches a trigger, supporting a magnet effect. It also is likely that an impending circuit breaker in one market might cause volume to migrate away to another market, an issue that has not yet been tested in an experimental setting. More studies are needed on the magnet effect as well as the effect of breakers on satellite markets.

Kuhn, Kuserk, and Locke (1991) consider price formation in cash and futures markets on October 13, 1989, when circuit breakers were triggered. They are not able to find evidence that circuit breakers reduced volatility in cash or stock index futures markets on the day after the triggering of the breaker. Lauterbach and Ben-Zion (1993) consider order flow data from the Tel-Aviv Exchange during the crash of 1987, when the exchange imposed a closure due to extreme order imbalance. With respect to circuit breakers, they find that the closure smoothes price fluctuations around the crash but has no long-run impact on the price drop. The evidence supports the notion that long-run price behavior would be unaltered with or without the presence of the breaker.

Only one study of which I am aware has attempted to determine how coordinated circuit breakers adopted by the NYSE, CME, and other derivatives exchanges affect day-to-day volatility. Santoni and Liu (1993) test for changes in volatility following the adoption of circuit breakers using an ARCH model. Using data from the inception of the breakers through 1991, they find no significant effects on volatility. Thus, they conclude that the imposition of circuit breakers has had no discernible impact on volatility.

As pointed out earlier, an alternative impediment to trade is the discretionary trading halt mechanism in place on the NYSE. This particular mechanism involves the halting of trade whenever a significant announcement is pending, or there is an extreme order imbalance. While this halt is not equivalent to a breaker triggered solely by a price move, it is still an impediment to trade, so that the evidence on its efficacy is pertinent. The rationale behind such a halt is to reduce losses of uninformed traders to privately informed insiders. The July 1999 issue of the *Exchange* magazine published by NYSE supports rules requiring disclosure of impending informational events. To quote (p. 3): "Regulatory halts are designed to alleviate the instantaneous volatility that occurs when significant news is released, to give investors a chance to interpret the news and make informed investment decisions, and to price the stock in a calm environment. If a drilling company comes out with a technical release, such as an announcement that it has discovered 300,000 barrels of oil per day out of a 3/4-inch choke, many individual investors and brokers might not know what it means to the firm. A company contacting the Exchange before releasing the news would let us know the impact is big. We would then recommend a trading halt, research analysts would interpret that news and release their recommendations, and brokers would get on the phone with their clients."

Similarly, Christie, Corwin, and Schultz, (1999, p. 7) state that news-pending trading suspensions on Nasdaq are not uncommon and are governed by the following disclosure policy: "Traditionally, companies are required to provide [Nasdaq's] StockWatch with a press release no later than 15 minutes prior to the public disclosure of information contained in the release. Analysts at Nasdaq evaluate the information and determine whether the news would materially affect stock prices. In the event the news is deemed material, StockWatch notifies the news wires and all markets where the Nasdaq issue and its derivative securities are traded. The issuing company must also be notified of the impending halt before it could be implemented."

Note that the reasoning also applies to marketwide disclosures about informational events. For example, the Federal Reserve usually times important announcements to coincide with the end of the week (see, for example, Ederington and Lee, 1993). This strategy may cause investors to trade on leaked information towards the week's end, and potentially lead to decreased liquidity. By the same logic as for firm-specific halts, it may be argued that the Fed could report to the exchange whenever a sufficiently important announcement was imminent, whereupon the exchange could decide whether to halt trade. That such halts have not been proposed is intriguing, but may be because in these cases of market-wide informational events, existing market-index based price-triggered halts would be quite effective.

There is limited evidence on whether these types of firm-specific closures are beneficial to investors. In probably the most well-known study on such halts, Lee, Ready and Seguin (1994) address the effects of firm-specific halts on trading volume and volatility. To control for the fact that these events are usually associated with large price changes, they match trading halts with "pseudo halts" – similar price moves in the same stock for which there was no halt. Their results show that volumes are significantly higher for three days following halts than following pseudo halts. Volatility is significantly higher for one trading day. Overall, they conclude that this evidence is inconsistent with the hypothesis that trading halts tend to stabilize prices. Kryzanowski and Nemiroff (1998) analyze trading halts on the Montreal Stock Exchange. They find that trade price volatility and trading activity increase around halts, but revert to the levels before the halt in two days after the day of the halt.

Aitken, Frino, and Winn (1997) examine the effects of trading halts on market quality for the case of the Australian Stock Exchange, where halts are triggered upon high trading activity or wide bid–ask spreads. They conclude that halts around news releases hinder market quality. They base this conclusion on the finding that bid-ask spreads and price volatility appear to be abnormally high for two days following halts.

We now turn to the evidence on the efficacy of a third impediment to trade, namely, price limits. In October, 1989, price limits on stock index futures were triggered at the Chicago Mercantile Exchange (CME). Moser (1990) and McMillan (1991) examine the price process around these days. Moser shows that failure to coordinate the price limits across NYSE and the futures exchanges caused volumes to increase substantially at the NYSE. He argues that this may have exacerbated the adverse impact of the price limits. McMillan's study focuses on the index futures markets. Using sophisticated econometric techniques such as logit and error-correcting models for price processes, he finds some evidence of a magnet effect prior to the price limits triggered on October 13, but price-stabilizing effects before the limit triggered on October 26.

Thus, the evidence on whether price limits stabilize prices in equity markets appears mixed.

Two studies investigate price limits in Treasury bond futures markets. First, Holder, Ma, and Mallett (2002) show that theoretical and actual futures prices diverge significantly from each other three hours prior to the activation of price limits, suggesting price destabilization. Belcher, Ma, and Mallett (2003) observe reversals of the actual futures prices back to within the limit range after a limit hit. This observation supports the argument that traders tend to overreact when market prices are near price limits.

An important role of market structure is to allow for price discovery, i.e., to allow prices to converge to an equilibrium level that fully reflects public information. Do price limits promote this price discovery process? Kao and Ma (1992) examine the series of four popular currency futures contracts—British pounds, Canadian dollars, German marks, and Swiss francs—to address this issue. They find significant short-term serial dependence in prices whether price limit rules are in effect or not. This finding seems to indicate that price limits are not the cause of short-term dependence and rejects the notion that price limits obstruct price discovery. They do not provide any evidence that price limits enhance the process of price discovery. Hall and Kofman (2001) attempt to identify the effect of price limits on traders' expectations. Using five agricultural futures contracts traded at the Chicago Board of Trade, they do not find conclusive evidence that price limits stabilize markets and reduce price volatility.

In sum, the bulk of the literature has not found consistently compelling and solid evidence that circuit breakers or discretionary trading halts or price limits reduce volatility or enhance price discovery. The benefits of trade impediments such as breakers may exist as informal arguments but do not receive much support in the data. I suspect that the popularity of such impediments to trade may be to provide an assurance to the lay public that their "wealth is being protected". In my view, however, the primary focus should be more on deterring the root causes of sudden, large, and short-lived fluctuations in financial markets than on blocking the process of price discovery. We now turn to this issue in the context of a phenomenon that has renewed interest in circuit breakers, the rise of automated trading, which is thought to have been partially responsible for the "flash crash" of May 2010.

It goes without saying that there have been significant improvements in technology that have changed the way that assets are traded. Retail investors commonly indulge in online trading as opposed to trading with a broker. These online trades often never see any human intervention and are executed automatically at the posted quotes. Furthermore, in the olden days, a large institutional order either had to be "shopped" in a "upstairs market" or split up into smaller pieces to avoid market disruption. Nowadays computers can be programmed to execute the same order as an automated "package" designed to execute algorithmically and automatically. Furthermore, computers may also be programmed to seek out markets with the best possible prices and thus may also be used to allocate orders across markets as well as across time. Finally, algorithms may be used to identify pricing discrepancies and thus automatically execute arbitrage trades when such discrepancies are identified. Such trading is thought to account for more than two-thirds of US equity volume (en.wikipedia.org/wiki/Algorithmic_trading).

It seems fairly evident that arbitrage-driven algorithmic trading designed to should enhance pricing efficiencies since it is truly more effective than humans at arbitrage. On the other hand, the effect on liquidity is less clear. Large arbitrage trades or potentially large orders hitting a market offering lower trading costs may be counterproductive to the market and lower liquidity by potentially creating a one-sided market. In actuality algorithms seem to improve liquidity.

That is, using electronic messaging as a proxy for algorithmic trading, it has been shown (Hendershott, Jones, and Menkveld, 2011) that when algorithmic activity increases, liquidity increases as well. The NYSE started using a system to automatically disseminate inside quotes (autoquoting) in 2003, which should have stimulated more algorithmic trading. After the start of autoquoting, the positive impact of algorithmic trading proxies on liquidity increased even more.

There is other evidence that in the algorithmic trading regime with much higher levels of volume, market quality has actually increased. For example, Chordia, Roll, and Subrahmanyam (2011) show that intraday volatility has declined on the NYSE during recent years. Variance ratios of returns during trading hours to those in non-trading hours have decreased as well. An analysis of hourly to daily variance ratios indicates that prices are closer to the efficient market benchmark of a random walk in recent years.

On another note, at the turn of the century, considerable evidence has accumulated that stock returns were predictable from past returns as well as a host of other variables such as size, market-to-book ratio of the firm, accounting accruals (the difference between accounting income and cash flow), and earnings surprises. This evidence represented a challenge to market efficiency since it contradicted the notion that in an efficient market, stock prices should incorporate all public information and hence be unpredictable from such information. Since algorithms are in part designed to eliminate such inefficiencies, the question naturally arises as to whether they have been successful in doing so.

In actuality, the evidence is that the predictability of stock returns from public information has sharply diminished in recent years. Indeed, Chordia, Subrahmanyam, and Tong (2011) show that during the period from the mid-90s to the present (when algorithmic trading has become more prevalent), none of the variables mentioned above yield any abnormal returns for NYSE/AMEX stocks (where most of the algorithmic trading presumably takes place). Thus, the evidence seems to suggest that algorithmic trading has benefited financial markets. On the other hand, one rogue algorithm, or an error in a computer program to execute trades algorithmically, can cause severe disruption in financial markets, suggesting that a price-triggerd breaker may be helpful.

2.1. Options

The options available to regulators are to impose price-triggered circuit breakers, triggered upon point movements in one market, percentage movements in one market, point movements in multiple markets, and percentage movements in multiple markets. As pointed out earlier, the breaker would be designed to reduce panic during times of extreme market declines triggered possibly by rogue algorithms.

2.2. Costs, risks, and benefits

Financial markets serve many roles in modern society. Before considering how circuit breakers may affect these roles, let me delineate these roles.

First, financial markets allow individuals to reallocate consumptions across time. Someone who wants to save for the future may invest to do so, and someone who needs immediate income may borrow (or short-sell) at a competitive rate of return. Second, financial markets allow people to optimize their reward to risk ratios. The more the number of assets available to invest the more this allocation will benefit the individual.

Third, financial market prices serve as barometers for aggregate beliefs and thus convey important information to financial managers and policy-makers. For example, corporations are always looking to stock markets to understand how they should allocate corporate resources. If a firm has just recently expanded into a certain geographic region, it wants the stock market price to signal whether it should continue to expand or withdraw. This, of course, requires the financial markets to be a more accurate amalgam of information than the manager himself. The information is brought to the market by privately informed traders who conduct their own analysis of what the stock should be worth. Note here that both positive and negative information is relevant. Price declines due to negative information can signal managers to stop squandering corporate resources on projects not highly regarded by the market. Conversely, a positive stock price move can provide encouragement to the manager to continue with existing projects.

A similar logic applies to the aggregate economy as well. A rising stock market signals to policy-makers that sentiment is positive and investors expect economic conditions to improve. Appropriate policy actions can then be taken (such as moving away from a low interest rate regime that may have been to temporarily encourage economic growth). In a similar vein, a falling stock market signals to policy-makers that market participants expect future economic conditions to be bleak. Policy-makers may then take actions to stimulate growth and perhaps contain inflation.

We now consider how circuit breakers may impact financial markets in the context of the above roles. First, let us now consider the issue of whether circuit breakers can arrest panic attacks amongst investors and prevent an unwarranted fall in stock prices. Now, if the market is falling steeply, and a breaker is not in place, a trader wanting to sell can at least be assured of being able to sell when he or she wants. With a breaker in place, however, the trader may be so concerned about not being able to execute the sell order that this could lead to a panic attack of its own. Instead of calming traders, a breaker can actually exacerbate panic attacks.

Let us now consider whether breakers allow for more accurate pricing. Without a breaker, the price is continuously available as a barometer for investor beliefs. However with a breaker in place the price simply ceases to be displayed. This causes uncertainty amongst market participants as to what the asset is truly worth. The execution price uncertainty can also lead to misallocation of resources and the bearing of unwanted and avoidable risk.

Finally, let us consider if breakers may allow for batching unexecuted orders at a more reasonable price, as opposed to a price established in a one-sided market. The problem with this argument is that it assumes that market participants do not know what they are doing when they transact in financial markets. Given the increasing levels of sophistication exhibited by investors and concomitant recent increase in market quality, it appears to me that this is highly presumptuous. Any interruption in trading is likely to have a more deleterious impact on rational investors than any benefits it may confer by allowing them to take a breather.

To reiterate, financial markets fulfill a number of roles. First, they allow participants to exchange risky assets and thus achieve desired levels of consumption and investment. Second, they allow corporations to obtain an accurate barometer for what firms' securities are worth and thus allow resources to be allocated efficiently. Third, they allow for information about the economy to be promptly incorporated into prices and thus allow for better resource allocation by governments. Circuit breakers impede all of these objectives. It does not seem like using one or two outlier incidents to impose barriers to trading justifies the costs of doing so.

Suppose instead that regulators are intent upon having some sort of trade halting rule in place. The question is what kind of rule would best serve regulatory purposes. Should it be a price-triggered rule or a discretionary rule, seldom triggered? I use arguments from Subrahmanyam (1995) to answer this question. So, let us suppose that market participants are unable to monitor conditions continuously and need to be protected from conditions of high illiquidity. This premise assumes that somehow these participants should be protected more than those who actually can monitor conditions continuously, but assume for the moment that this is true. Now, a large price move can be indicative of extremely high price response to orders, or a very high price impact and can thus signal that market conditions are not very liquid. This latter possibility is mentioned by Grossman and Miller's (1988) in the context of the October 1987 crash that "markets had become highly illiquid and virtually incapable of supplying immediacy at low cost…" Shutting down the markets in such conditions helps reduce the losses of naïve retail investors.

The problem with the preceding argument is that a price move may genuinely signal a re-valuation of the asset and not necessarily a temporary episode of high illiquidity. If it is the former that is the cause of a price decline, then shutting down the market based on the decline alone may preclude markets from accurately reflecting pricing information. In contrast to a breaker triggered on a price decline (triggered mechanically without regard to the cause of the price move), discretionary halts will only occur if market illiquidity is truly high. So one possibility is that the halts be built into the charter of exchanges as discretionary. But this discretionary power should seldom be used lest it interfere with the efficiency-enhancing role of financial markets.

There are other reasons why discretionary halts may be superior to price-triggered halts. First, imposing price-triggered breakers across multiple markets presents a challenge because of varying degrees of volatility across markets and through time. An appropriate price trigger for one market and in one time span may not be for another, so some human judgment is required on a case-by-case basis. Second, as we have seen earlier, one problem with price-triggered halts is that they may cause traders to advance trades before the price hits the trigger, and thus increase volatility prior to the halt. Discretionary halts not only allow the use of appropriate human judgment but insert a random element into the process and thus reduce the chances that the "magnet effect" will happen. These lines of arguments also indicate that a seldom-used discretionary deterrent may be worth considering in preference to a mechanical, price-triggered breaker. The overarching argument is that since discretionary closures allow policy makers to bring more information into the system than just the size of the price movement, they can be a more effective way to attain policy objectives.

On the other hand, discretionary halts can cause a lack of trust if investors fear that they may be imposed arbitrarily. This may particularly be the case for retail investors who may not be fully familiar with the regulatory environment in financial markets. In this case, a price triggered breaker may be used to calm such investors during periods of market stress due to extreme order imbalances. If a price trigger is to be used for this purpose, it should be based on percentage, rather than point moves to allow for comparable triggers across markets. The price-triggered closure should also be coordinated across markets to preclude the possibility of disruptive trading moving to other markets.

3. The future

The analysis of how risks of circuit breakers may evolve in the future is related to risks associated with algorithmic trading. Since the flash crash, there have been moves to regulate such trading before it hits the market. Indeed, there has been some talk about having algorithms vetted by regulators (http://www.ft.com/cms/s/0/28130ab2–650c-11e0–9369–00144feab49a.html). However, algorithmic trade by itself is not bad for markets. As we have seen earlier, the evidence indicates that algorithmic trading improves liquidity and price discovery. It was in fact just a single badly-designed algorithm that triggered the flash crash. The algorithm was set to sell a large quantity of index futures contracts without regard to price in a short span of time (see U.S. Commodity Futures Trading Commissions and U.S. Securities and Exchange Commission, 2010). One badly designed algorithm does not justify imposing wholesale regulatory impediments.

There is also a view that the flash crash was caused by "flash orders." But, such orders appear fleetingly to alter prices in a desired direction; indeed most executed are cancelled almost immediately (see http://seekingalpha.com/article/151385-how-flash-orders-work). Hence, it does not seem that flash orders alone can cause long-lasting market crashes. However, an issue the flash crash raised was that of coordinating circuit breakers. In the flash crash, CME hit the circuit breakers but NYSE did not. This meant that CME derivatives halted trading, but cash products at NYSE did not. Coordinated market breakers simply ensure consistency. But this observation does not justify why circuit breakers should be imposed in the first place.

Nonetheless, the flash crash has resulted in the imposition of stock-specific circuit breakers. For example, under recently proposed rules, trading in a stock would pause for a five-minute period in the event that the stock experiences a 10 percent change in price over the preceding five minutes. The avowed objective again is to promote market confidence by allowing market participants time to assimilate information and mobilize liquidity during periods of sharp and potentially destabilizing price swings. The NYSE also has introduced liquidity replenishment points (LRP) that preclude automatic execution at a lower trigger, typically 2 to 4% price movements.

It is worth emphasizing that impediments to trade are often proposed as reactions to episodic events. The first imposition of circuit breakers happened because of the crash of October 1987. Since that time the circuit breakers have rarely been triggered. The most recent imposition of stock-specific circuit breakers has occurred in response to the flash crash in a single stock. Whether coordinated or not, there is modest evidence that such impediments to trade actually do deliver the promised economic benefits. If anything there are potential phenomena related to magnet effects and blockage of price discovery that can impose costs on market participants.

Note also that the situations that any proposed breakers might be designed to address are episodic in nature and are not likely to become frequent occurrences. Thus, algorithmic trading, that was avowed to cause the flash crash, has, in general proven beneficial in financial markets. Specifically, the evidence suggests automated algorithmic trading has improved pricing efficiency and liquidity, and reduced volatility in financial markets. Regulations to restrict it may potentially be counterproductive, unless they are erected to combat extremely disruptive algorithmic trades. Further, computing firepower will always be designed to counteract regulation. I can easily see algorithms being designed to ensure circuit breakers are not triggered and such algorithms may shift trading to venues that lie beyond the pale of policy makers, which may have unintended political consequences.

Another issue is that with deeply fragmented markets and inter-related assets, how can we ensure that circuit breakers in the modern era are truly successful? For example, if a breaker is triggered in a multinational company's stock in Netherlands, the volume is sure to migrate outside the EU or in the case of institutional volume, to a dark pool where institutions can directly cross orders. Indeed, dark pools are increasing in popularity and one was recently introduced in Switzerland (http://www.marketwatch.com/story/swiss-exchange-launches-dark-pool-venture-2011–07–08). What will the imposition of breakers do to alternative off-floor and non-EU markets? Similarly, if a breaker is triggered in one stock, volume can often go to related stocks within the industry. How will the breaker affect those stocks? As one can see, it is extremely difficult to cover all the contingencies created by triggering of breakers even if one believes that breakers are indeed the way to go. Given the modest evidence that breakers actually confer economic benefits, one should be cautious about imposing them. However, one can certainly assuage investor anxiety from a psychological standpoint by putting breakers in place. Specifically, there is a potential benefit, that of "calming" active retail investors who may not be intimately familiar with causes of extreme market moves (Odean, 1998), and discouraging panic-driven selling by such investors.

4. Summary and recommendation

Since price-triggered breakers happen mechanically, they do not allow breakers to incorporate more information than just the size of the price move. So, one possibility is to have the right of a discretionary halt built into the regulatory books, but use it rarely or sparingly as a deterrent. Such a deterrent would be just that, a deterrent. Specifically, for example, the deterrent of a possible halt would be sufficient to ensure that algorithms are designed carefully to minimize the likelihood of a flash crash occurring in the future. On the other hand, however, the possibility of a discretionary may cause concern for traders on the grounds that it may be used arbitrarily. Alternatives to such halts are "sidecars", where market orders are batched over short intervals and then matched against limit order books, and moving from a continuous auction to batching orders during extreme market moves, which would potentially slow trading down and calm markets. These procedures do not cause all cessation of trade and price discovery, but may still not resolve the problem of extreme order imbalances due to panic-driven selling by retail investors.

If one considers a price-triggered breaker as the preferred tool to combat extreme disruptions due to rogue algorithms, and thus calm retain investors, then, to impede price discovery as little as possible, such halts should be designed to trigger in only the most extreme of circumstances, such as an unusually large price move in a short span of time. Such halts should be coordinated across markets, and triggered using percentage movements on more than one exchange. This would preclude an anomalous trade on a single exchange disrupting multiple venues of price discovery, and also prevent preclude traders from migrating other exchanges and disrupting trade at alternative venues.

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