Chapter 2.

Literature Review

There have been extensive studies on intraday, programmed circuit breaker mechanisms since the market crash of 1987. The first line of studies on circuit breakers was initiated by stock market-related institutions. These studies include those made by the Federal government, and also by major stock exchanges such as the New York Stock Exchange (NYSE) and the Chicago Mercantile Exchange (CME).

In response to this extraordinary market break, a Task Force on Market Mechanisms was organized to examine what happened and why, and to provide guidance in helping to prevent such a break from happening again. *The Report of the Presidential Task Force on Market Mechanisms (1988,* known as the Brady Report) attributed much of the volatility associated with the crash to aspects of market microstructure and suggested circuit breaker mechanisms as a response to extreme market volatility. Identifying the need for circuit breaker mechanisms with the inherently limited capacity of markets to absorb massive, one-sided volume, the Brady Report stated the benefits to circuit breaker mechanisms as follows:

> *First, circuit breaker mechanisms limit credit risks and loss of financial confidence by providing a "time-out" amid frenetic trading to settle up and ensure that everyone is solvent.*
>
> *Second, they facilitate price discovery by providing a "time-out" to pause, evaluate, inhibit panic, and publicize order imbalances to attract value traders to cushion violent movements in the market.*

Finally, they counter the illusion of liquidity by formalizing the economic fact of life.... that markets have a limited capacity to absorb massive one-sided volume.

This report also recognized the disadvantages of circuit breakers mechanisms:

They hinder trading and hedging strategies. Trading halts may lock investors in, preventing them from exiting the market.

Also, they may hinder price discovery and may..... even contribute to the intensity of price declines by giving rise to a gravitational effect.[2]

Despite of the above perceived disadvantages, the Brady Report recommended the installation of circuit breaker mechanisms to cushion the impact of market movements which would otherwise damage market infrastructures, thereby protecting markets and investors. Following the recommendation of this report, major stock exchanges such as the NYSE and CME introduced circuit breakers mechanisms.

Subsequent studies initiated by other major institutions were made following the Brady Report. *Final Report of the Committee of Inquiry* (1989, CME) and the *Market Volatility and Investor Confidence Panel* (1990, NYSE) offer a comprehensive discussion of circuit breakers. Examining performances of the CME and its S&P 500 contract during the October crash, the *Final Report of the Committee of Inquiry* addressed key policy issues such as margins, circuit breakers and regulatory obstacles to market efficiency. After giving the main arguments for and against making the price limits the permanent feature of the futures contract, it states that "under the conditions of system overload, the Brady Report's call for the installation of circuit breakers is certainly understandable, and the possible need for circuit breakers has

[2]A gravitational effect occurs, for example, when traders, who are afraid of being locking into their position as prices approach the lower circuit breaker bound, expedite their selling activities.

been a concern of the exchanges themselves as well."

The *Market Volatility and Investor Confidence Panel* analyzed the issues of extreme short-term stock market volatility and made recommendations intended to help maintain a strong market for all participants. Reflecting their concerns to install circuit breaker mechanisms, the first among eight recommendations is stated as follows:

> *Recommendation 1: Coordinated "circuit breakers" should be introduced to halt or limit trading in times of market stress. These measures should be mandatory across all domestic equity and equity derivative markets. Enhanced price and trade information should be made available times when circuit breakers are triggered.*

In the Appendix of this report, they also illustrated some desirable features of circuit breakers which are only partly mentioned in the above recommendation.[3] Although the above three studies recognize perceived disadvantages of circuit breakers, they seemed to have reached the same conclusion that formal circuit breakers may have benefits over unplanned, *ad hoc* circuit breakers.

A more rigorous theoretical study was made by Greenwald and Stein (1988, 1991). Focusing on the immediate pricing decision of market makers, they argue that potential buyers in a real-world market, whose market makers are confronting an unexpectedly large surge of sell orders, cannot always be sure of the price at which their *market orders* to buy will be executed. This transaction price uncertainty may lead to deviations from Walrasian prices and allocations. In their stylized model, there are two periods that contain uncertainty about fundamentals and also about the

[3]See the Appendix E, prepared by Mann and Sofianos, of the Market Volatility and Investor Conficence Panel (1990) for the details about the desirable features of circuit breakers.

behavior of value buyers. An *informationless* supply shock occurs in the first period. Market makers must absorb the excess supply until value buyers arrive in the second period. Value buyers submit *market orders* at the beginning of the second period without knowing what their transaction price will be. This transaction price uncertainty affects the demand behavior of value buyers during period two and this in turn affects the inventory behavior of market makers during period one. They show that when a supply shock is large, the transmission of a supply shock into value buyers breaks down leading to a microstructure-induced crash. Rather than incorporating circuit breakers explicitly into the model, they offer a discussion that circuit breakers can reduce the uncertainty of value buyers by making the potential value buyers aware of the response of other traders to large shocks. Hence, the trade-off owing to circuit breakers, in their model, is between full information pricing and timeliness of execution.

On the contrary, Subrahmanyam (1993) suggests that circuit breakers may have the perverse effect of increasing price variability and exacerbating price movements. He focuses on the *ex ante* strategic trading decision of the discretionary trader with an exogenous demand, who can split his trades across two periods and also has the cost of not being able to trade in a period. When there is no circuit breaker, the discretionary trader splits his trades across periods rather than concentrating trades in period one or two in order to reduce the price impact of his trades. However, the introduction of a circuit breaker distorts his optimal trading behavior and causes him to concentrate his trading in an earlier period. In this model, he assumes that if the price in period one is outside the circuit breaker bound, trading in period two is halted while the period one trade goes through. In this situation, traders suboptimally advance their trades in time when the probability of a circuit breaker bound being

crossed is high. The expected cost of not being able to trade in the second period dominates the advantages of splitting his trades. As a result, price variability increases and the probability of the period one price crossing the bound also increases.

Park (1990) analyzes traders' behavior in the presence of price limits. Unlike trading halts, price limits allow trading to take place at the limit price. For example, when the (upper) limit is triggered, the sell orders below the limit are executed at the limit price. Since the amount of buy orders are greater than sell orders at the upper limit, exchanges usually prespecify how selling orders below the upper limit are to be assigned to buyers. Assuming a random assignment, he shows that a trader with a reservation price lower than the upper limit has an incentive to submit his bid at the upper limit since it makes his expected payoff greater than the case when he submits his reservation price. He also suggests that a triggering of the upper price limit can make people increase their reservation prices.

While the above studies analyze the circuit breakers in the cash market, Brennan (1986) and Miller (1990) approached this issue by analyzing the futures market. They attempt to explain why price limits have long been a standard feature of futures contracts. Brennan interprets the existence of price limits in the futures market in the context of efficient contract design. In a futures market, the problem of contract enforcement is liable to arise whenever the absolute value of the change in the futures price from the previous settlement exceeds the margin requirement, for then one party to the contract may have an incentive to renege, which would make it costly or even impossible to enforce the contract. Based on the premise that margin requirements are costly for at least some market participants, he showed that price limits may act as a partial substitute for margin requirements in ensuring contract performance. Since the

losing party's decision whether to renege depends on his expected loss, a daily price limit can alleviate or even eliminate the contract enforcement problem by limiting the information available to the losing party about the extent of his losses at the time he is required to make the daily settlement.

Miller (1990), focusing on the moral hazard problem, asserts that price limits typically exist in a futures market to assure clearinghouse solvency. The floor population of market makers in the trading pits consists primarily of "locals" trading for their own account, but whose settlements are guaranteed by a clearing firm, a member of the exchange's clearinghouse. Thanks to the zero-sum nature of futures trading, every large price move, whether up or down, leads to substantial losses for half the floor population. As guarantors the clearing firms protect their interests by imposing capital requirements on their locals enough to cover a normal day's potential trading losses. However, large sudden price moves not only can hamper this protection, but also create additional incentives for the locals that are adverse in the extreme to the clearing firm's interests. A local already wiped out has nothing more to lose and potentially much to gain from "double-or-nothing" strategies with what amounts to the clearing firm's money. He argues that price limits are a cost effective way to control clearing firm exposure, since a triggering of price limit gives the clearing firm time to remove potentially insolvent traders from the floor before they accumulate further losses.

Both studies attribute the existence of price limits in the futures market to the particular environment surrounding the futures market where sudden price changes might pose problems for its particular trading, clearing and settlement technology. Although they provide a rationale for circuit breakers in futures markets, the question of how the existence of price limits affects price behavior is not addressed.

Despite the controversial effect of circuit breakers on price movements, not many empirical studies have been made due to data limitations. Since circuit breakers are, by design, rarely triggered, it is inherently difficult to obtain sufficient evidence to evaluate their effectiveness. When circuit breakers were first triggered in October 1989 after their introduction, two separate empirical studies of this event appeared.[4]

McMillan (1990) gives a very thorough investigation of the impact of the circuit breakers in the futures market on October 13, 1989. Using S&P 500 future price series before and after the circuit breaker bound is triggered, he found that the dispersion (the average absolute value) of successive price changes increased after circuit breakers were lifted. He also found more price dispersion on October 13, 1989 than on October 13, 1987, another Friday on which the market fell by about 6 percent, but with no circuit breakers in place.

Kuhn, Kuserk and Locke (1990) also analyzed the same event employing several measures of volatility.[5] Their findings, similar to McMillan's, indicate that circuit breakers did not function as a calming device on October 13, 1993. Further, they found an evidence that a binding constraint in one market (S&P 500 futures) is associated with increased volatility in unconstrained markets (MMI futures). Hence, both studies found that circuit breakers impaired price discovery rather than facilitating it as Greenwald and Stein suggest.

Empirical studies based on a different approach were made by Roll (1989) and

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[4]On October 13, 1989, stock prices declined precipitously after the announcement of the failure of the management of United Airlines to secure financing for their leveraged buyout. In the cash market, the Dow Jones Industrial Average fell 191 points (6.9 percent), which was not enough to trigger trading halts. However, the S&P 500 futures index fell to its 12-point limit and also subsequently hit the expanded 30-point limits. For details, see McMillan (1990) pp. 252-256.

[5]The volatility measures they employed are 'standard deviation of price change', 'average absolute log price change' and 'range'. They also tested whether the median level of volatility changed from one period to the next.

Bertero and Mayer (1990). Both studies investigate whether substantial variations in stock market performances across countries during the international crash in October 1987 can be attributed to their market microstructure. They employed cross-sectional data on market performances during the October and institutional structure variables over 23 countries.[6] Regressing the full October return on 10 institutional variables, Roll finds that none of the institutional market characteristics including a 'price limits' dummy were significantly associated with the October return. Bertero and Mayer ran similar regressions but used returns during the days immediately surrounding the crash (rather than the full month of October as in Roll) as a dependent variable. Contrary to Roll, they find that markets with circuit breakers in operation on average declined by between 7% and 9% less than those without circuit breakers.

Another evidence about the effect of circuit breakers is suggested by Mann and Sofianos (1990). In January 1988, the NYSE put restrictions on index arbitrage orders transmitted over the Exchange's SuperDot automated order routing system in an effort to reduce volatility. Although these restrictions, known as a "collar," made index arbitrage program trades more costly, it did not make them impossible. Using the seven collar-triggered events when the collar was in effect, they find that the collar was not effective in preventing a sharp price decline. The trades were simply executed manually at a higher cost by those firms with direct access to the floor. Due to its ineffectiveness, the collar restriction was eventually abandoned in October 1988. Their findings suggest that circuit breakers might bring inefficiency by creating spill-over effects into substitute instruments and markets.

Unlike other empirical studies which examined *formal* circuit breakers, Gerety

[6]As dummy variables representing institutional structure, both studies commonly used "circuit breakers," "continuous trading,"' "computer-assisted trading," and "future trading," but also included a different set of other institutional variables.

and Mulherin (1992) analyze the effect of regular market closings on trading volume behavior. Since every stock market experiences a daily "natural circuit breaker" between the close of trading on one day and the opening of trading the following morning, as Grossman (1990) points out, the analysis of price and volume movements at the open and close can provide some understanding of the effect of *formal* circuit breakers. Based on the trading volume and price series from the NYSE over 50 years (1933-1988), Gerety and Mulherin find that much of the clustering of volume around the open and the close is due to the desire of investors to exchange the risk of holding positions overnight. Using this evidence based on the desire of investors to trade prior to *predictable* market closings, they suggest that to the extent that circuit breakers increase the uncertainty regarding the ability to exit the market, an environment with circuit breakers may be less stable than an environment without circuit breakers. The possibility of a trading halt after a price change of a given percent would make investors generally skittish after price changes of some fraction of the trigger amount and cause investors to overreact and leave the market more quickly than if a circuit breaker did not exist. That is, their findings suggest an evidence of the "gravitational effect" caused by circuit breakers.

The potential benefits and costs of circuit breakers that have been discussed so far are summarized in Table 2.1.

Table 2.1: Major Arguments for and against Circuit Breakers

	benefits	costs
price discovery	**facilitate price discovery and reduce volatility** •provide a cooling-off period •reduce credit risk related to the margin calls •improve information about order imbalances • prevent bottlenecks due to the limited capacity of exchanges to absorb massive, one-sided volume	**may impede price discovery** •may scare investors away from markets rather than reassuring them •slow down the incorporation of new information into prices •gravitational effect (*i.e.*, traders expedite selling activities when price approaches the lower bound) •distort trading decision
efficiency	**welfare gain > efficiency loss** planned circuit breakers are better than unplanned, ad hoc ones	**incur inefficiency** •keep traders from completing mutually beneficial trades • spill-over effect