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An Empirical Analysis of the Market-Wide Circuit Breaker Mechanism in India: An Exploration of the Market Microstructure

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ABSTRACT

The market-wide circuit breaker mechanism was introduced in India on July 02, 2001 with the intent of curbing extreme movements in the market. It is thus a financial instrument that works to prevent both excessive losses as well as speculative gains within a short span of time. The market-wide circuit breaker is calculated on the basis of the index movements. However, although the Nifty 50 index levels have risen from 1000 points in 2001 to 11,500 points in 2019, the circuit breaker system has not undergone amendments to the different levels at which it gets triggered. This is the rationale for the study, which aims to investigate whether there is a need for a revision of the mechanism. An exploratory study of the equity markets utilizing an Event Study methodology reveals that circuit breakers are definitely useful towards curbing volatility, but are not essential for the process of market recovery. The study also shows that investors tend to panic more when the markets show extreme movements in the downward direction than in the upward direction.

Section I

Introduction

Financial markets serve as the engine of an economy by propelling economic growth and development. They help in the efficient utilization of savings to propagate investment and thus fuel production in the economy. Thus, it is necessary to have a well-developed, well-functioning and efficient system in place to guide the flow of capital to achieve maximum benefit for the investors, companies, government and economy as a whole. With this in mind, capital market regulators across the globe constantly strive to prevent market disorder and preserve the integrity and quality of the stock markets. In lieu of this, the Securities and Exchange Board of India (SEBI) was set up in 1988 to "promote the orderly and healthy growth of securities and to provide protection to investors" (Kalpana, 2015)[1].

However, markets undergo periods of uncertainty as new events define the direction of the economy be it at the micro or macro level. Many stock exchanges in the world have systems in place to impose a halt in trading when the markets face conditions of extreme volatility. Such systems are referred to as circuit breakers. They are defined as "pre-defined values in percentage terms, which trigger an automatic check when there is a runaway move in any security or index in either direction" ("Definition of Circuit Breakers", 2016)[2]. Such systems have been designed in order to provide time to market participants to recover from abnormal fluctuations in stock prices so that they can take rational decisions post the halt. This brings in stability by bridging the gap caused due to information asymmetry. It allows for orderly movement of the markets towards price discovery rather than a panic stricken one.

Circuit breakers can be applied to the market as a whole or to a specific security. When trading is curbed across the entire market, it is referred to as a market-wide circuit breaker. On the other hand, when a similar mechanism is applied to an individual security it is termed a price limit, whereby the security can only trade within a given range during a specified time period. When trading in the specific security is halted on reaching the price bands, it is termed as stock specific trading halts. While some countries such as Japan and Germany have a separate circuit breaker mechanism in place for the equity and derivatives markets,

[1] URL: http://www.businessmanagementideas.com/stock-exchange/securities-and-exchange-board-of-india-sebi-purpose-objectives-and-functions/2259

[2] URL: https://economictimes.indiatimes.com/definition/circuit-breakers

countries such as India and the United States of America implement a co-ordinated halt between the cash and derivatives markets. This means that trading is suspended across all segments of the security if a circuit breaker is triggered in the equity market.

The origins of the circuit breaker mechanism can be traced back to the stock market crash of October 19, 1987 which is also referred to as Black Monday. On this day, the Dow Jones Industrial Average (DJIA) fell by 22.6 percent or 508 points. The downward spiral which started in Hong Kong, soon spread to markets around the globe spanning Tokyo, Berlin, London and New York. While reasons for the crash included overvaluation, illiquidity and market psychology, the most important explanation for the crash was that it occurred due to program trading. With the advent of computerization gaining popularity, there was widespread use of this technique to engage in arbitrage and portfolio insurance strategies. Such a dramatic growth in computer technology for trading resulted in the crash. In an effort to understand the problem as well as to develop a solution to similar situations that might arise in the future, the then President of the United States Ronald Reagan assembled a Task Force on Market Mechanisms, popularly known as the Brady Commission as it was chaired by the former U.S. Senator Nicholas Brady. The Brady Commission investigated the causes for the crash and prepared a report on the same underlining the issue at hand as well as a possible solution for the problem viz. circuit breakers. The report stated that the regulatory agency responsible for monitoring the equity markets must design and implement price limit systems known as circuit breakers.

This paper investigates the market-wide circuit breaker system currently in place in India as well other countries across the globe. Through a series of empirical analyses, it aims to determine whether the existing system in India serves its intended purpose or whether it is time to bring about changes in the design of the system. Section II consists of a literature review of all prior work that has been done in relation to the circuit breaker mechanism. Section III traces the background of the circuit breaker mechanism in India as well as consolidates all the information regarding the existing system in other countries. Section IV examines the data and methodology that were used to conduct the research. Section V comprises of results, which addresses the findings of the research. Section VI is a discussion and conclusion section, wherein the implications of the results are considered.

Section II
Literature Review

A substantial amount of work has been done on the topic of circuit breakers. The body of literature comprises papers that address a variety of questions ranging from the impact of circuit breakers on measures of stock performance to comparative analyses of the existing system across countries in the globe. While some argue in favor of this mechanism, yet others try to put forth arguments that disprove the validity of the system. The scope of the work done in this area ranges from theoretical assertions to quantitative results based on empirical findings via econometric modeling.

As with any regulatory policy, this mechanism has also had its fair share of support and opposition. Singh (2017) brings to light both sides of the coin by highlighting the reasons for the same. He speaks about how the lack of consensus regarding the effectiveness of this tool during crises stems from arguments that are equally strong and valid in their backing and assumptions. On one hand circuit breakers provide investors with a period to "cool off", thereby calming the sensations of fear and panic that could coerce them to take haphazard trading decisions during periods of steep market movement. On the other hand, circuit breakers can be viewed as counter effective due to the drain on liquidity as well as reduction of market depth that it brings about. Putting forth a similar argument as Singh towards the positives of circuit breakers, Kim et al (2008) further goes on to discover that such halts also aid efficient price discovery and helps to protect value, as opposed to a sudden inflation or deflation in the prices driven by speculation and over-reaction. Moving further into the realm of such policies and viewing the same through the lens of price limits, Brennan (1986) theoretically argues that price limits can act as substitutes for margin requirements and can thus ensure contract performance without the need for costly litigation. This resolves the issue in those situations where margin requirements can be considered costly for some market participants. He believes the risk of a trading interruption through the imposition of price limits might be worth the potential to reduce margin requirements. Chen (2002) also empirically studies the same effect and comes to a conclusion in support of Brennan's study that there is a negative relationship between price limits and margin requirements and that margins are smaller when price limits are put in place.

Chowdhry and Nanda (1998), who are again proponents of the system present that price limits can enhance market stability. This can be done via the exclusion of potentially destabilizing market prices. However, the model they adopt assumes information symmetry and that there is no new information that is generated during the process of trading. Their argument is that rigidity of margin requirements can result in price instability. This happens because a drop in price results in a tightening of borrowing constraints, while a rise in price is equivalent to an easing of the constraints. Investors who need to add leverage in order to trade in risky assets will face a disadvantage in the purchase of their desired quantity due to the increased constraints that result from a drop in price, since such assets will be held by few risk-averse investors who ask for a higher risk premium to hold a larger quantity of risky assets. The opposite is true in cases of price rise. Thus, price limits can improve the stability of the markets by striking out prices that are potentially destabilizing. The study combines different levels of margin requirements with price limits to prove that such tools can help in attaining market stability.

Opponents of the system have equally strong arguments too. A study by Fong (1996) discovers that the volatility that ensues in the market post the imposition of a trading halt is actually higher than the pre-halt scenario. This was also evinced by the study conducted by Christie et al (2002) which quantified the same and presented that volatility increases to more than nine times the normal level following a halt. Another common argument regarding the viability of these mechanisms has to do with delayed price discovery. A study conducted by Crowin and Lipson (2000) argues that artificial imposition of a trading halt results in the interruption of information flow from institutional investors, who are more informed about the markets to non-institutional investors, who generally lack the level of information that institutional investors do. Thus, there is a slowdown in the speed of execution and increase in costs associated with trading.

Yet other studies propound a neutral view regarding these policies. For instance Park's (2000) study that investigates agricultural futures contracts to understand if price limits can moderate volatility comes up with the result that it is likely that such limits do not directly affect the price volatility. Another study by Chen (1998) investigates the effect that price limits can have on overreaction and whether they do anything to counter the same. The study analyses nineteen futures contracts to come to the conclusion that there is not much evidence for such a relation. It says that the direction of price movements on the day after a big price

movement is mostly unpredictable and thus, overreaction does not serve as a good enough reason for the application of such systems.

Other studies in the literature that have to do with topics in this area include impact analyses of the circuit breaker mechanism on market outcomes. Brugler et al (2014) perform such a study in the context of the London Stock Exchange. The paper evaluates the efficacy of single-stock circuit breakers on the stock markets by using proprietary data during July and August 2011. It finds that trading suspensions help to reduce the noise of market microstructures as well as price inefficiencies during a period of falling markets, but does the exact opposite when markets are rising. The conclusion the paper draws is that while trading halts may not be the solution with regards to improvement of the trading process within individual securities, it does play a paramount role in the prevention of the spread of poor market quality and can thus be viewed as efficacious tools for the promotion of stability at the market level. Another study conducted by Chari et al (2017) in this realm explores the same question in the Indian scenario. It assesses the impact of circuit breakers specifically on trading activity and volatility in an effort to understand how the system impacts these measures and whether it serves the purpose it is intended for. The study analyses specific events when the circuit breaker was triggered in India and finds that the effects of the circuit breaker last for up to three days post these events. Xu et al (2014) also studies the circuit breakers from the perspective of the impact it has on the markets, in the context of China. They conduct a study comparing intra and inter day halts and find out that from the perspective of price trends, positive events are more effective for intraday halts and negative events are more effective in the case of inter day halts.

Many reports and papers around the topic are comparative studies of the system across different countries in the world. One such study presents a report of the difference in implementation of the circuit filter system spanning Hong Kong, Japan, Korea and the United States and makes a comparison of the same with the Indian system in terms of percentage levels at which the filter is triggered and what that implies (Mukherjee, 2007). The study conducts an in-depth analysis of how many stages the filter is executed in. Another study that documents the same is that conducted by Srivastava (2016). Both the above papers consider circuit breakers as one aspect in their comparative study of the entire stock market system between India and other countries. Other reports however exclusively conduct a detailed study of the circuit breaker mechanism across countries. One such report is that

prepared by the International Organization of Securities Commissions (IOSCO) which talks about how trading venues use such mechanisms to manage extreme volatility and preserve orderly trading. It covers the regulatory aspect of the system and analyses how dissemination of information to market participants and the public occur when such systems are in place and subsequently executed. Yet another survey on circuit breakers among international trading venues was conducted by the World Federation of Exchanges (WFE). It considered the differences between those venues that had such a system in place and those that did not and how it impacted the markets during periods of high volatility. It presents a detailed report on the topic of circuit breakers spanning sub topics such as the different types of circuit breaker implementations, the triggering process of circuit breakers, initiation and revision of these mechanisms and how the system has evolved since its initiation in different venues.

The analysis of the literature presents scope to consider another dimension of the issue, which is regarding the levels at which the circuit breaker mechanism gets triggered. A research gap can be identified in this regard. While countries like India and the United States of America have undergone amendments to the originally proposed mechanism, the same has not been deeply investigated in the literature. There have been mentions of the same, but not an analysis of the reasons for the amendments or whether the system post the changes have significantly improved upon the previous system. This paper aims to analyse the current mechanism in India and whether the existing levels at which the trading halt gets triggered at the market level are fine or whether there is any empirical evidence to support that it may need to be changed. The inspiration for the same arises from the fact that the levels for implementation of the halt have not changed since the mechanism was initially introduced in 2001 in spite of the system having undergone other changes, such as the introduction of a pre-open auction session post the halt. The index level for the Nifty 50, which is the National Stock Exchange of India's benchmark index, have risen from 1000 points in 2001 to 11,500 points in 2019, which brings to light the question whether it is necessary to adjust the circuit breaker mechanism according to the change in the index level. This paper aims to explore the above question through an exploratory study of the events that warrant volatility in the markets, and hence trigger the circuit breakers at the index level.

Section III
A Review of the Circuit Breaker Mechanism Across Countries

A. The Indian System

The index-based market wide circuit breaker mechanism in India came into effect on July 2, 2001 with the aim of bringing about a co-ordinated halt in all the equity and equity derivative markets across the country during instances of extreme market movements. The circuit breakers are applied in three levels when the markets breach 10%, 15% and 20% of index movement in either direction. The market wide circuit breakers are triggered either if the NSE S&P CNX Nifty or the BSE Sensex (the two major indices in India) breaches the above mentioned levels, whichever breaches the same earlier. The system has undergone amendments to the originally proposed method twice in subsequent years.

The initial regulation mandated that the percentage points of the levels would be calculated based on the absolute points of index variations every quarter. These absolute values were calculated on the basis of the closing level of the index on the last day of trading in that particular quarter and then rounded off to the nearest 10 points for the Nifty index and rounded off to the nearest 25 points in the instance of the BSE Sensex. Any breach that crossed 10%, 15% or 20% from these levels in that quarter would warrant the setting off of the circuit breaker mechanism. A detailed overview of the system was as follows:

- In the event of a 10% breach, the market would suspend trading for 1 hour if the breach happens before 1 p.m. In case the breach takes place between 1 and 2:30 p.m. on the trading day, the markets would close for a period of 30 minutes. If however, the breach takes place post 2:30 p.m. it would result in no halt, and the markets would continue functioning as usual.
- In the event of a 15% breach before 1 p.m. the markets would halt trading for 2 hours. The duration of halt was for 1 hour if the breach took place between 1 and 2 p.m. If the 15% breach happened post 2 p.m. it would result in a shutdown of the markets for the day.
- Finally, if there was a 20% breach, it would result in the close of the markets immediately.

The system underwent a regulatory change in 2013 wherein the levels at which the circuit breakers would be triggered remained constant; however the halt durations were changed.

Further, there was the introduction of a 15 minute pre-open call auction session post the trading halt. Thus, the duration of the halt was reduced by 15 minutes each in order to accommodate the pre-open call auction session. The new system is thus as follows:

- On breaching the 10% level before 1 p.m. there is now a suspension of trading for a period of 45 minutes. The halt duration is 15 minutes if the breach happens between 1 and 2:30 p.m. and post 2:30 p.m. there is no halt like the previous system.
- The breach of a 15% level results in a trading halt of 1 hour and 45 minutes if it happens before 1 p.m. Such a breach happening between 1 and 2 p.m. results in a 45 minute break and a market close post 2 p.m.
- A 20% breach results in immediate suspension of trading activities.

Table 1: Evolution of Duration of Circuit Breaker Mechanism in India

Sl. No.	Date		Level I		Level II		Level III
1.	July 2, 2001	Threshold	10%		15%		20%
		Duration of Halt	Before 1 pm	1 hour	Before 1 pm	2 hours	Market Close
			1-2:30 pm	30 mins	1-2 pm	1 hour	
			After 2:30 pm	No Halt	After 2 pm	Market Close	
2.	September 3, 2013	Threshold	10%		15%		20%
		Duration of Halt	Before 1 pm	45 mins	Before 1 pm	1 hour 45 mins	Market Close
			1-2:30 pm	15 mins	1-2 pm	45 mins	
			After 2:30 pm	No Halt	After 2 pm	Market Close	
3.	January 12, 2015	Threshold	10%		15%		20%
		Duration of Halt	Same as September 3, 2013		Same as September 3, 2013		Same as September 3, 2013

The new regulation further required that the market-wide circuit breaker limits be calculated on a daily basis based on the previous day's closing level of index. This differs from the quarterly basis on which circuit breaker limits were calculated previously.

The final regulation that came into being in this realm on January 12, 2015 did not bring about any changes to the levels of the triggering mechanism. It just revised the mechanism for computation of the levels, which were made more stringent. Currently, the system mandates that the market-wide circuit breaker limits must be calculated post every trade in the index constituent stocks. Table 1 summarizes all the changes to the system since its inception.

B. An Overview of the Trading Halt Mechanism in Different Countries

We consider the trading halt mechanism implemented in different countries across the world to get a general idea of the various prevailing systems. This helps to provide a comparison with the existing mechanism in India and its similarities and differences to other such systems. We consider three developed markets viz. the United States of America, the United Kingdom and Japan, as well as three emerging markets viz. Malaysia, Korea and China in detail. China is a special case since the circuit breaker mechanism was implemented in the country and later revoked. A general overview of the system prevailing in more countries is also provided in a tabular format.

United States of America

The market-wide circuit breaker system, which was initially initiated in the United States, was developed with the intention of preventing severe market price declines. The circuit breakers get triggered at a threshold of 7%, 13% and 20%. These triggers are determined based on single-day decreases in the S&P 500 index. The levels are decided by the New York Stock Exchange (NYSE) based on daily calculations of the closing value of the S&P 500, rounded to the nearest 50 points. It was earlier determined by the DJIA (Dow Jones Industrial Average) index, when the levels of trigger were 10%, 20% and 30% and the levels were determined by quarterly calculations of the corresponding index price level. However, this was changed as per the Amended Rule 80B. The system currently in place has the following features:

- Level 1 circuit breaker is triggered if there is a breach of 7%. The markets are halted for a period of 15 minutes, if the breach happens before 3:25 p.m.
- Level 2 circuit breaker is triggered if the market movement crosses 13%. Once again, if the breach happens before 3:25 p.m. the markets are halted for a period of 15 minutes.
- A Level 3 circuit breaker is put in place if the breach crosses 20%. In this instance, the markets are prematurely closed for the rest of the trading day.

Before the amendment, the United States circuit breaker mechanism oversaw periods of suspension of trading for as long as an hour. However, the new rule decided to amend the same in order to "reflect today's high-speed, highly electronic trading market".

United Kingdom

The United Kingdom has static and dynamic thresholds of 5% to 25% put in place on a per instrument basis, depending on the liquidity of the security. Individual trading venues have their own thresholds based on which the trading halt mechanisms are triggered, which is dependent on the idiosyncratic tendencies of the individual market. For instance, the London Stock Exchange has a circuit breaker mechanism that is triggered when the market price movement breaches either a static or dynamic threshold that results in a trading halt. The dynamic threshold is based on the FTSE100, which is breached when a potential order book trade price is more than 3% away from the previous executed trade price in the order book. The static threshold for the same gets surpassed when a potential order book trade price is more than 8% away from the price that gets established in the previous auction, such as an opening price. Thus, when the potential matching trade price breaches either of the above mentioned values, it results in the automatic implementation of a circuit breaker, wherein trading is halted for a period of 5 minutes, during which no trades get executed. A call auction is implemented post the halt and once the auction is completed, continuous trading once again commences. The static threshold is reset post the auction.

Japan

Japan implements market-wide circuit breakers when threshold limits of 5% and 10% are breached. Each of the trading halts that are triggered on implementation of the break lasts for a duration of 15 minutes, if it is triggered before 2:30 p.m. The threshold limits are set based on the previous trading day's settlement price. Limits do not apply to the final 30 minutes of

the trading day, unless the 15-minute cooling off period spills over into that time frame. The Japanese system does not have co-ordination between the equity and derivatives markets, such as in India and the United States. Instead, they implement a separate system in the derivatives market. In this instance, there are no limits for the last day of trading for the contract nearest to expiry.

Malaysia

Circuit breakers in Malaysia are triggered based on percentage falls in the FBMKLCI index, which is an index composed of the 30 largest companies on the Bursa Malaysia by market capitalization. Such percentage falls are determined against the previous day's closing index. Suspension of trading as usual occurs when the circuit breaker is triggered. The categorization for the triggers is as follows:

- If the level is greater than 10% but less than 15%, trading is suspended for 1 hour.
- If the level of the breach is greater than 15% but less than 20%, then the halt occurs for a period of 1 hour.
- Finally, if the breach is greater than 20%, then the markets are closed for the rest of the day.

The Malaysian markets also have a static price limit for each security. However, the circuit breaker mechanism is implemented only in the cash markets and not in the derivative market.

Korea

The Korean circuit breaker system is implemented both in the cash and derivatives segments. Introduced as early as 1998 with the motive of pacifying over-reaction of investors to sudden price drops, the circuit breaker gets implemented in three stages. The system also resumes with an auction period post the halt, like the Indian system. The system is as follows:

- The breach of an 8% movement in either direction results in a 20 minute halt followed by a 10 minute auction.
- Breaching of the 15% level once again results in a 20 minute halt followed by the 10 minute auction.
- Crossing 20% results in suspension of trading for the rest of the day.

During the periodic call auction that lasts for 10 minutes, orders are submitted and collected in the system. Then when trading resumes post the auction, the orders get matched at a single price.

China

China implemented a market-wide circuit breaker system on January 1, 2016. The system was designed to be triggered on the basis of the movement of the CSI 300 index. If the index rose or fell by 5% before 2:45 p.m. (which is 15 minutes before the normal closing time) then the markets would halt for a period of 15 minutes. If the same happened post 2:45 p.m. or if the index breached a level of 7% at any point in time, trading would halt immediately for the remainder of the day. Within three days of its inception, "full breaking' was triggered on multiple occasions. The first instance happened on January 4 and the second on January 7, 2016 respectively. Thus, the system which was meant to "protect investors and calm markets" ended up setting off a panic induced spiral that resulted in two consecutive market crashes mere days apart. This resulted in China suspending the circuit breaker mechanism on January 8, 2016.

Table 2 gives a broad overview of the trading curb mechanisms existing in various countries across the globe.

Table 2: Circuit Breaker Systems in Different Markets

Sl. No.	Exchange		Level I	Level II	Level III	Remarks
1.	US	Threshold	7%	13%	20%	1. Developed market 2. Market-wide CB 3. Co-ordination between cash and derivatives market
		Duration	15 mins (before 3:25 pm)	15 mins (before 3:25 pm)	Rest of day	
2.	Canada	Threshold	7%	13%	20%	1. Developed market 2. Market-wide CB 3. Harmonized with the US
		Duration	15 mins (before 3:25 pm)	15 mins (before 3:25 pm)	Rest of day	

3.	UK		Static and Dynamic Thresholds of 5% to 25% depending on liquidity of security. Once the tolerance level is breached, the trading for securities resumes with an auction and after the auction is completed, continuous trading commences.			1. Developed market 2. Stock-specific CB
4.	Japan	Threshold	5%	10%		1. Developed market 2. Market-wide CB 3. Separate CB implemented in derivatives market
		Duration	15 mins (before 2:30 pm)	15 mins (before 2:30 pm)		
5.	Germany		The exchange does not publish thresholds for price limits. However, a Volatility Auction is triggered when either a static or a dynamic price limit is breached. This auction lasts approximately 2 minutes and ends randomly. Further, if the price lies beyond the defined range, the auction continues until manually terminated.			1. Developed market 2. Stock-specific CB 3. Separate CB implemented in derivatives market
6.	Australia		Dynamic range of 10% updated approximately every 3 mins.			1. Developed market 2. Order rejection mechanism only in the cash market.
7.	Singapore		Circuit breaker on single security at and above $0.50: +/-10% from the reference price (last traded price as of 5 minutes prior/opening price/previous day's close/last traded price, in that order of precedence). Once a circuit breaker is triggered, a five-minute cooling-off period follows during which trading can only take place within the ±10% price band.			1. Developed market 2. Stock-specific CB

8.	Malaysia	Threshold	10%	15%	20%	1. Emerging market 2. Market-wide CB 3. Also has static price limit for each security 4. Cash market only
		Duration	1 hour	1 hour	Rest of day	
9.	Korea	Threshold	8%	15%	20%	1. Emerging market 2. Market-wide CB 3. Operated in both cash and derivatives segments
		Duration	20 min + 10 min auction	20 min + 10 min auction	Rest of day	
10.	Israel	Threshold	8%	12%		1. Emerging market 2. Has static and dynamic volatility interruption mechanism also 3. Co-ordination between cash and derivatives market
		Duration	45 min	Rest of day		
11.	Brazil	Threshold	10%	15%	20%	1. Emerging market 2. Market-wide CB
		Duration	30 mins	1 hour	Rest of day	
12.	Hong Kong		The VCM is triggered if the price of a VCM security deviates more than ±10% from the last traded price 5-min ago. When VCM is triggered a 5-min cooling-off period will follow during which trading is allowed within a ±10% price band. Normal trading without restriction will resume after cooling-off period. VCM can only be triggered once per session			1. Emerging market 2. Volatility Control Mechanism at the security level 3. Both cash and derivatives markets

13.	China	Threshold	5%	7%		1. Emerging Market 2. Market-wide CB
		Duration	15 min (before 2:45 pm)	Rest of day		
14.	Thailand	Threshold	10%	20%		1. Emerging market 2. Market-wide CB 3. Co-ordination between cash and derivatives markets.
		Duration	30 mins	1 hour		

Section IV
Data and Methodology

A. Data

The paper made use of data obtained from the website of the National Stock Exchange (NSE). Historical index data regarding the open, close, high and low prices are easy to access on the website. Further, data regarding the volume of trades, viz. 'shares traded' and 'turnover' are also available for the range of dates that one wants to access the data for. The study entailed an analysis that primarily comprised the above measures for the index, Nifty 50, which comprises 50 stocks that are representative of India's equity market. Thus, the database was chosen due to its ease of accessibility regarding the required variables. The website itself provides an extensive range of data on a variety of measures for equities, mutual funds, IPOs, exchange traded funds, etc. to name a few.

B. Methodology

The paper follows an 'Event Study' method to assess the impact that certain events have on measures of volatility and liquidity for the index. This is done with the intention of analyzing whether the circuit breaker mechanism currently in place is effective and if there is scope to revise the same. The analysis starts by considering the index data for all the trading days since July 2001, when the circuit breaker mechanism was introduced in India. The circuit breaker mechanism in India works on the basis that it gets triggered if either the Nifty 50 or BSE Sensex (which is the stock market index of the Bombay Stock Exchange) breaches the percentage levels that have been set for setting off the circuit breakers. Thus, it is dependent on which index breaches the said levels first. Hence, this study considers the Nifty 50 index since a preliminary analysis of the two indices reveals that they move in a similar fashion in both the upward and downward directions.

The percentage fall and rise in the index levels was calculated by considering the previous day's close with respect to the present day's low and high values respectively. We define all those events that fall within 99% of the total events as 'normal events'. The events that lie within the remaining 1% are considered as 'outliers', and hence warrant a closer observation. The events that fall within that 1% range constitute the sample for the Event Study analysis being used in this paper. A closer observation shows that all events that lie within 4% in terms of market movement (fall and rise) come within the above mentioned 99% of events. Thus, all those events that lie above 5% of market movement are the outliers. This constitutes

49 events out of a total of 4457 for movement in the downward direction, and a total of 28 events in the opposite direction. Each of the events was then individually assessed to find out the reason for the abnormal activity on that day. This was done using information available from news archives online. The same is provided in the Appendix section of this paper. A glance into the same showed that for events that come under 'Nifty Low' (which refers to the events that occurred when the Nifty 50 index underwent a fall greater than 5%), 39 of the 49 events were caused due to global occurrences. While 9 of the events happened due to local incidents, 1 event was fuelled by a mix of both global and local occurrences. A similar analysis for the events of 'Nifty High' (which comprises the events when Nifty 50 index underwent a rise above 5%) showed that 18 of the 28 events happened due to global incidents, while the remaining 10 were a result of local incidents.

The next step involved a close scrutinization of each of the events to understand the impact a particular event had on measures of volatility and liquidity in the markets. The measures chosen were as follows:

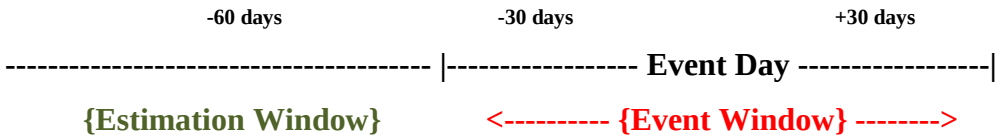
1. **Volatility:** The natural logarithm of the day's high price divided by the day's low price was taken as the measure of intraday volatility. This measure is backed by the literature as it was utilized by Kim et al (2008) in their study. It gives an indication of the extreme movement within the market on a particular day.

   Volatility = ln(day's high price / day's low price)

2. **Liquidity:** We have considered two measures of liquidity for this study viz. 'Shares Traded' and 'Turnover'. These two measures give an indication of the volume of trades that have happened in the market on a trading day.

The Event Study method required a value that could be used as the benchmark indicator against which the values for the above measures on the event day could be compared. For the same purpose, we first considered 30 days prior and post the event day and termed it the 'Event Window'. The event window is set aside as a period during which the values of the respective measures could be biased and hence deviant from the norm, as it could be influenced by factors that affect the event. Then, we consider a period of 60 days prior to the 30 days before the event day and term that the 'Estimation Window'. The average value for all the above measures for this period was calculated and established as the benchmark

against which subsequent analyses could be conducted. The reasoning behind the same is that this period could be free from any influences that would affect the forthcoming event day.



The values obtained for each of the three measures for the estimation period was then compared with that of the event day to analyze if there was any significant difference in the value on the event day. This would give perspective on the behavior of the markets on the event day and whether it was different from the behavior on a normal day. The performance of an F-Test conveyed that the dataset comprised unequal variances. Thus, the study was conducted using a T-Test assuming unequal variances, to identify whether the difference in average values between the estimation period and the event day was significant. The same analysis was further extended for a period of 15 days prior and post the event to understand the behavior of the markets during the event window. Such an analysis helped to understand how many days post the event the market normalized.

The above methodology was applied after dividing the dataset into two buckets viz. (i) events where market movement was greater than 5% but less than 10% and (ii) events where the market fluctuation was greater than 10%. While the former group does not warrant the triggering of a circuit breaker, the latter group does. This division is done with the purpose of understanding whether the circuit breaker is effective in curbing the volatility, and to know what it does to liquidity in the markets. Thus, it can be looked upon as a study that analyses the instances of outliers with and without a circuit breaker being triggered. This methodology was separately applied to both Nifty Low as well as Nifty High. Further, it was noted that while Nifty Low comprised a total of 49 events, Nifty High only contained 28 events. A One Sample Chi-Square Test is applied to understand if there is a significant difference between these two values and what this observation means.

Section V
Results and Analysis

First considering the case of Nifty Low, the Event Study analysis reveals that for both the groups, i.e. (i) greater than 5% but less than 10% market movement (Group I) and (ii) greater than 10% market movement (Group II), volatility gets affected more than liquidity. This shows that during such situations there is no dearth of traders willing to buy or sell shares, i.e. markets are not drying out during these periods of extreme volatility. But there is a need to regulate the manner in which these trades happen so that the panic does not induce haywire buying and selling. This is an issue that can be resolved by the application of a circuit breaker. The above observation is inferred from the number of days it takes for the markets to normalize post the event, in the instances that warrant the application of a circuit breaker and otherwise.

Table 3: Comparison of Normalization of Markets

Group	Measure	Normalization pre-event	Normalization post-event
Group I	Volatility	8 days	Not normalized even after 15 days
	Shares Traded	1 day	8 days
	Turnover	NA	NA
Group II	Volatility	2 days	4 days
	Shares Traded	2 days	Same day
	Turnover	NA	NA

*__Normalization pre-event:__ Refers to the number of days prior to the event that the measures were showing behavior deviant from that of the estimation period, which is dubbed 'normal'.
*__Normalization post-event:__ Refers to the number of days post the event it took for the measures to return to 'normal'.
**__NA:__ The measure does not show behavior deviant from that of the 'normal'.

From the above table, we can see that the circuit breaker is effective in curbing the volatility. Whereas in the instance of Group I, the markets do not return to a state of normalcy with regards to volatility even after 15 days post the event, it does so within a span of 4 days on the application of the circuit breaker. A detailed table of the results of the T-Test is provided in Tables 3 and 4 of the Appendix. However, since 22 out of the 41 events in Group I comprised events that lie in the category that show a market movement greater than 5% but less than 6%, a second analysis was performed to weed out the bias in the sample that could be caused due to the same. Thus, we re-define the groups as follows: (i) events that show market movement greater than 6% and less than 10% (Group I) and (ii) events that show

market movement greater than 10% (Group II). Performance of the Event Study analysis on these groups yields the results as shown in Table 4.

Table 4: Comparison of Normalization of Markets

Group	Measure	Normalization pre-event	Normalization post-event
Group I	Volatility	3 days	7 days
	Shares Traded	0 days	Same day
	Turnover	NA	NA
Group II	Volatility	2 days	4 days
	Shares Traded	2 days	Same day
	Turnover	NA	NA

The above analysis yields similar results as the previous study in terms of how circuit breakers are efficient in curbing the volatility. While in this case, it does not take more than 15 days for the volatility to be curbed, it still takes 7 days in the instance of Group I, which is sufficiently higher than the 4 days it takes for the same in the event of triggering a circuit breaker. The T-Test results for the same are provided in Table 5 of the Appendix. In a bid to understand another dimension of the issue, we perform an analysis to understand what the 'market recovery' is for the event days in Group I. The market recovery is computed as the difference of the previous day's close and present day's close divided by the previous day's close.

Market recovery = (previous day close – present day close) / previous day close

Thus, it gives an idea of how much the market has recovered in comparison to the previous day post the occurrence of an event. The same is presented in Table 6 of the Appendix. An analysis of the same shows that in 16 out of the 19 events in this group, the markets have witnessed more than 50% recovery. In 14 instances, the markets have shown more than 75% recovery and in 8 instances, it has shown more than 90% recovery. These statistics show that the market is able to recover to the level of its previous close even without the application of a circuit breaker. Thus, the inference that can be drawn is that circuit breakers definitely help to improve the situation and bring about orderly movement of markets with regards to curbing the volatility, while it does not play a role in helping the markets recover post an event.

Out of the 8 events that triggered the circuit breaker when the markets fell more than 10%, a trading halt was applied in only 5 of the instances. This is because in the other 3 cases, the markets fell more than 10% post 2:30 p.m., which as per the design of the mechanism does not warrant a halt. A similar Event Study analysis on (i) events that saw a market movement greater than 10% that resulted in a trading halt (Group A) and (ii) events that saw a market movement greater than 10% that did not result in a trading halt (Group B) showed that there isn't a difference between the time it takes for normalization of the measures between the two groups. The same is presented in Table 5 below. The results of the T-Test are provided in Tables 7 and 8 of the Appendix section.

Table 5: Comparison of Normalization of Markets

Group	Measure	Normalization pre-event	Normalization post-event
Group A	Volatility	0 days	1 day
	Shares Traded	2 days	Same day
	Turnover	NA	NA
Group B	Volatility	0 days	Same day
	Shares Traded	NA	NA
	Turnover	NA	NA

A possible explanation for the above could be that there is already an embedded circuit breaker in the case of those events that do not result in a trading halt as the markets close at 3:30 p.m.

An Event Study similar to that of Nifty Low could not be conducted for Nifty High since there was only one event where the markets resulted in a 10% rise and triggered the circuit breaker. However, an interesting observation that warrants attention is the fact that 49 events were observed to be outliers in the case of Nifty Low, while only 28 such events were available for Nifty High. Statistical analysis of the same using a One Sample Chi-Square test revealed that there is a significant difference between the two values, as the p-value shows that the null hypothesis that both the values are the same can be rejected at the 5% significance level. This shows that investors tend to panic more when the stocks are showing extreme movement in the downward direction than in the upward direction. The same is also reflected in the fact that there are 5 instances of the circuit breaker being applied when the markets fell more than 10% as opposed to 1 such event when the markets rose above 10%. The results are as follows:

Table 6: Results of Chi-Square Test

	Nifty Low	Nifty High
Observed Value	49	28
Expected Value	38.5	38.5
p-value	0.016703	

Thus, the study reveals that there is scope for a downward revision of the circuit breaker from the point of view of curbing volatility. This can be further backed by taking into consideration the psychological aspect wherein on decreasing the level at which the circuit breaker gets triggered, the investor gets alert with regards to his market participation in anticipation of a circuit breaker. This can ensure that investors get time to make rational decisions at an earlier stage than would be possible currently.

Further analysis with regards to understanding whether the circuit breaker levels need to be brought down can be done by considering the behavior for the measures in the derivatives markets. This will ensure an in-depth exploration of the problem in light of the market as a whole since in India the circuit breaker mechanism is co-ordinated between the equity and derivatives markets.

Section VI
Conclusion

This paper investigates the existing circuit breaker mechanism in India and tries to understand whether there is a need to revise the levels at which the circuit breakers are triggered. An exploratory study of the equity markets reveals that there is scope for a downward revision from the perspective of curbing volatility. However, from a market recovery perspective, it is found that markets do recover without the imposition of the system. Thus, there is a need to probe further into the issue to understand if there are other dimensions that can be considered, that could speak for or against such a downward revision. One such dimension that can give more perspective is a similar study of the derivatives markets along with the equity markets. This will give a comprehensive understanding of the market behavior on event days in terms of volatility and liquidity. The study thus aims to understand the market microstructure to suggest changes if required so that investors can have a more conducive environment for trading, which is the objective of the regulator too.

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Appendix

Table 1: Events that Resulted in a Fall in the Index

Date	% Fall	Event	Nature of Event
17-May-04	18.3392	Unfavourable election results	Local
05-Oct-12	15.5401	NSE error	Local
22-Jan-08	14.5965	Global crisis and meltdown	Global
24-Oct-08	14.2059	Imminent recession in USA	Global
27-Oct-08	12.8193	Continuation of global crisis and meltdown	Global
21-Jan-08	12.7636	Fear of US economy going into recession	Global
22-May-06	10.7949	Concern on margin pressure and taxation	Local
17-Oct-07	9.8932	Clampdown on P Notes by SEBI	Local
10-Oct-08	8.9565	Fears of global recession deepened	Global
14-May-04	8.7656	Aftermath of unfavourable election results	Local
08-Oct-08	7.6845	Global financial crisis	Global
18-May-06	7.4056	US CPI number above expectations	Global
11-Nov-08	7.2675	Global financial crisis	Global
07-Jan-09	7.2154	Satyam Computers scandal	Global
16-Oct-08	7.1441	Global financial crisis	Global
14-Sep-01	7.101	Selling pressure exerted by foreign funds	Global
17-Oct-08	6.8119	FIIs taking money out of Indian markets to repay obligations	Global
31-May-06	6.6681	Sentiment in the markets turned bearish	Local
06-Jul-09	6.5672	Concerns regarding prolonged recession in the US	Global
15-Sep-08	6.4574	Heavy selling by FIIs	Global
12-Sep-01	6.3953	Terrorist bombings in NY and Washington	Global
24-Aug-15	6.3922	Concerns about China's stalling economy	Global
17-Sep-01	6.3771	US attack	Global
09-Nov-16	6.3358	Demonetisation, US elections showing Trump's lead	Local, Global
06-Oct-08	6.1991	US $700 billion bank bailout plan	Global
08-Jun-06	6.1966	Rate hikes by Fed and other central banks	Global
11-Feb-08	6.1861	Continuation of reasons listed for 21-Jan-08	Global
13-Mar-08	5.9904	Global economic jitters	Global
28-Jan-08	5.8021	Possibility of US recession	Global
22-Oct-08	5.6601	Weak global cues and general nervousness	Global
28-Feb-07	5.6255	Wave of selling set off by worries of weakening economies	Global
17-Mar-08	5.5565	Weak cues from overseas markets	Global
15-Oct-08	5.5163	Recession scare in the US	Global
03-Mar-08	5.503	Deepening concerns on US recession	Global
05-Nov-08	5.4454	Worries about the struggling economy in the US	Global
21-Sep-01	5.435	Economic toll due to deadly terrorist attacks in the US	Global
19-May-06	5.4192	Global fall in metal and other commodity prices	Global
05-Jan-05	5.3999	Release of minutes of Fed's policy meeting in December	Global

02-Apr-07	5.3525	RBI decision to hike the CRR and repo rate	Local
03-Jul-08	5.3379	Rise in crude prices as supplied get tighter	Global
29-Sep-08	5.218	Stock market crash of 2008	Global
18-Oct-07	5.2102	World Financial Crisis	Global
18-Sep-08	5.2068	Financial panic	Global
28-May-04	5.1942	Aftermath of May 17 2004	Local
17-Dec-07	5.078	Federal Reserve's 25 bps cut	Global
07-Mar-08	5.0626	Weak cues from overseas markets	Global
15-Jul-08	5.0548	Global financial crisis	Global
13-May-04	5.026	Electoral loss of the Vajpayee government	Local
20-Nov-08	5.0133	Growing fears of deep global recession	Global

Table 2: Events that Resulted in a Rise in the Index

Date	% Rise	Event	Nature of Event
18-May-09	19.4095	UPA won elections	Local
18-May-04	9.2781	Heavy buying	Local
23-Jan-08	8.7513	Rate cut by the US Fed	Global
31-Oct-08	8.3165	Gains reflect all the selling in the previous weeks	Global
25-Jan-08	7.2674	Multiple positive corporate developments	Local
13-Oct-08	7.0199	Global campaign to unlock the flow of credit in the world	Global
15-Jun-06	6.8881	US rate hike dispelled market's uncertainty over rates	Global
28-Oct-08	6.8041	Cut in a key short-term interest rate expected in the US	Global
21-Nov-08	6.4802	Reports that Timothy Geithner will be treasury secretary	Global
10-Nov-08	6.332	Economic stimulus package introduced in China	Global
25-Mar-08	6.2247	Various positive corporate developments	Local
16-May-14	6.182	Modi becomes PM	Local
03-Nov-08	6.1148	US Fed's decision to cut interest rates	Global
23-Jul-08	5.9303	Bailout plan for Fannie Mae and Freddy Mac	Global
14-Feb-08	5.8992	Sentiment of trading counters turned bullish	Local
23-Oct-07	5.8738	Multiple corporate developments	Local
16-Jun-06	5.765	US Fed Chairman says not to be worried about inflation	Global
10-Dec-08	5.6088	Extension of buying on Dec 5 2008	Global
19-Sep-08	5.5595	Govt's plan to rescue banks from toxic mortgage debt	Global
09-Jun-06	5.5573	Bull domination	Local
02-Apr-09	5.5026	Key accounting rule that has impact on banks is changed	Global
04-May-09	5.4851	Precursor to 18 May 2009	Local
08-Dec-08	5.4211	President Obama's plan to create jobs	Global
02-Jul-08	5.3994	Multiple positive corporate developments	Local
20-Oct-08	5.3361	Investors welcome lending-market improvement	Global
09-Oct-07	5.1838	Fed meeting add to bets that Fed can lower rates	Global
04-Dec-08	5.1704	Starting of a period of buying that took off on Dec 5 2008	Global
23-Mar-09	5.0836	Obama administration plan to buy $1 trillion bad bank assets	Global

Table 3a: T-Test Results for Volatility for Group I (including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-9	0.0251	0.0349	0.0797
E-8	0.0251	0.0341	0.0157
E-7	0.0251	0.0383	0.0138
E-6	0.0251	0.0374	0.0063
E-5	0.0251	0.0368	0.0121
E-4	0.0251	0.0412	0.0012
E-3	0.0251	0.0418	0
E-2	0.0251	0.3677	0.0004
E-1	0.0251	0.0406	0.0002
Event Day	0.0251	0.0664	0
E+1	0.0251	0.0536	0
E+2	0.0251	0.0512	0.0001
E+3	0.0251	0.0451	0
E+4	0.0251	0.0456	0
E+5	0.0251	0.0413	0.0003
E+6	0.0251	0.0457	0.0001
E+7	0.0251	0.0427	0.0007
E+8	0.0251	0.0387	0.0017
E+9	0.0251	0.0385	0.0002
E+10	0.0251	0.0429	0.0001
E+11	0.0251	0.0436	0.0004
E+12	0.0251	0.0388	0.002
E+13	0.0251	0.0402	0.0009
E+14	0.0251	0.0397	0.0015
E+15	0.0251	0.0377	0.0003

*E-x = x days before the event day
*E+x = x days after the event day

Table 3b: T-Test Results for Shares Traded for Group I (including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-2	125000000	1.45E+08	0.1118
E-1	125000000	152000000	0.0446
Event Day	125000000	179000000	0.0064
E+1	125000000	177000000	0.0031
E+2	125000000	158000000	0.0201
E+3	125000000	166000000	0.0115
E+4	125000000	152000000	0.0392
E+5	125000000	161000000	0.0129
E+6	125000000	159000000	0.0193
E+7	125000000	159000000	0.0345
E+8	125000000	158000000	0.0336
E+9	125000000	150000000	0.0967

Table 3c: T-Test Results for Turnover for Group I (including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	6271.83	6295.43	0.963
Event Day	6271.83	7207.89	0.1283
E+1	6271.83	6964.75	0.2284

Table 4a: T-Test Results for Volatility for Group II

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-3	0.0236	0.0309	0.2823
E-2	0.0236	0.0476	0.03
E-1	0.0236	0.0746	0.0266
Event Day	0.0236	0.1495	0
E+1	0.0236	0.0881	0.0039
E+2	0.0236	0.0542	0.0057
E+3	0.0236	0.0518	0.0124
E+4	0.0236	0.0522	0.006
E+5	0.0236	0.0370	0.0895

Table 4b: T-Test Results for Shares Traded for Group II

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-3	123000000	1.48E+08	0.1814
E-2	123000000	161000000	0.0240
E-1	123000000	200000000	0.0161
Event Day	123000000	226000000	0.0106
E+1	123000000	172000000	0.1529

Table 4c: T-Test Results for Turnover for Group II

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	6087.19	8472.11	0.0544
Event Day	6087.19	9337.22	0.0547
E+1	6087.19	7305.17	0.4768

Table 5a: T-Test Results for Volatility for Group I (not including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-4	0.0249	0.0368	0.0759
E-3	0.0249	0.0378	0.0186
E-2	0.0249	0.0354	0.0367
E-1	0.0249	0.0421	0.0061
Event Day	0.0249	0.0724	0
E+1	0.0249	0.0602	0.0019
E+2	0.0249	0.0521	0.0007
E+3	0.0249	0.0459	0.0004
E+4	0.0249	0.0478	0
E+5	0.0249	0.0500	0.0041
E+6	0.0249	0.0525	0.0051
E+7	0.0249	0.0442	0.0141
E+8	0.0249	0.0354	0.0535

Table 6b: T-Test Results for Shares Traded for Group I (not including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	132000000	161000000	0.2201
Event Day	132000000	210000000	0.0463
E+1	132000000	194000000	0.0696

Table 5c: T-Test Results for Turnover for Group I (not including 5%)

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	5736.95	6404.90	0.446
Event Day	5736.95	7950.67	0.0526
E+1	5736.95	7159.29	0.1724

Table 6: Market Recovery

Date	% Fall	% Recovery
11-Feb-08	6.18	5.42
06-Oct-08	6.19	5.99
08-Jun-06	6.19	4.99
09-Nov-16	6.33	1.32
17-Sep-01	6.37	5.44
12-Sep-01	6.39	4.19
24-Aug-15	6.39	6.28
15-Sep-08	6.45	3.81
06-Jul-09	6.56	6.2
31-May-06	6.66	3.72
17-Oct-08	6.81	6.34
14-Sep-01	7.1	5.65
16-Oct-08	7.14	2.11
07-Jan-09	7.21	6.58
11-Nov-08	7.26	7.13
18-May-06	7.4	7.26
08-Oct-08	7.68	2.64
14-May-04	8.76	8.53
10-Oct-08	8.95	7.12

Table 7a: T-Test Results for Volatility for Group A

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	0.0199	0.07	0.101
Event Day	0.0199	0.1542	0.0011
E+1	0.0199	0.0691	0.0215

Table 7b: T-Test Results for Shares Traded for Group A

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-3	114000000	1.26E+08	0.5067
E-2	114000000	1.51E+08	0.039
E-1	114000000	176000000	0.006
Event Day	114000000	181000000	0.0467
E+1	114000000	157000000	0.0637

Table 7c: T-Test Results for Turnover for Group A

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	5338.44	8625.90	0.098
Event Day	5338.44	2032.42	0.1174
E+1	5338.44	7764.98	0.2812

Table 8a: T-Test Results for Volatility for Group B

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	0.0297	0.0823	0.268
Event Day	0.0297	0.1417	0.0015
E+1	0.0297	0.1198	0.0842

Table 8b: T-Test Results for Shares Traded for Group B

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	139000000	240000000	0.243
Event Day	139000000	44600000	0.0679
E+1	139000000	198000000	0.554

Table 8c: T-Test Results for Turnover for Group B

Day	Mean of Estimation Period	Mean of Comparison Day	p-value
E-1	7335.11	8215.79	0.401
Event Day	7335.11	9148.43	0.4115
E+1	7335.11	6538.81	0.8204