BARCLAYS

Equities
Electronic Trading

May 2013

The Real Impact of Limit Up-Limit Down

Overview and Analysis

Abstract

This paper provides an overview of the "Limit up-Limit down" (LULD) rule and analysis on how frequently the rule might impact markets. We investigated 14 instances in which the rule would have impacted trading during Q1 2013, had it been in effect at the time. While it is difficult to fully represent the impact of the rule during a period in which it was not in effect, we conclude that LULD should affect markets only on rare occasions. The rule should successfully prevent erroneous trades and mitigate the negative impacts of short-term order imbalances.

Introduction

In the wake of the May 6, 2010 "flash crash," during which major US equity indexes dropped and then recovered several percentage points within minutes, the US Securities and Exchange Commission (SEC) undertook a series of market structure-related regulatory initiatives to address extraordinary short-term volatility in US securities, establish risk controls, and increase oversight. Among other measures, the SEC introduced the following:

- *Circuit breakers*: New stock-by-stock circuit breaker rules that required the exchanges and FINRA to pause trading in certain stocks if the price moved 10% or more in a five-minute period;[1]
- *Erroneous trades*: New exchange and FINRA rules that clarified how and when erroneous trades would be broken;[2] and
- *Stub quotes*: New exchange and FINRA rules that strengthened the minimum quoting standards for market makers, effectively prohibiting "stub quotes" in the US equity markets.[3]

Within a year of the flash crash, market participants soon realized that a better plan was needed to address volatility in individual securities. Perhaps one of the most pertinent criticisms with regulation following May 6, 2010, was that the stock-by-stock circuit breakers were insufficiently calibrated. For example, the circuit breakers were sometimes triggered by trades that occurred at or outside of the price band, and erroneous trades had been known to trigger trading halts.[4]

Seeking a better system for addressing rapid and excessive volatility in individual stocks, in April 2011, the exchanges and FINRA jointly proposed the limit up-limit down mechanism to prevent trades in individual listed securities from occurring outside of specified price bands. The mechanism also introduced trading pauses to accommodate more fundamental price moves. Approved in May 2012, the limit up-limit down rule began rolling out to certain securities on April 8, 2013.

[1] See: http://www.sec.gov/news/press/2010/2010-98.htm (Jun 2010).
[2] See: http://www.sec.gov/news/press/2010/2010-167.htm (Sep 2010).
[3] See: http://www.sec.gov/news/press/2010/2010-216.htm (Nov 2010).
[4] See p. 40 at: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.

What is Limit up-Limit down (LULD)?

Overview

On April 5, 2011, national securities exchanges and FINRA (collectively, the self-regulatory organizations, or SROs) filed a proposal to establish a new limit up-limit down rule to address extraordinary volatility in US securities.[1]

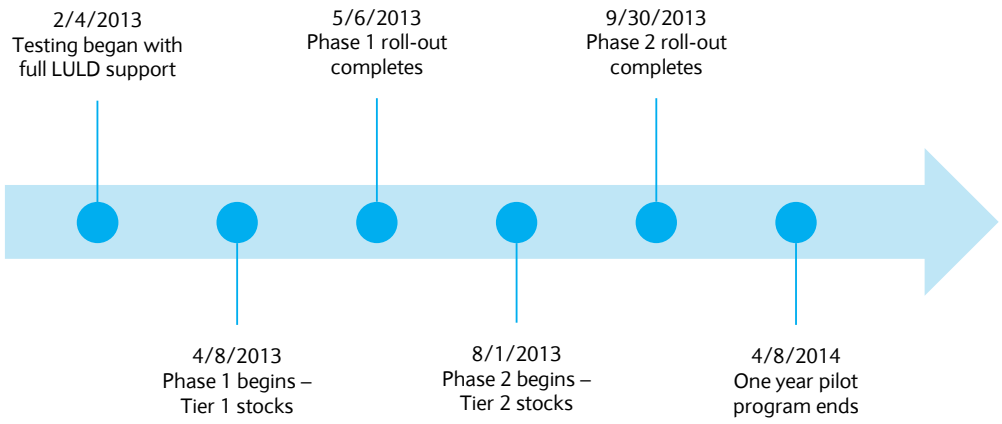
The rule, which was approved on May 31, 2012 on a pilot basis, provides for market-wide limit up-limit down requirements designed to prevent trades in individual securities from occurring outside of specified price bands.[2] The limit up-limit down requirements are coupled with stock-specific trading pauses to accommodate more fundamental price moves. LULD is replacing the single-stock circuit breakers (SSCBs) that were introduced following the May 6, 2010 flash crash.

Under LULD, US trading centers are required to have and enforce written policies and procedures that are reasonably designed to comply with the new limit up-limit down and trading pause requirements. Each of the US equities exchanges has published a document that explains how their particular marketplace will handle LULD.[3]

LULD, a one-year pilot program, enters effect in two phases, rolling out to all NMS stocks over the next several months.[4] Phase 1, which began April 8, 2013, includes "Tier 1" securities. Phase 2, which begins August 1, 2013, includes "Tier 1" and "Tier 2" securities.

- Tier 1: S&P 500, Russell 1000, and select exchange-traded products (ETPs)
- Tier 2: all US securities other than those in Tier 1, excluding rights and warrants

Figure 1
LULD Timeline



[1] See: http://www.sec.gov/news/press/2011/2011-84-plan.pdf.
[2] See: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.
[3] Links to Exchange FAQs are as follows: http://bit.ly/Zn4Ne6 (BATS); http://bit.ly/11Erv1w (NASDAQ); http://bit.ly/ZRfQfC (CBSX); http://bit.ly/10HbSaK (CHX); http://bit.ly/YE23GQ (Direct Edge); http://bit.ly/WRYyio (NSX); and http://bit.ly/X8Boa3 (NYX).
[4] The term "NMS stock" is defined in Reg NMS as "any NMS security other than an option." "NMS security" is defined as "any security or class of securities for which transaction reports are collected, processed, and made available pursuant to an effective transaction reporting plan, or an effective national market system plan for reporting transactions in listed options. http://www.sec.gov/rules/final/34-51808fr.pdf.

Price Bands

The price bands introduced by LULD are set at a percentage above and below a "reference price" for each security. A security's reference price represents the arithmetic mean of eligible trades in the security over the preceding five minutes, except for periods following openings and re-openings.[5]

Reference prices and price bands are calculated and disseminated by the securities information processors (SIPs) responsible for consolidation of information for US stocks. They are only updated if the new reference price is at least 1% away from the current reference price.

The percentage parameters of a given security will depend on the reference price of the security, the tier of the security, and – beginning in Phase 2 – the time of day.

In Phase 1, as LULD rolls out to securities in Tier 1, the rule is in effect from 9:45am to 3:30pm Eastern Time (ET). The price bands applicable during Phase 1 are shown in Figure 2 below.

Figure 2
Phase 1 Price Bands

Reference Price	Price Band Parameters – Tier 1 Securities
Greater than $3.00	5%
$0.75 up to and including $3.00	20%
Less than $0.75	Lesser of $0.15 or 75%

In Phase 2, as LULD rolls out fully to all securities covered, the rule is in effect from 9:30am to 4:00pm ET. Double-wide price bands will apply during the first 15 minutes and the last 25 minutes of trading (i.e., 9:30-9:45am and 3:35-4:00pm ET). The price bands applicable during Phase 2 are shown in Figure 3 below.

Figure 3
Phase 2 Price Bands

	Price Band Parameters	
Reference Price	Tier 1 Securities	Tier 2 Securities
Greater than $3.00	5%	10%
$0.75 up to and including $3.00	20%	20%
Less than $0.75	Lesser of $0.15 or 75%	Lesser of $0.15 or 75%

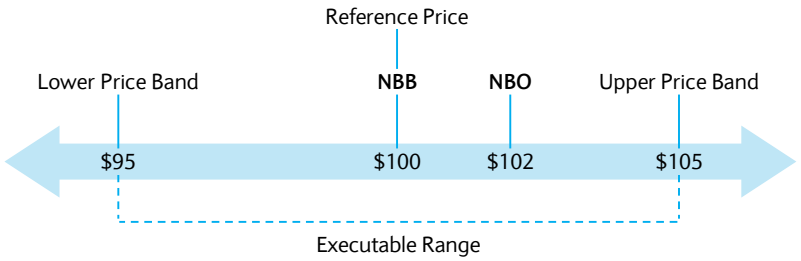
Note: Price bands are double wide from 9:30am to 9:45am and from 3:35pm to 4:00pm ET.

[5] For details on the calculation of Reference Prices, see: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.

Regular State

During LULD hours, trades are executable at prices within the price bands (i.e., prices that are greater than or equal to the lower price band and less than or equal to the upper price band). Figure 4 illustrates a regular state. In this example, the reference price is $100 with a lower price band of $95 and an upper price band of $105. Trades would be executable from $95 to $105 (with applicable Order Protection Rule exemption if outside the NBBO).[6]

Figure 4
Regular State



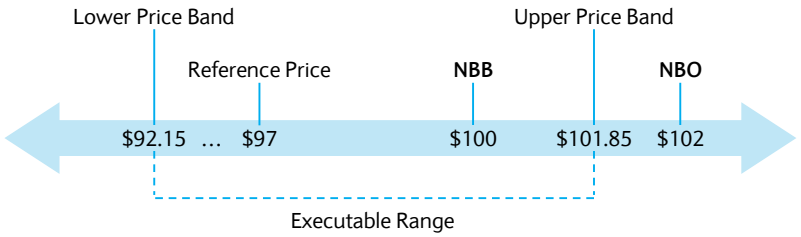
Note: For illustrative purposes only.

Straddle State

When one side of the market for an individual security is outside the applicable price band (i.e., when the NBB is below the lower price band, or the NBO is above the upper price band for a given stock), the SIPs are required to disseminate such NBB or NBO with an appropriate flag identifying it as non-executable.

Figure 5 illustrates a "straddle state" where the NBB and NBO are straddling the upper price band, a situation which could occur in a fast-rising market, in which the reference price trails behind the NBBO. In this example, only the NBB is executable, because the NBO is outside of the price bands.

Figure 5
Straddle State



Note: For illustrative purposes only.

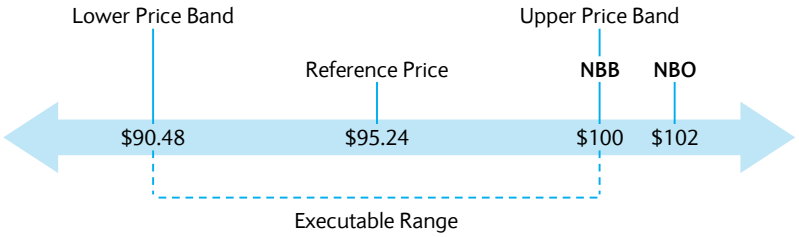
[6] NBBO stands for National Best Bid and Offer.

Limit State

The market for an individual security enters a "limit state" if the NBB is resting on the upper price band, or the NBO is resting on the lower price band. As with straddle states, limit states can occur in a rapidly rising or falling market, in which the reference price trails behind the NBBO. During a limit state, no new reference price or price bands are disseminated, and only the side of the market that is resting on the price band is executable.

Figure 6 illustrates a limit state in which the NBB ($100) is resting on the upper price band. In this example, only the bid side of the market is executable. Prices less than the NBB would only be executable with a valid Reg NMS Order Protection Rule exemption.

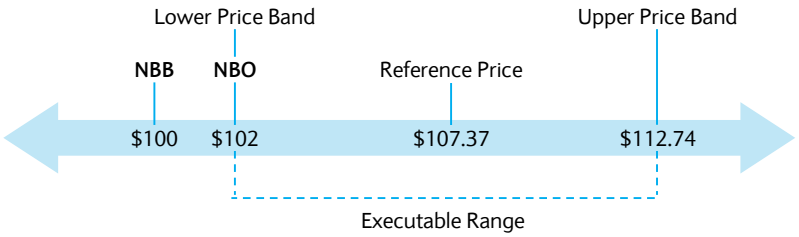
Figure 6
Limit State: NBB on Upper Price Band



Note: For illustrative purposes only.

Figure 7 illustrates a limit state in which the NBO ($102) is resting on the lower price band. In this example, only the offer side of the market is executable. Prices greater than the NBO would only be executable with a valid Reg NMS Order Protection Rule exemption.

Figure 7
Limit State: NBO on Lower Price Band



Note: For illustrative purposes only.

Trading Pauses

When trading for a security enters a limit state, it will only exit the limit state if, within 15 seconds, the NBB or NBO moves back inside the price bands. If a limit state lasts for more than 15 seconds, the primary listing exchange for the security will call a five-minute trading pause in the security. The onset of a trading pause would signal that market participants are unwilling to place orders within the LULD price parameters, a scenario that could result from a significant and unrelenting imbalance between buying and selling interest. The SEC rule filing refers to such a situation as a "liquidity gap."[7] The primary listing exchange can also issue a trading pause at its own discretion during a straddle state, which could happen if the symbol remained in a straddle state for an extended period of time.

During a trading pause, transactions in the affected security would be prevented at any price, but bids and offers would continue to display, allowing trading interest to replenish the order book. Five minutes after declaring a trading pause for a security, and if the primary listing exchange has not declared a regulatory halt in the security, the primary listing exchange will attempt to re-open trading using its established reopening procedures. Because of the fact that trading can reopen at a price that is significantly higher or lower than prices prior to the pause, large price movements in a security are still possible (only with reduced speed as a result of the pause).[8]

If the exchange cannot report a reopening price within 10 minutes from the start of the trading pause, and has not declared a halt, all other trading centers may then begin trading the security.

[7] See p. 84 and 86 at: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.
[8] For a discussion on this element of LULD, see p. 42 at: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.

Analysis

How Will LULD Impact Trading?

The limit up-limit down mechanism is intended to promote orderly markets by preventing extraordinary volatility in individual securities, while accommodating fundamental price moves. As stated in the SEC rule filing, LULD is designed to "reduce the negative impacts of sudden, unanticipated price movements" in individual securities, thereby "protecting investors and promoting a fair and orderly market."[9] The mechanism is meant to address, in particular, "the type of sudden price movements that the market experienced on… May 6, 2010" during the flash crash, when major US equity indexes dropped several percentage points within minutes, only to recover just as quickly.[10]

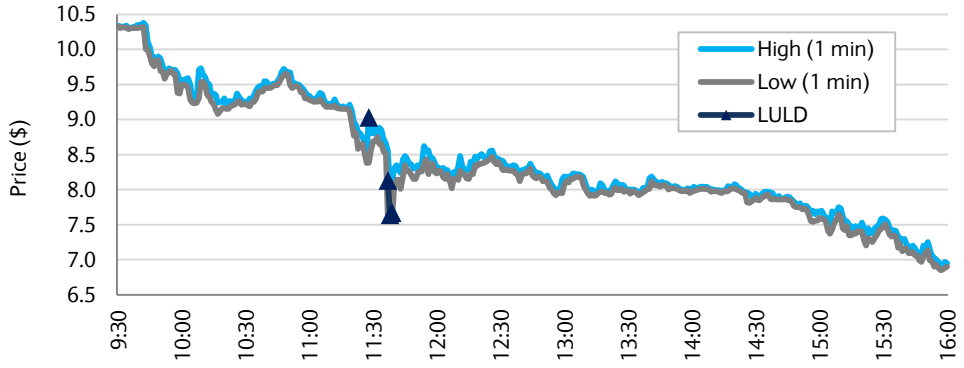
Price volatility in individual securities can occur for a variety of reasons as market participants digest new information that triggers decisions to trade. Factors that influence the discovery and volatility of stock prices may include:

- **Fundamental events** that impact expectations about a company's value (e.g., earnings announcements, legal action, changes in corporate governance)
- **Technical market conditions** that impact expectations about the stock's directional movement (e.g., volume trends, imbalance of buyers and sellers)

Because these factors are often unpredictable, deviations between the expectations of a stock's price and the fundamental value of a company are common. Such differences continuously drive market prices and make dramatic price swings possible as buyers and sellers trade on their convictions.

Consider, for example, the high-profile and extreme price swings in the trading of Knight Capital Group (NYSE: KCG) after its software error on August 1, 2012. Figure 8 shows the high and low price per minute for KCG from 9:30am to 4:00pm ET. In the chart, we indicate in navy blue the points at which trades would have been executed outside of LULD price parameters if LULD had been in effect.

Figure 8
Minute by Minute High and Low Prices for Knight Capital Group, Inc. (KCG) on August 1, 2012



Source: TAQ data; Barclays analysis.

[9] See p.10 at: http://www.sec.gov/news/press/2011/2011-84-plan.pdf.
[10] Id.

We find that over the course of the trading day on August 1, 2012, hundreds of executions in KCG were at prices outside of LULD parameters. The LULD price parameters were first breached at approximately 11:28am. Beginning almost ten minutes later, between 11:37am and 11:39am, approximately 1700 trades were executed outside of LULD parameters as the stock price fell precipitously. While it is difficult to determine precisely how trading behavior in KCG would have differed if LULD price parameters were in effect on that day, it is presumed that the rule would have prevented all of the trades that executed outside of the price bands, limiting the volatility in the stock to some extent.

It is interesting to note the sheer number of transactions that took place outside of LULD price parameters over the course of just two minutes, between 11:37am and 11:39am. As selling pressure dominated the market, the stock price fell from $8.13 to $7.64 in just 14 seconds. If trading scenarios such as the activity in KCG on August 1, 2012 arise in the future, the LULD trading pauses should reduce extreme short-term price movements,[11] improving the likelihood that such movements are the result of fundamental trading interest and not anomalous market behavior. With hundreds of transactions taking place every second in some securities, prices can move quickly, and a five-minute trading pause can provide time to replenish liquidity in a fast-moving market.

How Frequently Will LULD Affect Trading?

Volatile price swings often occur at the sub-second level as buyers and sellers submit orders based on their beliefs and different types of information. The level of short-term volatility that triggers LULD, however, is expected to be a rare occurrence. In the rule release, the SEC states that simulations conducted with historical data suggest that LULD should "not result in an excessive number of trading pauses."[12]

To provide insight into how frequently LULD might impact US equity trading and under what circumstances, we analyzed trade and quote activity for the period Q1 2013, when LULD was not yet in effect. Our sample set includes securities within the S&P 500 and Russell 1000, which are all within Tier 1 of LULD. Our analysis investigates three types of theoretical "LULD events," which we define as follows:

1. Price band breach (PBB), in which a trade is executed outside the price bands.
2. Straddle state (SS), in which a side of the NBBO is outside of the price bands.
3. Limit state (LS), in which either the NBB is resting on the upper band, or the NBO is resting on the Lower Band.

We find that there were 14 LULD events during Q1 2013, over a possible 57 trading days from a sample set of 1000 eligible symbols in Tier 1. This equates to a frequency of 0.025% over the set of possible events. In Q1 2013, only three S&P 500 symbols (DELL, STZ, and BMC) and ten additional Russell 1000 symbols would have been affected. Only one symbol, CWH, showed more than one day with an LULD event. Table 1 summarizes our findings.

[11] See p.39 at: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.
[12] Id.

Table 1

Summary Statistics for Symbols with LULD Events in Q1 2013

Symbol	Name	Last Price[1]	ADV (shares)[2]	Volatility[3]	LULD Event Type[4]	Date[5]
DELL	Dell Inc.	$14.29	23.6mm	13.3%	LS	1/14/2013
CWH	CommonWealth REIT	$22.76	6.6mm	147.0%	LS	2/26/2013
CWH	CommonWealth REIT	$22.76	6.6mm	147.0%	LS	2/27/2013
HLF	Herbalife Ltd.	$37.11	5.0mm	38.9%	LS	1/9/2013
STZ	Constellation Brands Inc.	$47.30	4.9mm	24.4%	LS	1/31/2013
SWKS	Skyworks Solutions Inc.	$21.20	4.6mm	45.7%	PBB	2/21/2013
FL	Foot Locker, Inc.	$33.82	3.1mm	31.1%	PBB	3/20/2013
ENDP	Endo Health Solutions Inc.	$30.72	2.2mm	31.7%	LS	1/30/2013
BMC	BMC Software Inc.	$46.02	1.8mm	18.4%	LS	3/21/2013
CHTR	Charter Communications, Inc.	$103.84	1.6mm	45.9%	LS	3/18/2013
CPWR	Compuware Corporation	$12.37	1.1mm	14.0%	LS	2/21/2013
AAP	Advance Auto Parts Inc.	$82.34	1.0mm	17.5%	PBB	2/7/2013
VNTV	Vantiv, Inc.	$23.26	0.9mm	23.3%	SS	2/20/2013
SPW	SPX Corporation	$77.40	0.6mm	17.9%	LS	2/25/2013

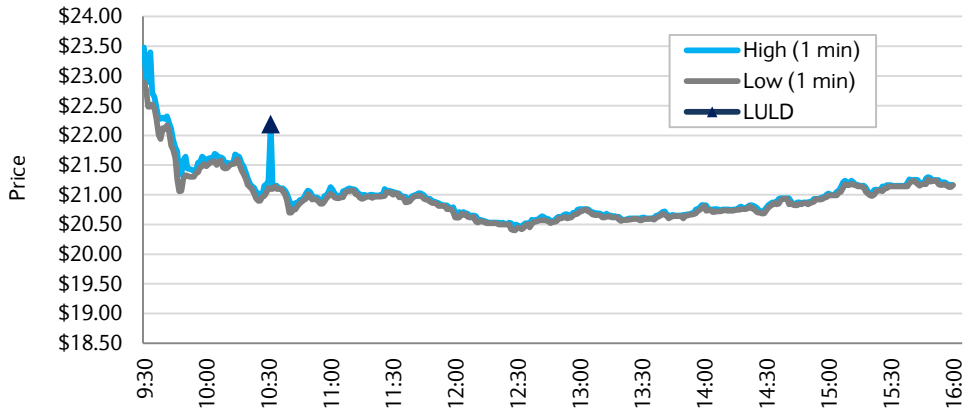
Source: TAQ data; Barclays analysis; Bloomberg. All statistics are estimated as of March 28, 2013.
1. Last Price is closing price as of March 28, 2013.
2. ADV is the 30-day average daily volume.
3. Volatility is the 30-day price volatility, calculated as the standard deviation of day-to-day logarithmic historical price changes, annualized.
4. LULD Event Type refers to PBB (Price Band Breach), SS (Straddle State), or LS (Limit State), as defined on page 8, as entered between 9:45am to 3:35pm ET.
5. Date indicates the dates on which the LULD bands were breached.

LULD Price Band Breaches

The first type of LULD event that we examined is the price band breach (PBB), denoting instances during Q1 2013 in which a single trade was executed outside of LULD price parameters. PBB transactions would have been prevented altogether if LULD was in effect at the time. In the example in Figure 9, a single trade in Skyworks Solutions Inc. (NASDAQ: SWKS) was executed at a price outside of LULD price parameters. Table 2 breaks down the data, showing trades leading up to and following the PBB event. The data shows that at 10:31:17.591 ET, an Intermarket Sweep Order (ISO) executed 100 shares of SWKS on NYSE ARCA at $22.19, a full dollar greater than the previous and subsequent trades.

Note that the trade was not considered to be erroneous under the current SEC pilot program that governs clearly erroneous transactions. The Clearly Erroneous program was extended until September 30, 2013, which is the expected completion date for the LULD rollout to all Tier 1 and Tier 2 securities. With the LULD and Clearly Erroneous rules coexisting until then, it is possible for scenarios to arise in which a trade could have been executed within LULD price parameters but exceeds the thresholds of Clearly Erroneous. For details and examples, see the footnote below.[13]

Figure 9
Prices for Skyworks Solutions Inc. (SWKS) on February 21, 2013



Source: TAQ data; Barclays analysis.

Table 2
Skyworks Solutions Inc. Trades Leading Up To and Following LULD Event

Time	Price	Reference Price	Price Band High	Price Band Low	Sale Condition	Exchange	Size
10:31:17.588	$21.19	$21.08	$22.134	$20.026	Intermarket Sweep Order	BATS	100
10:31:17.589	$21.20	$21.08	$22.134	$20.026	None	ARCA	100
10:31:17.589	$21.19	$21.08	$22.134	$20.026	Intermarket Sweep Order	NASDAQ	100
10:31:17.591	$21.19	$21.08	$22.135	$20.027	Intermarket Sweep Order	NASDAQ	100
10:31:17.591	**$22.19**	**$21.08**	**$22.135**	**$20.027**	**Intermarket Sweep Order**	**ARCA**	**100**
10:31:17.593	$21.19	$21.08	$22.135	$20.027	Intermarket Sweep Order	ARCA	100
10:31:17.593	$21.19	$21.08	$22.135	$20.027	Intermarket Sweep Order	NASDAQ	200
10:31:17.593	$21.19	$21.08	$22.135	$20.027	Intermarket Sweep Order	NASDAQ	100
10:31:17.597	$21.19	$21.08	$22.135	$20.027	Intermarket Sweep Order	Edge A	100

Source: TAQ data; Barclays analysis.

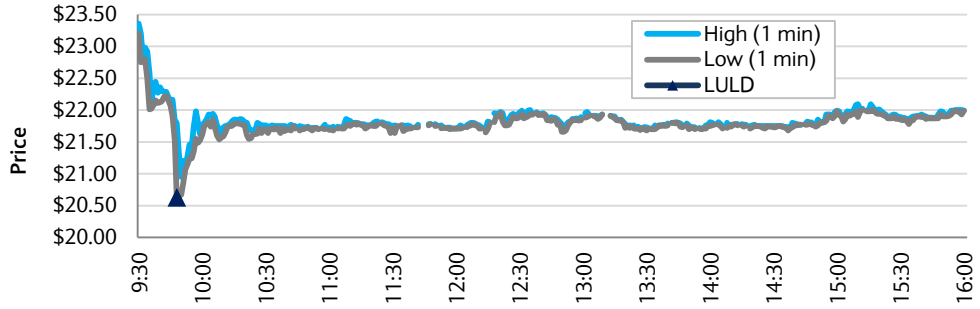
[13] See: http://www.finra.org/web/groups/industry/@ip/@reg/@notice/documents/notices/p120735.pdf (Clearly Erroneous Rule); and http://www.sec.gov/rules/sro/finra/2013/34-68808.pdf (extension of Clearly Erroneous pilot program through September 30, 2013).

During Q1 2013, single trade PBB events also occurred in the trading of Foot Locker, Inc. (NYSE: FL) and Advanced Auto Parts Inc. (NYSE: AAP). The PBB event in FL was an ISO order that executed 7205 shares reported to the ADF (Alternative Display Facility, signifying an off-exchange trade) at $34.25, when the prevailing market price was approximately a full two dollars lower. The PBB event in AAP was an ISO order that executed 112 shares on NASDAQ at $73.67, after market prices progressively fell several dollars.

LULD Straddle State

Most of the PBB events that occurred in Q1 2013 ultimately turned into LULD straddle state (SS) events, and in turn developed into LULD limit state (LS) events. There was a single example of an SS occurring and not preceding an LS. Figure 10 shows trade activity in Vantiv, Inc. (NYSE: VNTV) responding to an earnings announcement on February 20, 2013. At 9:48:44 ET, there was significant volatility as prices rapidly declined and recovered. Two trades executed outside of the LULD price parameters, and the NBB dropped below the lower price band.

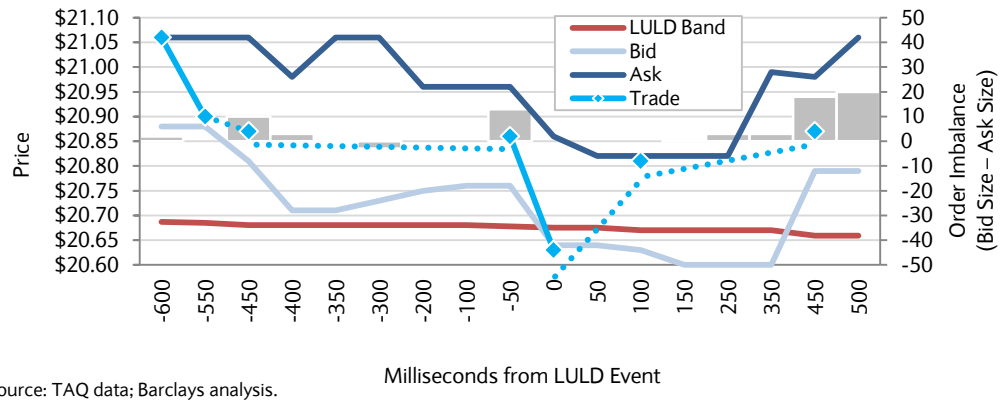
Figure 10
Vantiv, Inc. (VNTV) Responding to Q4 Earnings Report on February 20, 2013



Source: TAQ data; Barclays analysis.

Figure 11 offers a detailed view of the SS observed at 9:48:44 ET, when the NBB fell below the lower price band. A tick-by-tick examination reveals two instances in which buyers withdrew positions and re-entered the market ten cents lower. The straddle state, in which the NBB fell below the lower band while the NBO remained above, lasted approximately 300 milliseconds, until buying interest renewed and prices recovered.

Figure 11
Detailed View of Straddle State for Vantiv Inc. (VNTV) on February 20, 2013

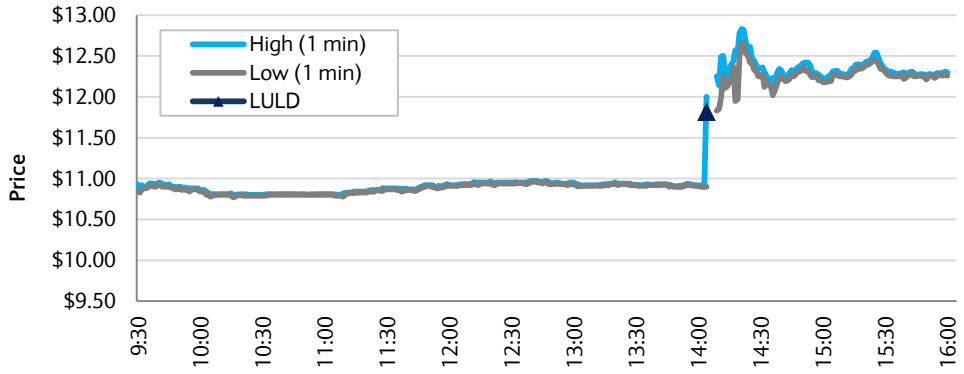


Source: TAQ data; Barclays analysis.

LULD Limit State

Because LULD price parameters were not actually in effect during Q1 2013, the majority of the LULD events that we observe developed into limit state (LS) scenarios and beyond. Figure 12 illustrates the market reaction to Dell Inc.'s (NASDAQ: DELL) buyout announcement on January 14, 2013. Within a minute of the announcement, the market price for DELL jumped $1 which breached LULD price bands and led to an LS event as buyers and sellers adjusted positions based on their expectations about the company's value. Similar events were also observed at other times throughout Q1 2013 in BCM, STZ, ENDP, CHRT, CPWR, SPW, HLF, and CWH.

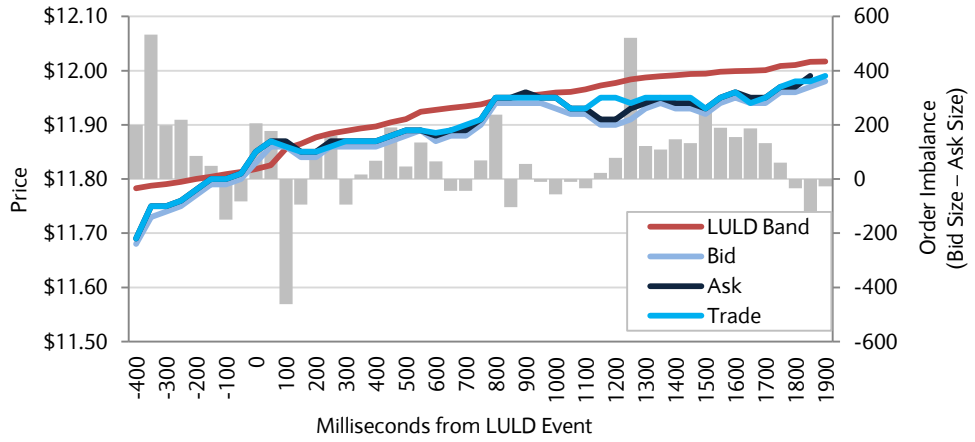
Figure 12
Prices for Dell Inc. (DELL) Responding to News of Buyout on January 14, 2013



Source: TAQ data; Barclays analysis.

The trading action in DELL at the millisecond level reveals an incremental increase in prices leading up the PBB. Figure 13 shows the trades, bids, asks, and LULD price bands by millisecond, leading up to the PBB at 14:04:11.729 ET. Within 50 milliseconds after the PBB, the bid and ask quotes increased rapidly, creating the LS event. Adjusting the LULD price parameters to account for recent elevated trade prices, DELL exited the LS and reverted to regular state a mere 150 milliseconds following the initial PBB. Just 650 milliseconds later, DELL entered a straddle state where the NBBO straddled the LULD price band. This example demonstrates multiple LULD events occurring in one day.

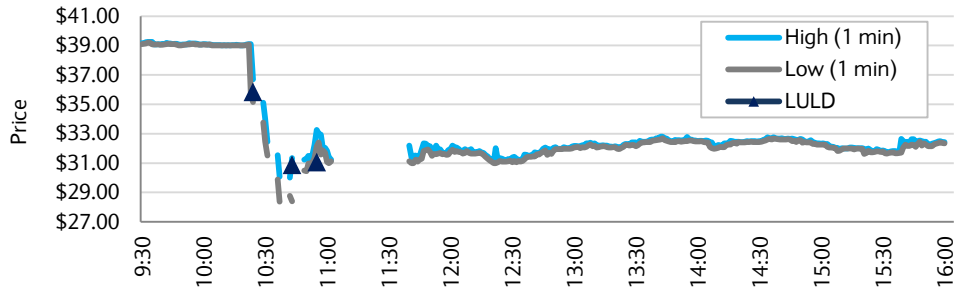
Figure 13
Evolution of Quotes and Trades for Dell (DELL) Leading Up To LULD Event



Source: TAQ data; Barclays analysis.

While the DELL example illustrates a situation in which incremental price increases led to the limit state, it is also possible for LULD events to occur during price reversions after fundamental price moves. Figure 14 shows the trade activity in Constellation Brands Inc. (NYSE: STZ) on January 31, 2013 as market participants reacted to news of the antitrust lawsuit filed by the Department of Justice (DOJ). After the initial market reaction would have triggered an LULD event (in reality the exchange declared a trading halt), there were two additional LULD events in the subsequent correction.

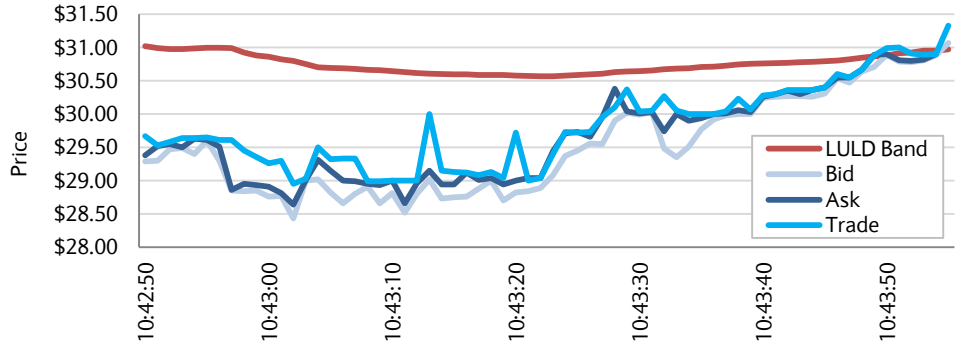
Figure 14
Constellation Brands Inc. (STZ) Responding to DOJ Antitrust Lawsuit on January 31, 2013



Source: TAQ data; Barclays analysis.

It is unclear whether and how LULD price bands, limit states, straddle states, and trading pauses will affect the market's price discovery function. The scenario with STZ, however, highlights a potential consideration with regard to reversions after market reactions. Figure 15 focuses on the second LULD event in STZ, occurring at 10:43:49.941. Following the trading halt, market participants began to correct the initial reaction, only to run into another LULD event. Because LULD price bands are "local" limits based on reference prices that are defined by only the most recent prices, there is potential in certain conditions for LULD to interfere with price discovery.

Figure 15
Price Reversion in STZ on January 31, 2013 Triggers a Second LULD Event



Source: TAQ data; Barclays analysis.

The examples above demonstrate a relationship between LULD and trading halts issued by the listing exchanges. In the DELL example, the limit state condition was triggered prior to a trading halt was called, but the trading halt was called prior to the point at which an LULD trading pause would have occurred. By introducing a market-wide system for controlling extraordinary volatility, LULD may reduce the need for individual trading halt programs at the exchanges.[14]

[14] Note that since LULD entered effect, the New York Stock Exchange (NYSE) filed to withdraw its Liquidity Replenishment Point functionality. See: http://www.tradersmagazine.com/news/nyse-withdraws-market-protections-over-own-objections-111061-1.html.

Conclusions and Implications

Our analysis provides insight into a number of cases in which stock prices progressed from price band breach to straddle state, and sometimes to limit state. Because LULD was not in effect during the period studied, and because trading halts were often called in these examples, it is not possible to fully apprehend the impact that LULD price bands and trading pauses would have had on trading.

LULD limit states and trading pauses were designed to limit significant short-term price deviations, promote an orderly trading process during temporary order imbalances, and accommodate fundamental price moves in a manner that lessens the velocity of short-term moves.[15] We anticipate that LULD price bands will successfully create frictions to extreme short-term price volatility. The LULD mechanism should affect markets only on rare occasions, and should successfully prevent erroneous trades and mitigate the negative impacts of short-term order imbalances or liquidity gaps.

Our analysis shows that extraordinarily volatile events, as defined by LULD, often transpire over the course of milliseconds, a frequency that is too rapid for most investors to digest and react to without sophisticated electronic trading tools. Nevertheless, the examples reveal that market participants responded within milliseconds to fundamental price discovery events. The friction created by LULD limit states and trading pauses should offer a greater segment of investors time to participate in the price discovery process during significant and rapid price moves.

In some cases, LULD may alter the price discovery process to some extent. It is possible, for instance, for prices to drop rapidly without triggering an LULD event, while a subsequent rapid recovery may trigger an LULD event. This could temporarily distort the true equilibrium of supply and demand, creating arbitrage opportunities for sophisticated, high-speed market participants.

Further Insights: Modelling Price Returns with Jump Processes

LULD events should be of great interest to the financial economics research community. The prevailing asset pricing models are composed of continuous diffusive Brownian components coupled with discontinuous jumps. Sampling at five-minute frequencies, a number of recent articles have stressed the importance of jump components (see Christensen, Oomen and Podolskij [2013] for a detailed literature review beginning on page 28).[16] Observing price evolution at the millisecond frequency reveals bursts of volatility that are accompanied by accelerated consumption of the limit order book as well as discrete price jumps. We find that price continuity is not always preserved in the presence of liquidity gaps.

As stated earlier, a less liquid name such as VNTN provides evidence of discrete price jumps. Focusing on the extreme setting leading up to the LULD event in DELL on January 14, 2013, we observe a progression of one cent quote changes of which the shortest duration between quote improvements was one millisecond. Sampling less frequently would result in observations of discrete price jumps. These preliminary examples support mapping liquidity characteristics to pricing model specifications.

[15] See: http://www.sec.gov/rules/sro/nms/2012/34-67091.pdf.
[16] Christensen, Oomen, Podolskij, "Fact or Friction: Jumps at Ultra High Frequency." January 2013. http://ssrn.com/abstract=1848774.

Contacts

Lada Kyj, PhD
lada.kyj@barclays.com
+1 212 526 8910

Kimberly Russell
kimberly.russell@barclays.com
+1 212 526 4504

Electronic Sales Trading Desk
est@barclays.com
+1 212 526 1130