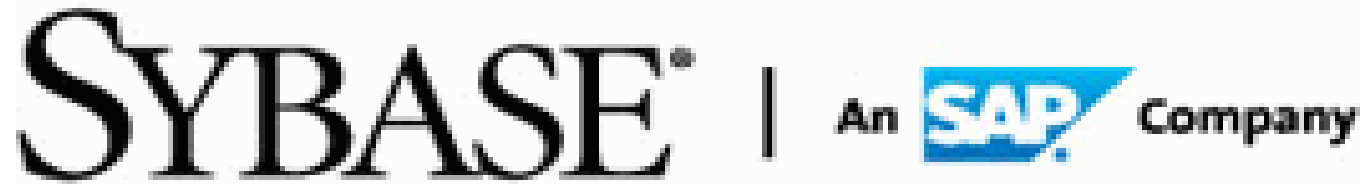# Evaluating the Effect of FINRA's Circuit Breaker Regulation on the First Anniversary of Flash Crash

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Richard Holowczak - Baruch College

- Sybase is interested in collaborating researchers in the area of finance

- Sybase is integrating open source tools, like R, into their products (IQ, Aleri, etc.) to support analytics
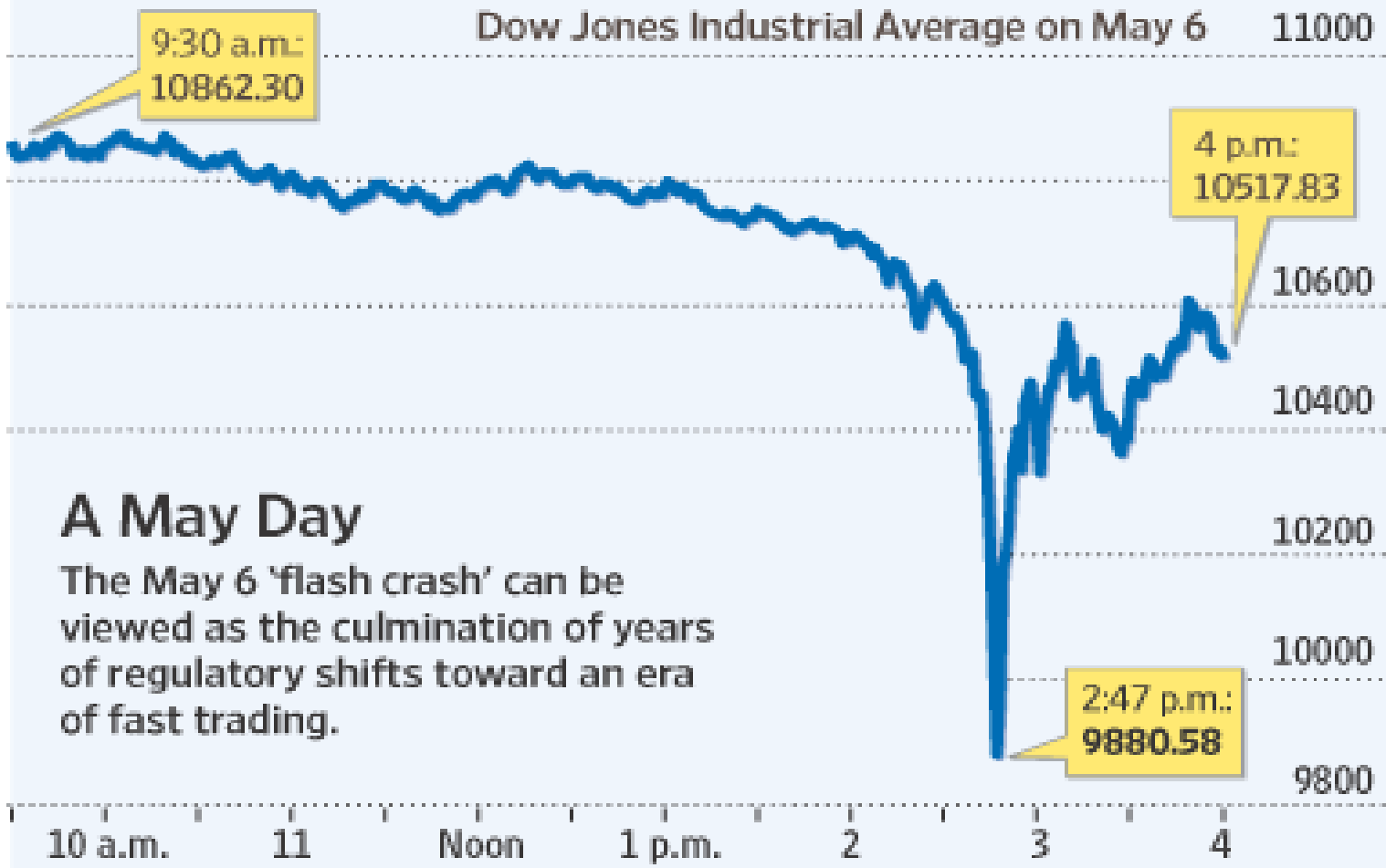
The New York Times

"One of the Most Terrifying Moments in Wall Street History. . ."

May 7, 2010

Dow Falls 1,000, Then Rebounds, Shaking Market

A bad day in the stock market turned into one of the **most terrifying moments in Wall Street history**. . .It lasted just 16 minutes but left Wall Street experts and ordinary investors alike struggling to come to grips with what had happened -- **and fearful** of where the markets might go from here (emphases added)

Dow Jones Industrial Average on May 6

9:30 a.m.: 10862.30

4 p.m.: 10517.83

2:47 p.m.: 9880.58

11000

10600

10400

10200

10000

9800

A May Day

The May 6 'flash crash' can be viewed as the culmination of years of regulatory shifts toward an era of fast trading.

10 a.m.   11   Noon   1 p.m.   2   3   4

Source: WSJ Market Data Group

The New York Times

"On the trading floor of the New York Stock Exchange, traders shouted or watched open-mouthed as the screens lighted up with plummeting prices and as phones rang off the hook. 'It was **almost like The Twilight Zone**.' said Theodore R. Aronson of Aronson, Johnson & Ortiz, a money management firm in Philadelphia." May 7, 2010 (emphasis added)

** FILE ** Trader Steven Rickard reacts in the S&P 500 futures pit at the CME Group in Chicago near the close of trading on Thursday, May 6, 2010. The stock market that day had one its most turbulent sessions ever, with the Dow Jones Industrial Average plunging nearly 1,000 points in a half-hour before recovering two-thirds of its losses. (AP Photo/Kiichiro Sato)

What was the response to an unexpected market swing, described by one trader as "like the twilight zone"?
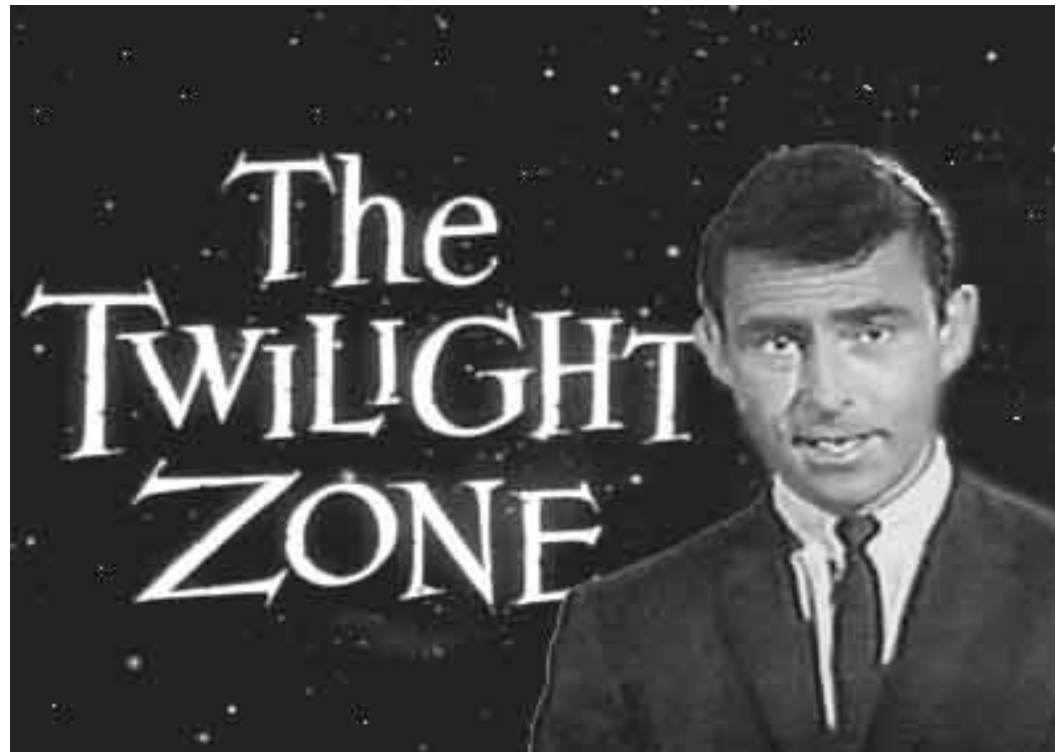
Fear

Twilight Zone
"Nightmare at 20,000 Feet"

From "60 Minutes"
October 10, 2010

(CBS) It may surprise you to learn that most of the stock trades in the U.S. are no longer being made by human beings, but by robot computers capable of buying and selling thousands of different securities in the time it takes you to blink an eye.

These supercomputers - which actually decide which stocks to buy and sell - are operating on highly secret instructions programmed into them by math wizards who may or may not know anything about the value of the companies that are being traded.

It's known as "high frequency trading," a phenomenon that's swept over much of Wall Street in the past few years and played a supporting role in the mini market crash last spring that saw the Dow Jones Industrial Average plunge 600 points in 15 minutes.

Most people outside of the industry know very little, if anything, about it. But the Securities and Exchange Commission and members of Congress have begun asking some tough questions about its usefulness, potential dangers, and suspicions that some people may be using computers to manipulate the market.

And an increasing political pressure to do something!

"most stock trades in the U.S. are **no longer made by humans, but by computers capable of buying and selling stocks at warp speed**"
—60 Minutes Report

The Need for Circuit Breakers for "Proper Functioning of Our Markets"

. . .the Treasury Department issued a statement saying that Mr. Geithner had ''reinforced the need for a coordinated and timely response to help ensure the proper functioning of our markets....'' (regarding circuit breakers) ". . .uniform parameters for deciding when trades are deemed to be ''clearly erroneous.''

Questions:

"What constitutes 'proper functioning?'"

"When is a trade 'clearly erroneous?'"

Why is a careful study of necessary measures is so difficult?

Mary L. Schapiro, the chairwoman of the Securities and Exchange Commission, said the enormous increase in trading volume in recent years was complicating efforts to draw clear conclusions about the plunge. When a special commission examined the market crash of 1987, for example, investigators looked at a day when trading on the New York Stock Exchange totaled about 600 million shares. On May 6, 2010, 10.3 billion shares of stocks listed on the exchange changed hands.

SEC Institutes Circuit Breaker Rules in Response to May 6,2010

SEC Approves New Stock-by-Stock Circuit Breaker Rules
FOR IMMEDIATE RELEASE
2010-98

Washington, D.C., June 10, 2010 — The Securities and Exchange Commission today approved rules that will require the exchanges and FINRA to pause trading in certain individual stocks **if the price moves 10 percent or more in a five-minute period**.

To which stocks do the circuit breakers apply?

"These circuit breaker pauses apply to stocks in the Russell 1000 Index and several hundred exchange-traded products, and halt trading in the applicable security in all U.S. markets for five minutes. U.S. exchanges and the Financial Industry Regulatory Authority (FINRA) proposed the rules in response to unusually volatile trading on May 6, 2010, that affected some stocks but was not broad enough to trigger the existing market-wide circuit breakers."

Securities and Exchange Commission
www.sec.gov/answers/circuit.htm

The Russell 1000

- The weighted average market capitalization of $81 billion

- The median market capitalization is approximately $4.6 billion

- The smallest company in the index has a market capitalization of $1.8 billion.

SEC Calculation

Just how does the SEC calculate a 10 percent change in stock price over 5 minutes?

Answer: In a somewhat "unexpected" way. . .

Our Email to the SEC:

My question is how this is actually going to get measured. For example can you just look at all trades within a 5 minute window and see if you have 3 trades below 10% of the high in that 5 minute window (assuming the three lower trades happen after the high was established)?

I also see the problem with multiple trades in a second. For example suppose you had:

```
10:00:00  XYZ $100.00
10:00:00  XYZ $100.02
10:00:00  XYZ $100.00
10:00:01  XYZ $99.99
10:00:01  XYZ $99.98
etc.
10:04:58   XYZ  $90.01
10:04:59   XYZ  $90.01
10:04:59   XYZ  $90.01
```

Would this trigger the pause? From the first trade at 10:00:00 down to $90.01 it would be just short of the 10% threshold. However if you took the second trade at $100.02 at 10:00:00 as the high then the three $90.01 trades would trigger the pause right?
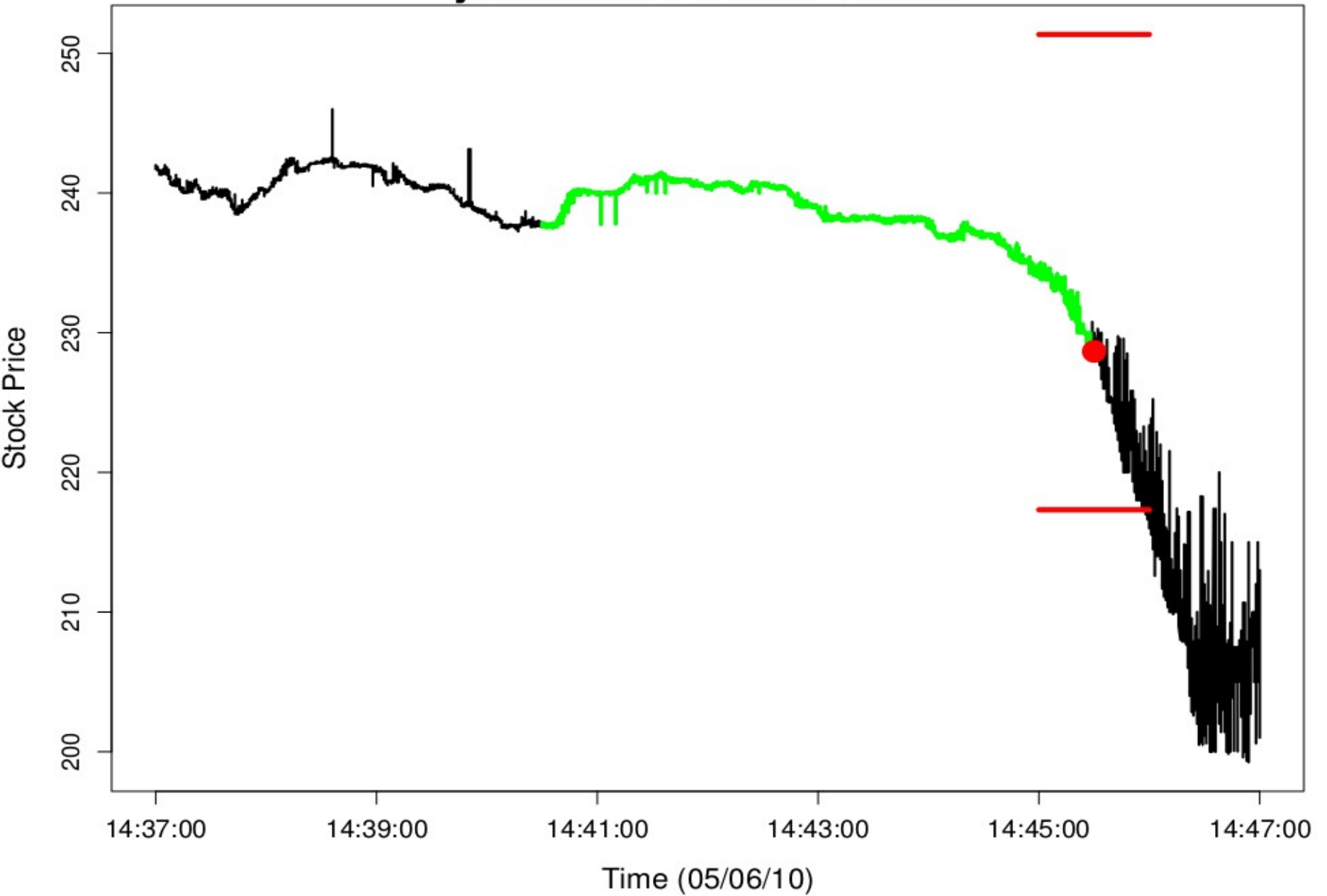
The SEC response:

"Here is the algo:

1)   Take the high and low during the last 5 minutes low = 99.98 & high = 100.02

2)   Create the thresholds by taking 10% below high and 10% above low.   Low threshold = 100.02 – 10.002 = 90.018, high threshold = 99.98 + 9.998 = 109.978

3)   At 10.04:58 compare trade price to low and high threshold. If outside the thresholds, trigger a trading halt."

        -SEC, email correspondence, March 10, 2011

Stock price for AAPL just before Flash Crash

Stock Price

250
240
230
220
210
200

14:37:00   14:39:00   14:41:00   14:43:00   14:45:00   14:47:00

Time (05/06/10)

''What the S.E.C. has recommended is working,'' said Patrick J. Healy of the Issuer Advisory Group, which advises public companies on how and where to list their shares for trading. ''Had they done this two months ago, there never would have been a **flash crash**.''

Circuit Breaker Is Enacted, Halting Trades For Citigroup.
The New York Times (June 30, 2010):

Our Research

- Back-test the FINRA rules on historic stock data

- Determine if the circuit breaker rules are needlessly coercive, triggering too often

- Determine if the circuit breaker rules are effective for controlling volatility during catastrophic events like the Flash Crash

What do the data look like?

```
SYMBOL,DATE,TIME,PRICE,SIZE,CORR,COND,EX
A,20101029,9:30:00,34.88,37,0,Q,T
A,20101029,9:30:11,34.86,100,0,@,N
A,20101029,9:30:11,34.82,200,0,@,N
A,20101029,9:30:24,34.82,200,0,F,N
A,20101029,9:30:24,34.82,100,0,Q,P
A,20101029,9:30:24,34.82,100,0,F,P
A,20101029,9:30:24,34.82,100,0,F,P
A,20101029,9:30:27,34.8496,209,0,@,D
A,20101029,9:30:27,34.82,1700,0,4,D
```

Processing 15 trillion trades

- Breaking up the data
  - About 500 files, 1 for each day
  - About 7800 symbols for each day
  - About 3800 trades per symbol
- An embarrassingly parallel problem!
  - Days be processed independently
  - For a given day, symbols can be processed independent of each other
  - For a given symbol on a given day 5 minutes windows can be processed independently

Parallelizing the search for 10% price drops

```
foreach (file in taqFiles) %dopar% {

  taqData ← read.csv(file)

  foreach(symbol in unique(taqData$symbol)) %dopar%

    FindCB(taqData[taqData$symbol==symbol])

}

FindCB ← function(taqData) {

  foreach(w=time.window.iter(taqData)) %dopar% {

    if (CBInWindow(w))

      WriteCBInfo(w)

  }

}
```

Just because we can parallelize doesn't mean we should

- Parallelizing over days doesn't help if you're on a single machine

- Parallelizing over symbols for a single day provides almost linear speed-gains

- Parallelizing over rolling windows doesn't help at all
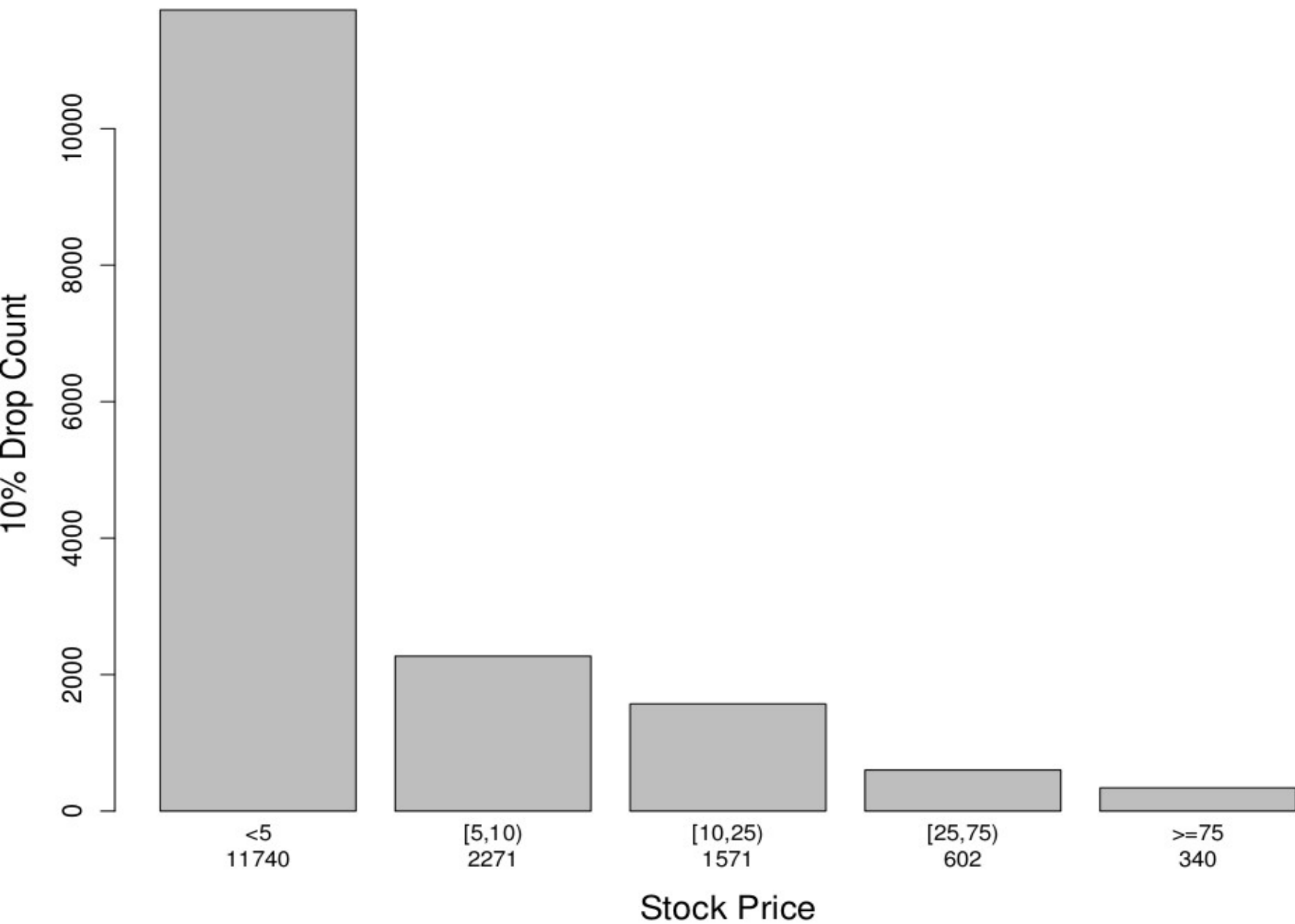
An alternative approach

- Reading files into a data.frame is slow

  - Disk I/O accounts a large portion of the processing time for a file

  - The read.csv function is robust but not fast

- Use a column-store database - Sybase IQ

  - Most people in will have this in a database to begin with

  - Both already in column-format

  - Data is already formatted

  - Iterate over select statements instead of files on a cluster

What did we find?

10% Drops by index

Exchange	10% drops	10% drops 05/06
S&P	24	24
Russell 1000	71	41
Russell 2000	726	223
Russell 3000	797	264
Total	26325	1777

10% Drop Count by Stock Price

Y-axis: 10% Drop Count (0, 2000, 4000, 6000, 8000, 10000)

Stock Price	Count
<5	11740
[5,10)	2271
[10,25)	1571
[25,75)	602
>=75	340

Conclusion

- Circuit breakers are not overly restrictive
- Circuit breakers would not have addressed significant sectors of the market and would have been insufficient in stemming broad and sudden loss
- Was this more a symbolic rather than substantive regulation measure in the face of intense political pressure?
- Should circuit breaker rules be modified to address broader market volatility?