Every cloud has a silver lining: Fast trading, microwave connectivity and trading costs

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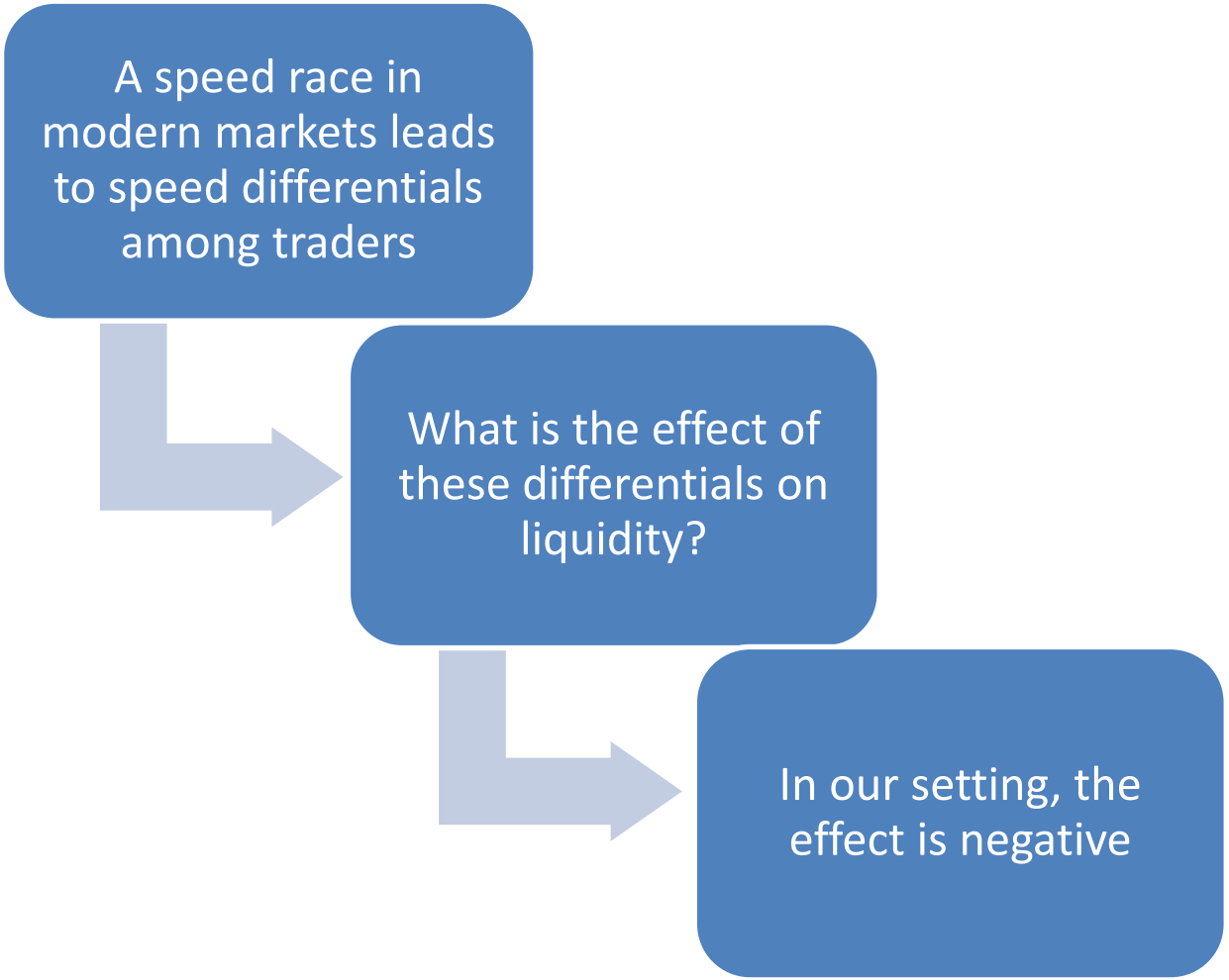
What we do, in a nutshell



Speed differentials: theory

- The effect of speed differentials on market quality may be positive or negative
  - Positive:
    - Hoffmann (2014)
    - Jovanovic and Menkveld (2015)
    - Roşu (2015)
    - Aït-Sahalia and Sağlam (2017)
  - Negative:
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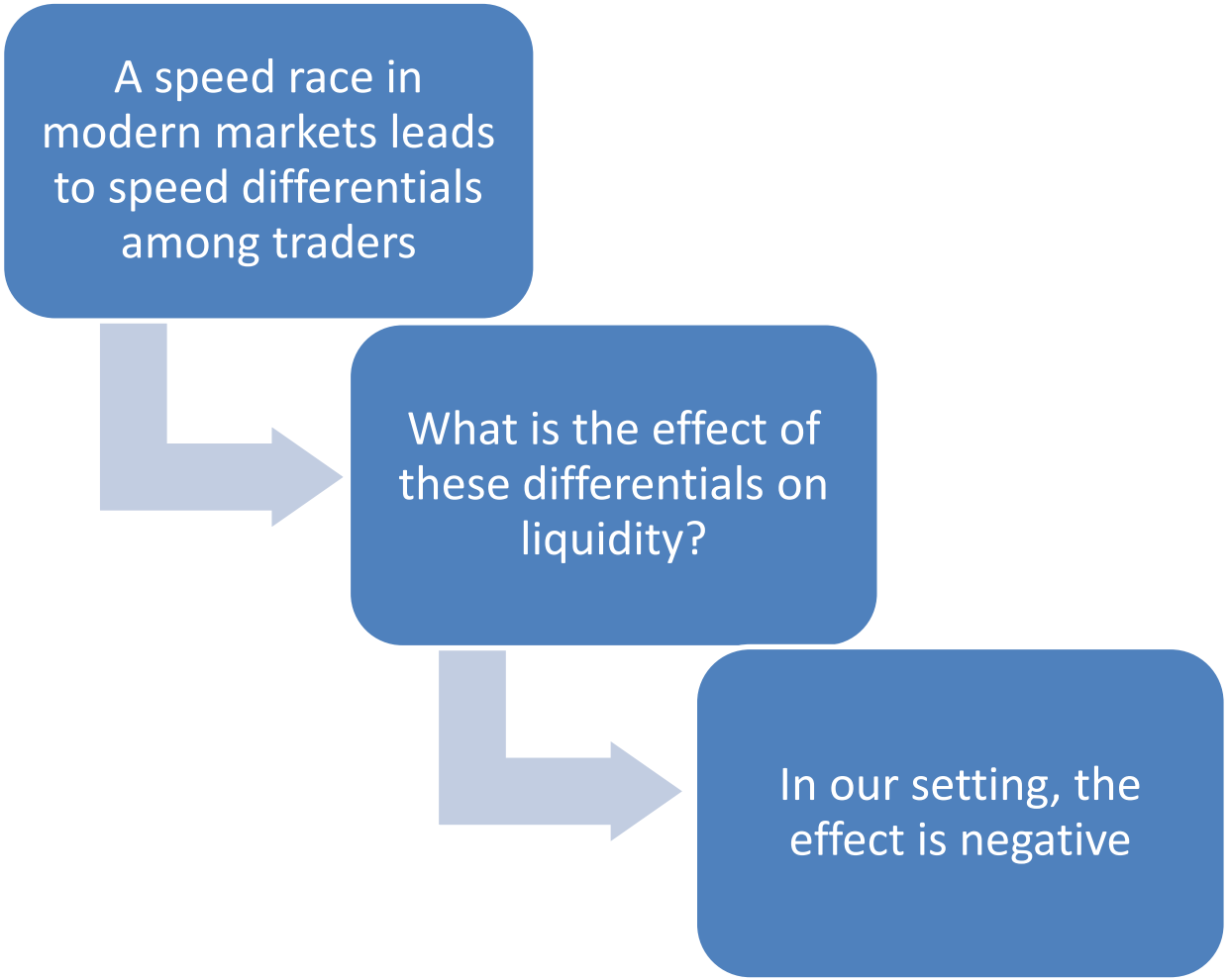
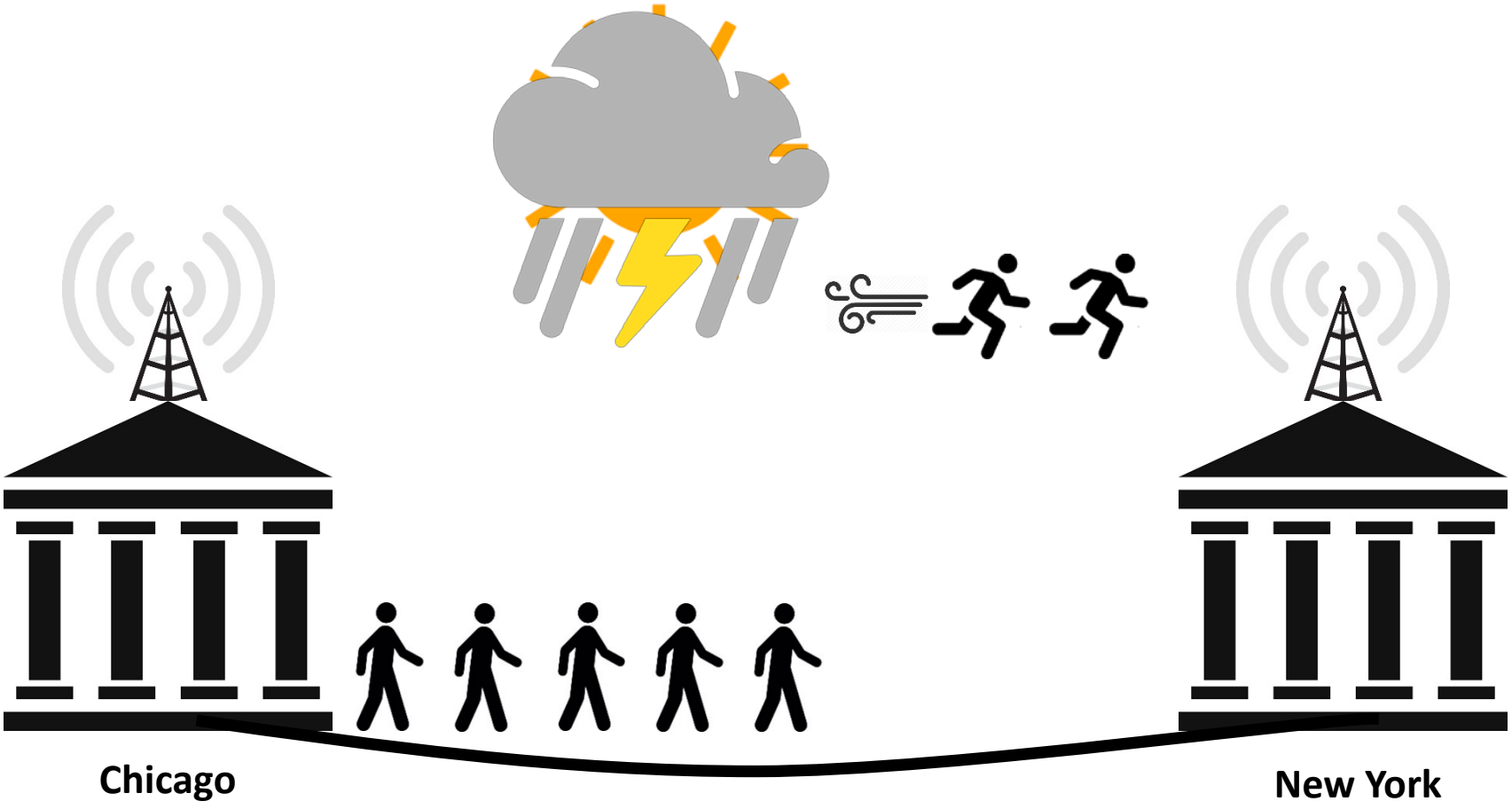


Our setting



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Speed differentials: empirics

- Liquidity suppliers try to stay on top of the latest technology to maintain a speed advantage
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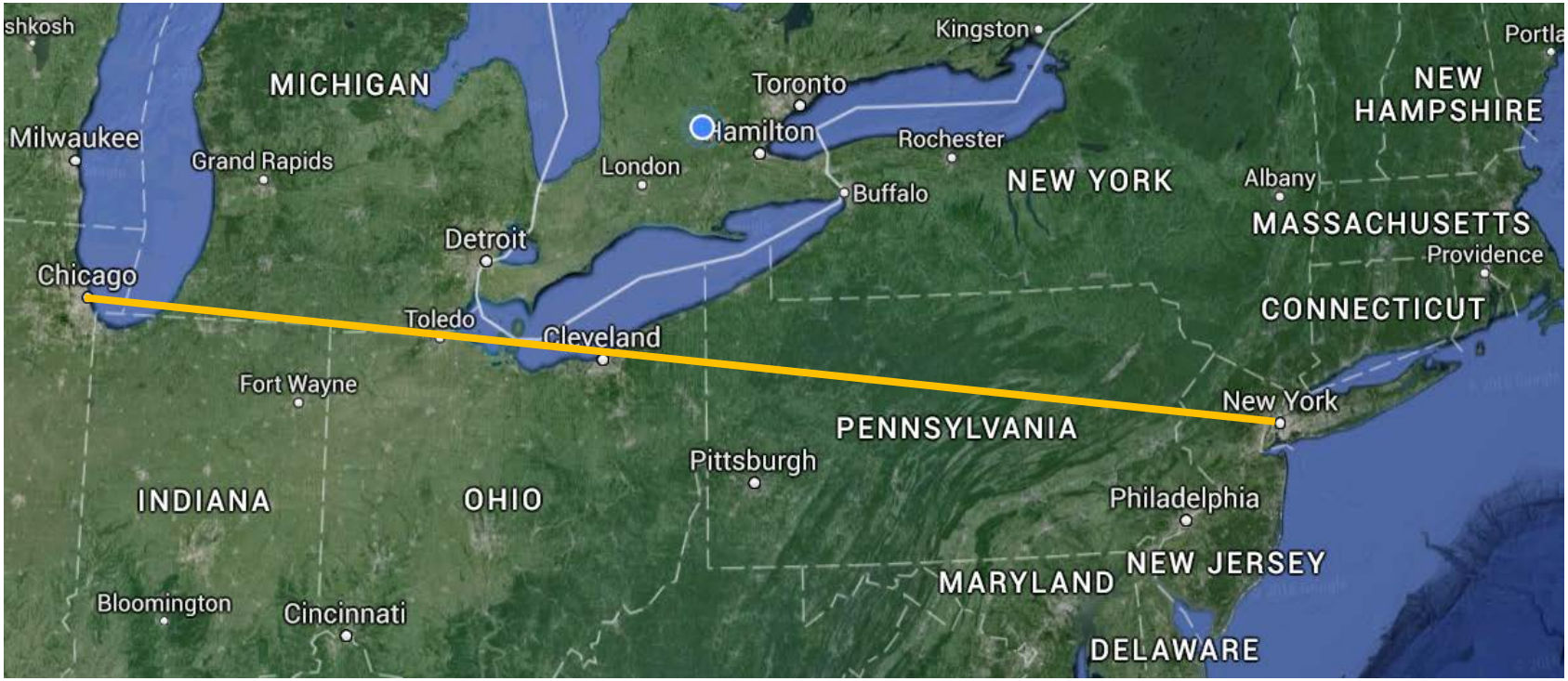
- Fast traders often provide liquidity
  - O'Hara (2015)
  - Yao and Ye (2015)
  - Brogaard, Hendershott and Riordan (2016)
  - Chordia, Green and Kottimukkalur (2016)

- Yet certain fast strategies are based on liquidity demand
  - Baron, Brogaard, Hagströmer and Kirilenko (2016)
  - Foucault, Kozhan and Tham (2016)

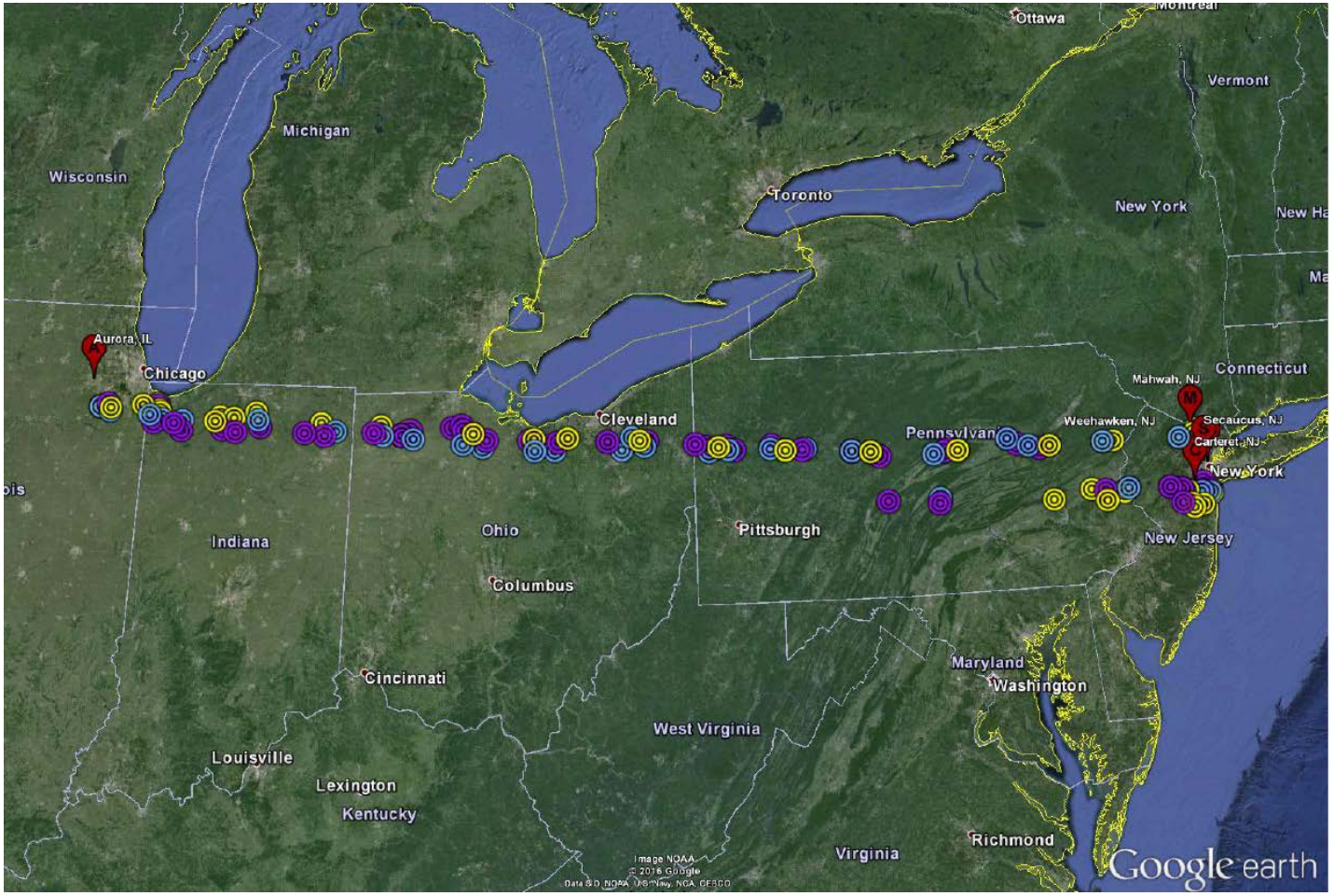
Information transmission between Chicago and New York



The race to zero in the Chicago-New York corridor

- Signal transmission speed:
  - Legacy fiber-optic cable: 8 ms
  - Spread Networks cable: 6.5 ms
  - Microwave networks: 4.5 ms
  - Speed of light: 4 ms

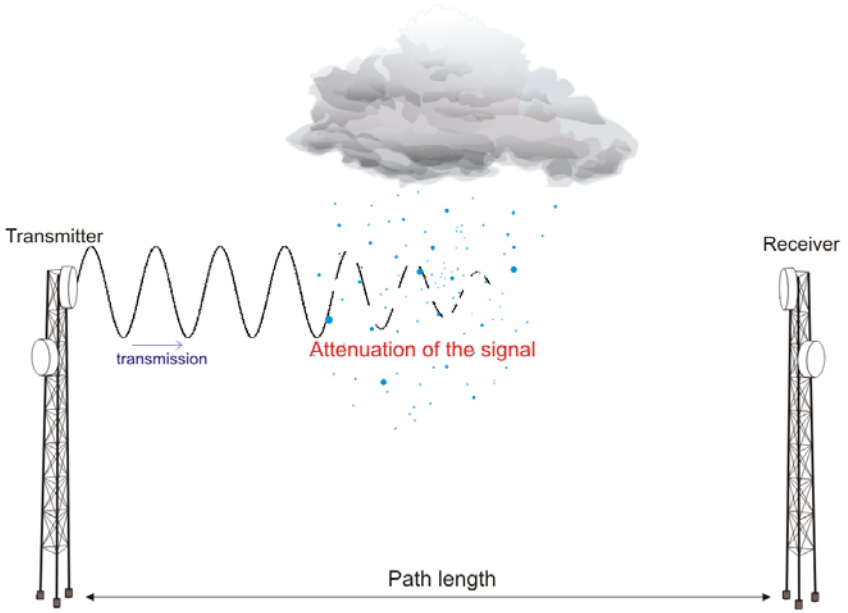
Microwave networks (MWNs)



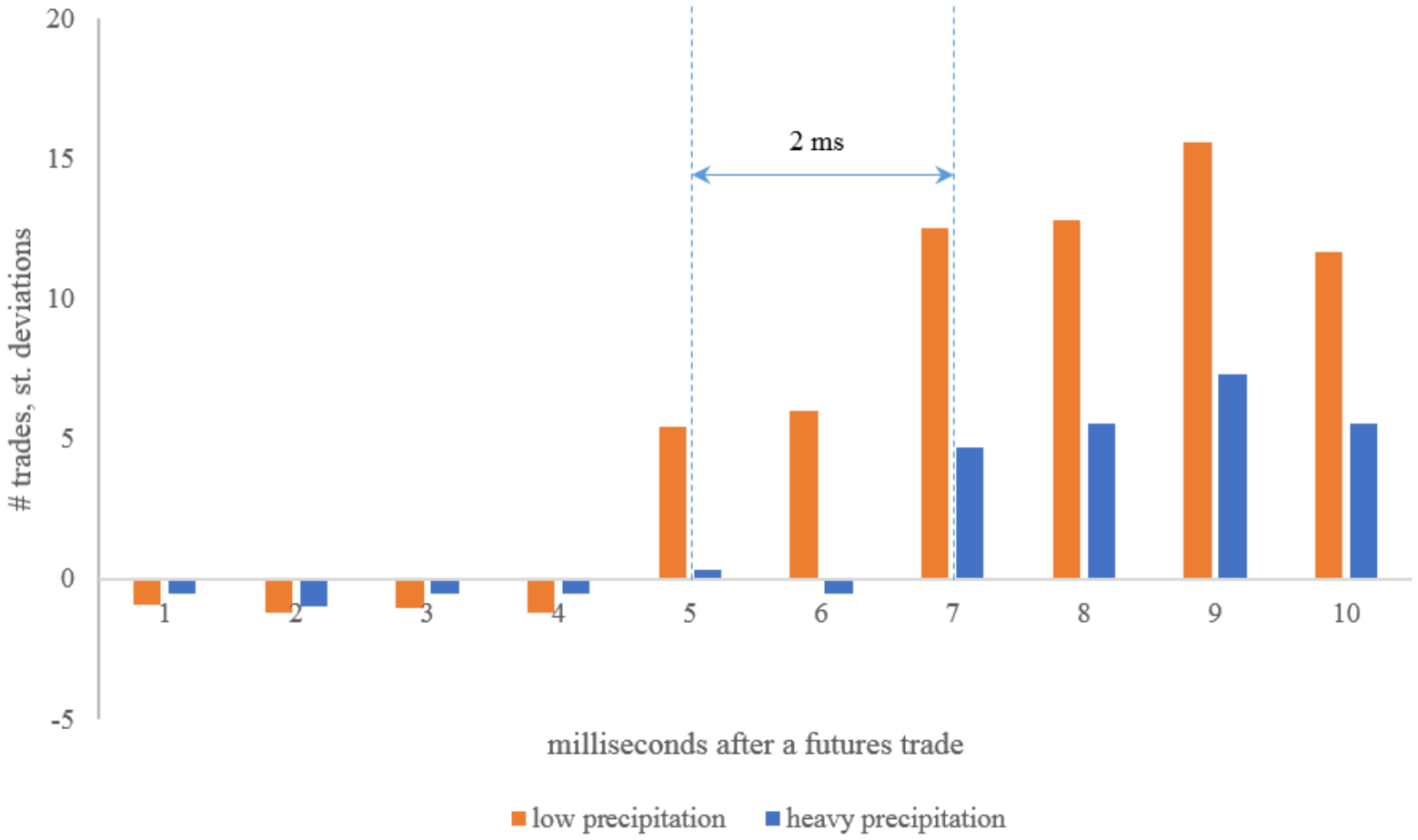
MWN characteristics

- In 2011-2012, accessible by a small number of trading firms
  - limited number of FCC licenses
  - low bandwidth

- Fast, but not always reliable due to rain and snow fade



Equity reaction to futures trades



What we find

- When speed differentials are eliminated due to precipitation
  - price impacts decline
  - trading costs decline, in part due to the emergence of latent liquidity
  - volatility declines

2013 democratization

- In early 2013, Quincy Data starts selling futures pricing information to everyone on a subscription basis
  - effectively democratizing information transmission

- The results of this move are similar to those of precipitation disruptions

Data and samples

- Trade and quote data for equities (DTAQ)
- Order book data for select futures from the CME
- Order book data from Nasdaq's ITCH

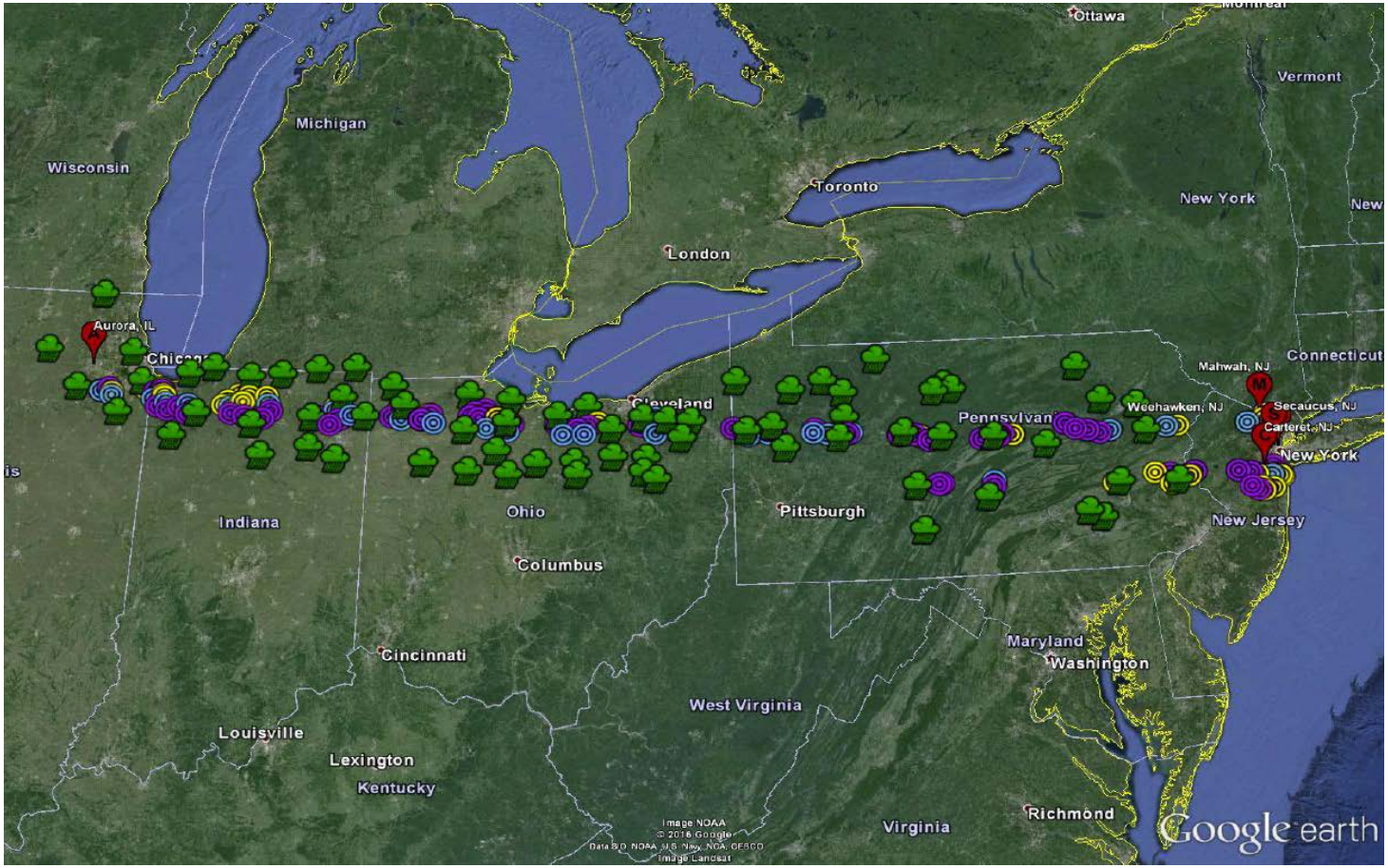
- Precipitation data from the National Oceanic and Atmospheric Administration (NOAA)

- Sample period I: 2011-2012
- Sample period II: 2013-2014

- Sample: 100 ETFs

Precipitation along the MWN paths

(www.noaa.gov)



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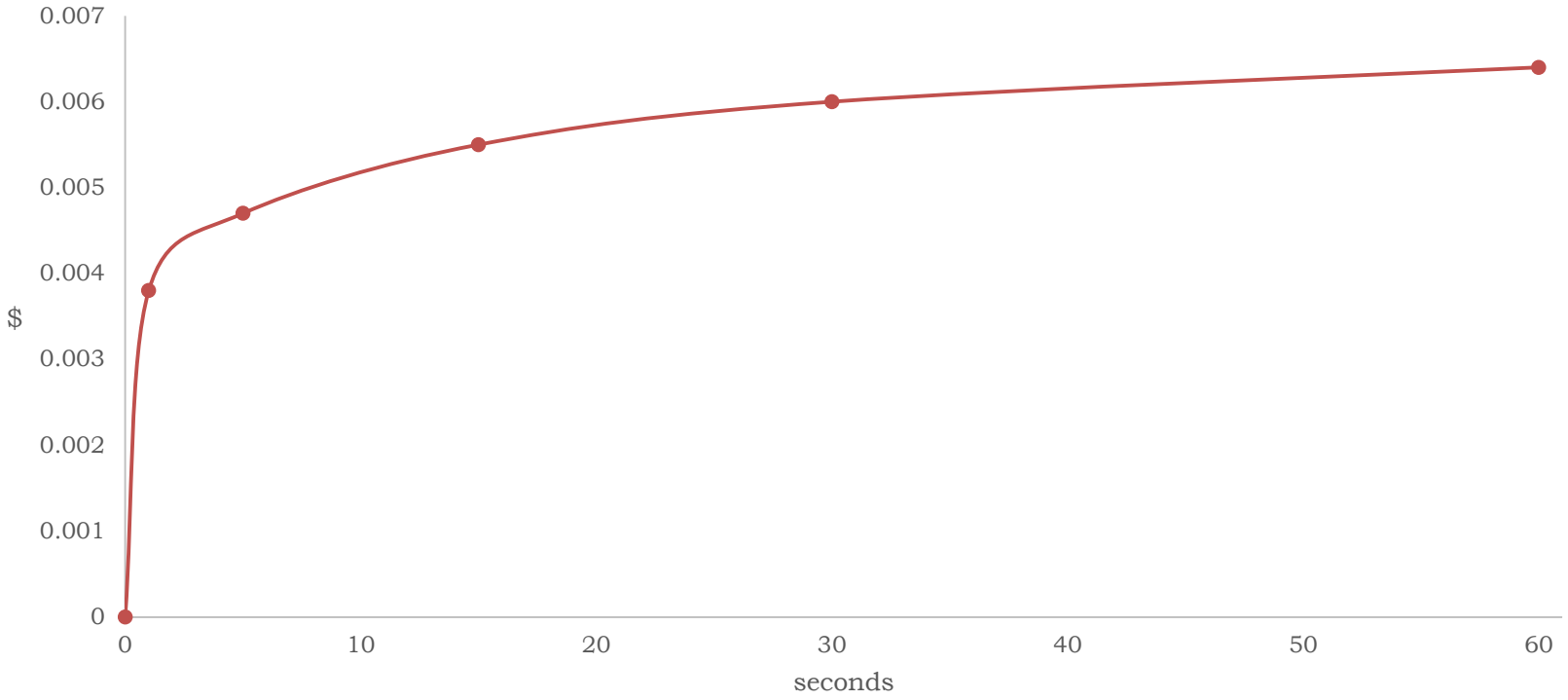
Price impacts



- Price impact are 30-40% of effective spreads
  - Chakrabarty et al. (2016) find a similar share for a recent sample of equities

Price impacts during MWN disruptions

PRECIP	-.010***		
	(.004)		
PRECIP1		-.035***	
		(.012)	
PRECIP2			-.047***
			(.013)
VIX	.035***	.035***	.035***
	(.009)	(.009)	(.009)

$$DEPVAR_{it} = \alpha_0 + \beta_1 PRECIP_t + \beta_2 VIX_t + \varepsilon_{it}$$

Price impacts decline by 0.047 standard deviations (or 7%) during heavy precipitation

This effect is most pronounced in assets with narrow spreads

Effective and realized spreads

	effective spread			realized spread		
PRECIP	-.010***			-.005**		
	(.003)			(.002)		
PRECIP1		-.041***			-.024***	
		(.010)			(.007)	
PRECIP2			-.043***			-.021***
			(.011)			(.008)
VIX	.057***	.058***	.057***	.036***	.036***	.036***
	(.008)	(.008)	(.008)	(.006)	(.006)	(.006)

Effective and realized spreads decline by, respectively, 7% and 5%

Order aggressiveness

	Panel A: NBBO match			Panel B: NBBO match or improve		
	full sample	most constr.	least constr.	full sample	most constr.	least constr.
	(1)	(2)	(3)	(4)	(5)	(6)
PRECIP	.017***	.025***	.038***	.006	.008	.041***
	(.004)	(.004)	(.006)	(.004)	(.005)	(.006)
PRECIP1	.054***	.080***	.095***	.028***	.006	.107***
	(.007)	(.008)	(.011)	(.006)	(.010)	(.010)
PRECIP2	.040***	.068***	.113***	.063***	.010	.126***
	(.012)	(.013)	(.013)	(.012)	(.015)	(.013)

Limit order aggressiveness increases by 2-3%

What happens to futures?

Hasbrouck (1995) methodology suggests that the futures market leads price discovery, CME information share is [0.64; 0.82]

Given that microwave bandwidth is a constrained resource, it should be used along the most profitable transfer channel: Chicago to New York

Indeed, price impacts do not change when the MWNs are disrupted

	Panel A: futures			Panel B: equities		
	(1)	(2)	(3)	(4)	(5)	(6)
PRECIP	-.004			-.037***		
	(.009)			(.006)		
PRECIP1		-.003			-.078***	
		(.022)			(.018)	
PRECIP2			-.014			-.079***
			(.031)			(.022)

Event study: 2013 democratization

- In early 2013, McKay Brothers begins selling latest price information at both ends of the Chicago-New York corridor
  - this move effectively removes advantages of the fastest traders

We find no precipitation effects in 2013-2014

The Quincy offering is associated with declines in price impacts, effective and realized spreads, and volatility

	PIMP	*ESP*	*RSP*	trades	volume	volatility	price
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
full sample	-.484***	-.711***	-.546***	-.071	.045	-.836***	.319***
	(.122)	(.127)	(.125)	(.129)	(.125)	(.244)	(.083)
most constr.	-.590***	-.454**	-.190	-.475***	-.174	-1.09***	.496***
	(.185)	(.179)	(.184)	(.171)	(.177)	(.254)	(.135)
least constr.	-.448***	-.965***	-.905***	.084	.095	-.542**	.284**
	(.100)	(.181)	(.178)	(.120)	(.123)	(.222)	(.129)

Conclusions

- In our setting, speed differentials lead to higher adverse selection, trading costs and volatility as the fastest traders choose to take liquidity

- Elimination of speed differentials not only reduces trading costs via the adverse selection channel, but also by strengthening liquidity supply

Thank you

Trading activity and volatility

	trades			volatility		
PRECIP	-.021***			-.025**		
	(.006)			(.010)		
PRECIP1		-.070***			-.103***	
		(.020)			(.032)	
PRECIP2			-.072***			-.118***
			(.023)			(.036)
VIX	.079***	.079***	.079***	.185***	.186***	.185***
	(.015)	(.015)	(.015)	(.024)	(.024)	(.024)

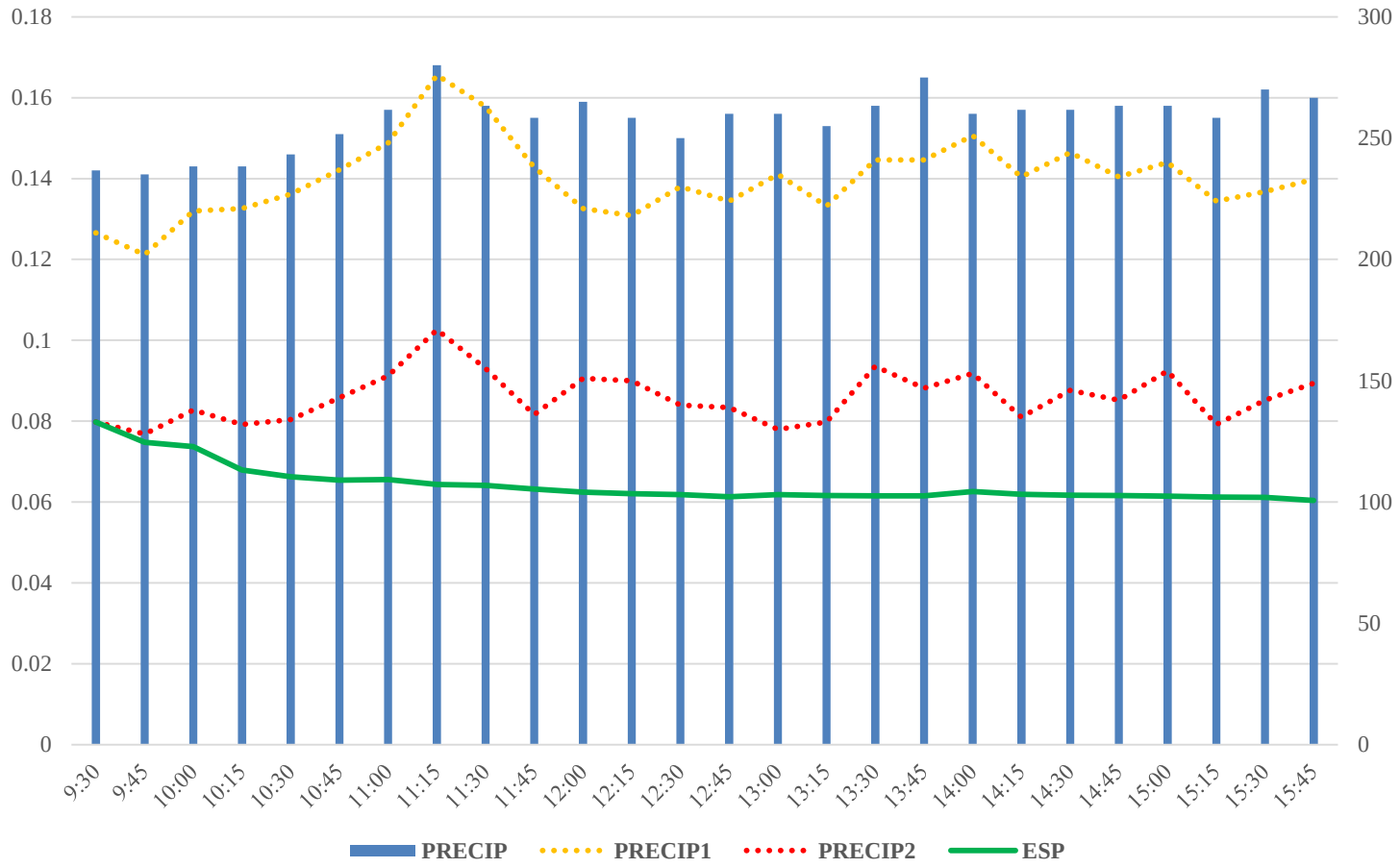
The number of trades declines by 17.8%. Expectedly, this decline is observed only in the most constrained ETFs

Volatility declines by 5.8%

Robustness

	price impact	effective spread	realized spread	trades	volatility
mood control	-.060***	-.061***	-.026***	-.094***	-.166***
	(.013)	(.012)	(.009)	(.024)	(.035)
expanded area	-.034***	-.040***	-.020**	-.055**	-.087**
	(.013)	(.012)	(.008)	(.023)	(.039)
placebo area	.006	-.012	-.001	.015	-.036
	(.016)	(.025)	(.019)	(.024)	(.038)
afternoon only	-.061***	-.063***	-.028***	-.080***	-.147***
	(.015)	(.014)	(.010)	(.026)	(.040)
intraday FE	-.054***	-.060***	-.028***	-.067***	-.141***
	(.012)	(.012)	(.008)	(.021)	(.035)

Intraday patterns



A weather front

Behavioral explanation