News Trading and Speed

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Informed trading in the silicon age

- **Today's financial markets:**
  1. **An almost continuous flow of signals:** corporate announcements, macro announcements, newswires, market data: quotes, trades, transaction prices, cancellations ($>$ 1 mio messages per second in U.S. equity and options markets), machine readable news: social media (300 million tweets per day), etc.

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  2. **Processed by computers**:

News Trading and Speed

- *Math-loving traders are using powerful computers to speed-read news reports, editorials, company Web sites, blog posts and even Twitter messages – and then letting the machines decide what it all means for the markets.*

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- *Authorities are exploring new algorithms referred to as "news aggregation" that search the internet, news sites and social media for selected keywords, and fire off orders in milliseconds. The trades are so quick, often before the information is widely disseminated, that authorities are debating whether they violate insider trading rules.*

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- *High-frequency traders do not care if information is accurate or inaccurate. [...] So this is very different than traditional insider trading [...]. This is all just about what might move the market, because they are in and out in milliseconds. They don't really care about the long-term effects of the information.*

  [Attorney General Schneiderman's speech on "High-frequency Trading & Insider Trading 2.0," Mar 2014].

Emerging facts on HFT

- **NB: HFT strategies are diverse (SEC, 2014)**
  - Market making/liquidity provision
  - Directional/aggressive/liquidity taking strategies
  - etc.

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- **Stylised facts on aggressive HFT strategies**
  1) Large volume $\approx$ 40% of total volume on Nasdaq (Brogaard et al 2014)
  2) **Anticipate short term price movements**, at an horizon of $\approx$ a few seconds (Brogaard, Hendershott, and Riordan 2014, Hirschey 2013)
  3) **Correlated with news:** market-wide returns, macro announcements, newswire items (Zhang 2013, Brogaard et al 2014)
  4) **Significant fraction of profits over long horizons**, e.g. daily (e.g., Carrion 2013): '*models where HFTs solely profit from very short term activities [...] may be incomplete.* (Carrion (2013))

Questions

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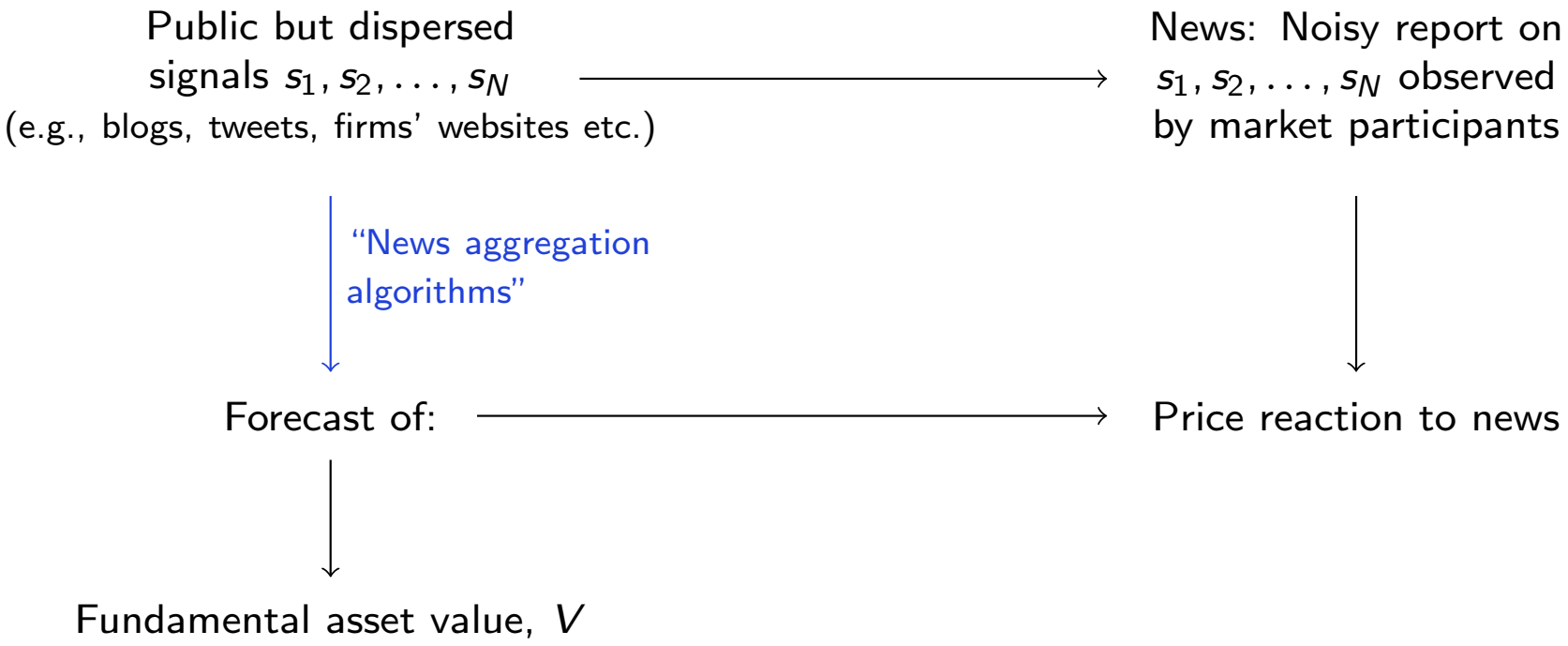
  - We need a theory.
  - Confront the theory to the data
  - Do we need a new model of informed trading? Of which type?

Very different from traditional informed trading?



Our Approach

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- **The informed investor uses this signal to forecast:**
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  2. Short run price reaction to news (novel)
- **We distinguish two cases:**
  1. The speculator is 'slow': prices reflect news before the speculator can trade on it.
  2. The speculator is 'fast': the speculator can trade on his forecast of news before prices reflect news.

Main Finding

- The speculator's trading strategy is significantly different when he is fast and when he is slow. When fast, changes in his optimal position are driven by:
  1. His estimate of the the extent to which the asset is overvalued and undervalued $\rightarrow$ he trades "smoothly" on this estimate (as in Kyle (85)).
  2. His forecast of the price reaction to incoming news $\rightarrow$ he trades aggressively on this forecast.
- **Implications**
  1. The "footprints" of the fast informed trader better match stylised facts about HFTs' aggressive orders (the model with fast trading predicts 1), 2), 3), and 4) on previous slide).
  2. Effects of news informativeness are different when the speculator is fast and when he is slow $\Rightarrow$ Good way to test the model.

Model

- Asset
  - Continuous trading over $t \in [0, 1]$
  - Final payoff: $v_1 = v_0 + \int_0^1 dv_t$, with $dv_t = \sigma_v dB_t^v$, $v_0 \sim \mathcal{N}(0, \Sigma_0)$

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- Market participants
  - One risk-neutral speculator: market order for dx_t shares at t
  - Noise traders: market order for $du_t = \sigma_u dB_t^u$ shares at t
  - Competitive risk-neutral dealer: absorbs net order imbalance $dy_t = dx_t + du_t$ at price $p_{t+dt} = E[v_1 \mid$ conditional on her information$]$

Information

- **Speculator knows v_0. Then, at each t:**
  - Dealer observes public news $dz_t = dv_t + de_t$
    $\longrightarrow 1/\sigma_e =$ precision of public news=News Informativeness
  - Speculator receives private signal: $ds_t = dv_t + d\varepsilon_t$
    $\longrightarrow$ for this talk, assume $d\varepsilon_t = 0$. Results generalize to $\sigma_\varepsilon > 0$

Forecasting news

Consider signal dv_t for the speculator. Can be used to:

1. **Forecast the asset payoff:** $v_t = E(v_1|\mathcal{J}_t) = v_0 + \int_0^t dv_\tau$

   $\longrightarrow$ Trade on mispricing $(v_t - q_t)$ where q_t is the dealer's expectation of the asset payoff before observing the order flow (standard)

2. **Forecast dealer's news:** $E(dz_t|dv_t) = dv_t$

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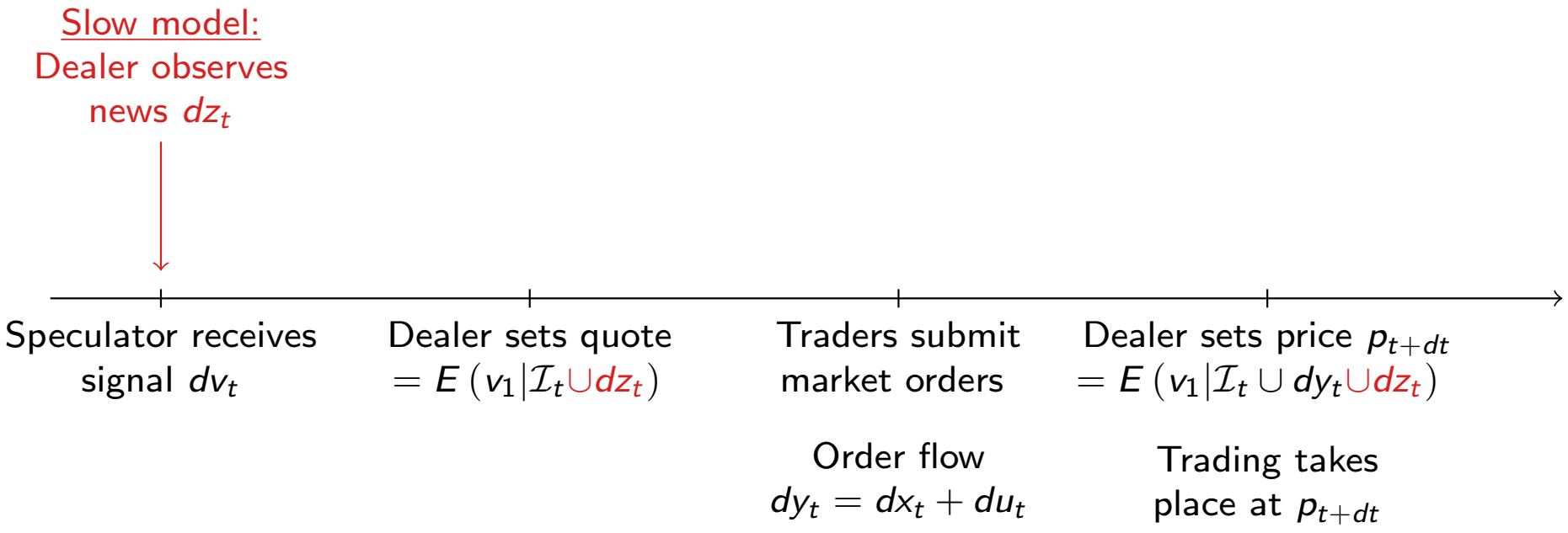
Speed of access to information:

- Slow model: Speculator is slow $\rightarrow$ Dealer observes the news before speculator can trade ($\Leftrightarrow$ Dealer is fast)
- Fast model: Speculator is fast $\rightarrow$ Speculator can trade before dealer observes the news ($\Leftrightarrow$ Dealer is slow)

Timing

- Trading round over $[t, t+dt]$:



where $\mathcal{I}_t$ = dealer's information set at t

= order flow and news history $\{y_\tau, z_\tau\}_{\tau \leq t}$

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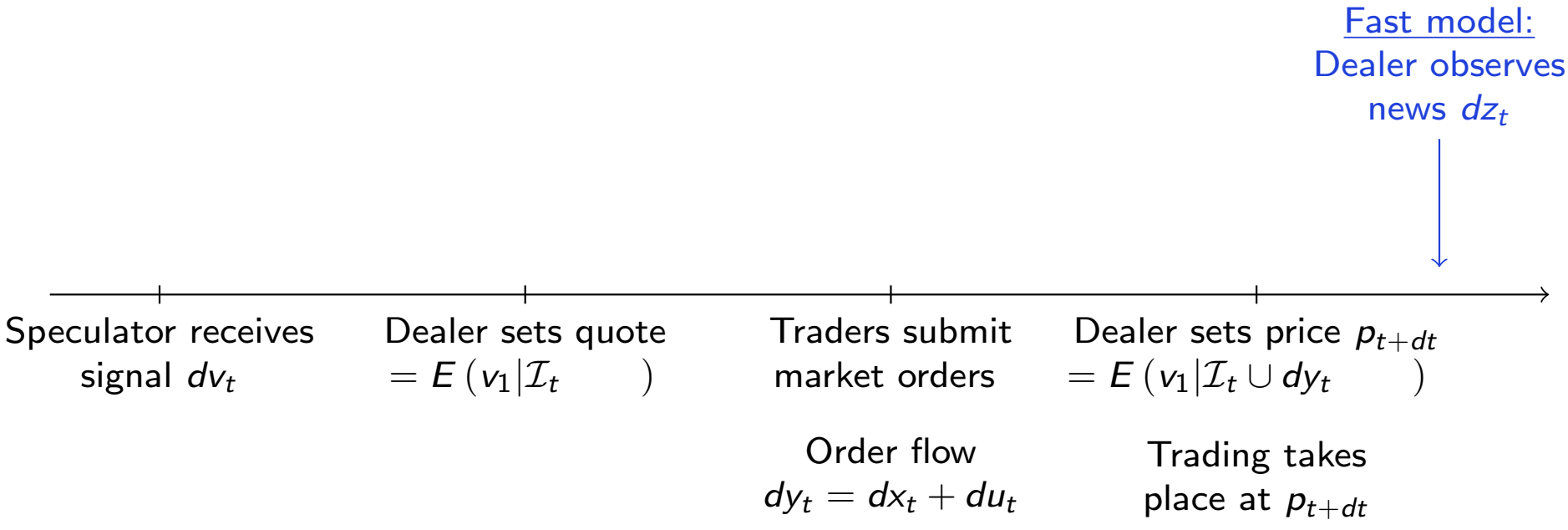

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Speculator's trading strategy

- **Speculator's information when choosing dx_t is:**

$$\mathcal{J}_t = \text{signal, price and news history } \{v_\tau, p_\tau, z_\tau\}_{\tau \le t} \cup \text{new signal } \{dv_t\}$$

- **Expected profit at t:**

$$\pi_t = E\Big[\int_t^1 (v_1 - p_{\tau+d\tau}) dx_\tau \mid \mathcal{J}_t\Big]$$

Equilibrium definition

- Kyle (1985): At any point in time
  1. Prices are equal to the dealer's forecast of the asset payoff given the speculator's trading strategy
  2. The speculator's trading strategy maximizes his expected profit given the dealer's pricing policy

Equilibrium

- **There is a unique linear equilibrium**
  - The speculator's optimal trade at t is:

$$dx_t = \underbrace{\beta_t^k \cdot (v_t - q_t)dt}_{\text{Value Trading}} + \underbrace{\gamma_t^k \cdot dv_t}_{\text{News Trading}} \quad \text{for} k \in \{F, S\}$$

  - Transaction prices are linear in the order flow (dy_t) and news:

$$p_{t+dt} = \begin{cases} q_t + \mu_t^S dz_t + \lambda_t^S dy_t & \text{Slow speculator} \\ q_t + \lambda_t^F dy_t & \text{Fast speculator} \end{cases}$$

and

$$dq_t = \begin{cases} q_t + \mu_t^S dz_t + \lambda_t^S dy_t & \text{Slow speculator} \\ q_t + \lambda_t^F dy_t + \mu_t^F (dz_t - \rho_t^F dy_t) & \text{Fast speculator} \end{cases}$$

Equilibrium

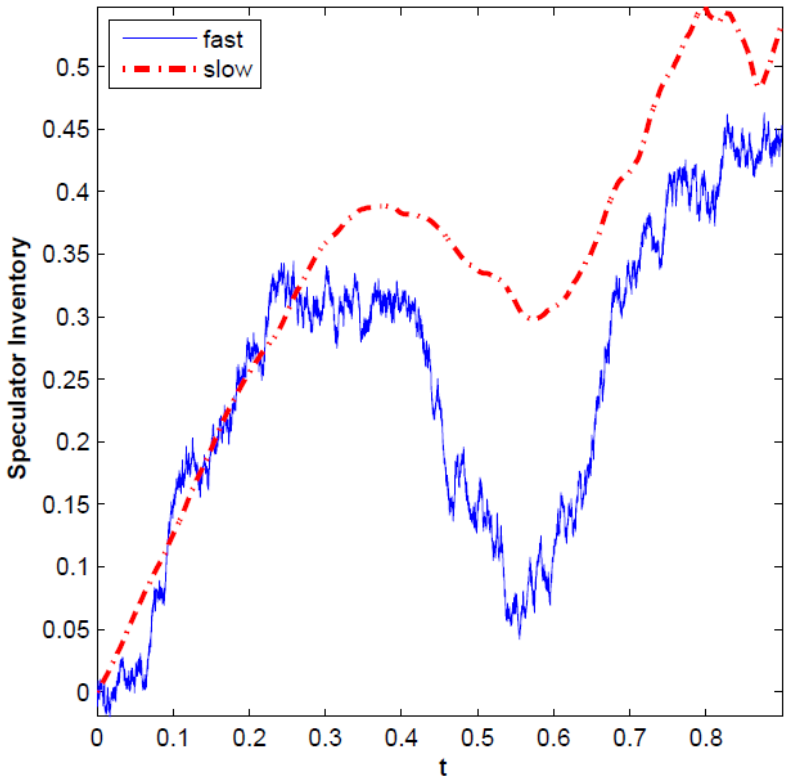
- **Speculator's strategy:**
  1. $\beta_t^k dt$ = sensitivity of the speculator's trade to the pricing error $(v_t - q_t)$
  2. γ_t^k = sensitivity of the speculator's trade to his anticipation of incoming news dv_t
- **Dealer's strategy:**
  1. λ_t^k = illiquidity of the market (the sensitivity of prices to trades): informational content of trades
  2. μ_t^k = sensitivity of dealer's quotes to news
- We characterize in closed form β_t^k, γ_t^k, λ_t^k and μ_t^k both when the speculator is fast $(k = F)$ and slow $(k = S)$

Speculator's strategy

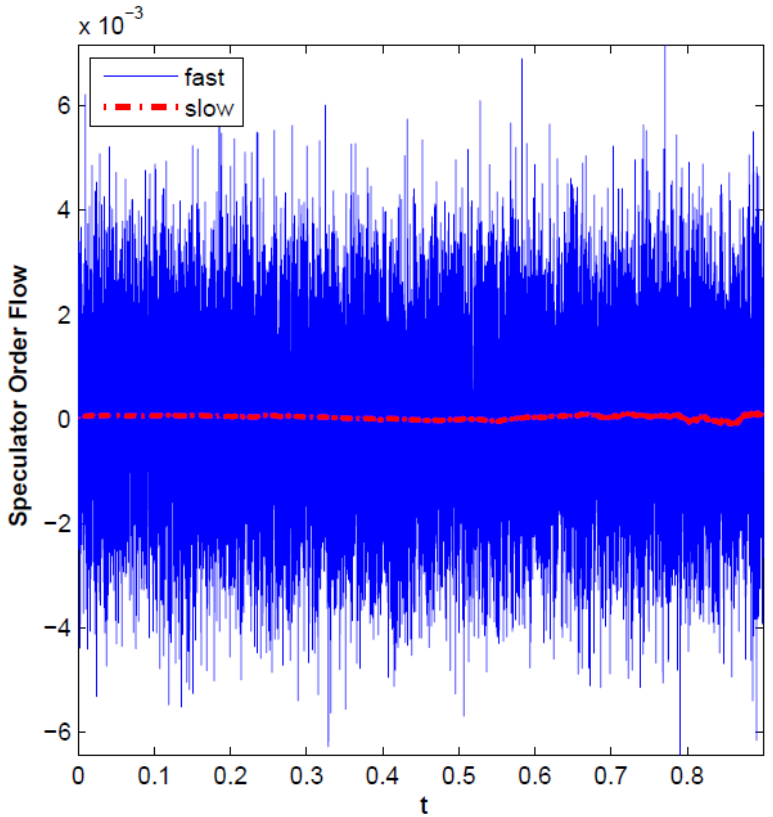
- **Result 1 (news trading):** There is news trading ($\gamma > 0$) if and only if the speculator is fast
  - $\Rightarrow$ More efficient information processing is not sufficient to generate news trading
- **Intuition:**
  - The speculator can forecast the price reactions to news whether fast or slow, but he can profitably trade on this forecast only if fast
- $\Rightarrow$ The strategy is significantly different with and without the speed advantage:
  1. x_t has only a drift component ($= \beta_t(v_t - q_t)dt$) if slow
  2. x_t has a volatility component ($= \gamma dv_t$) if fast

Speculator's strategy

Informed inventory



Informed order flow

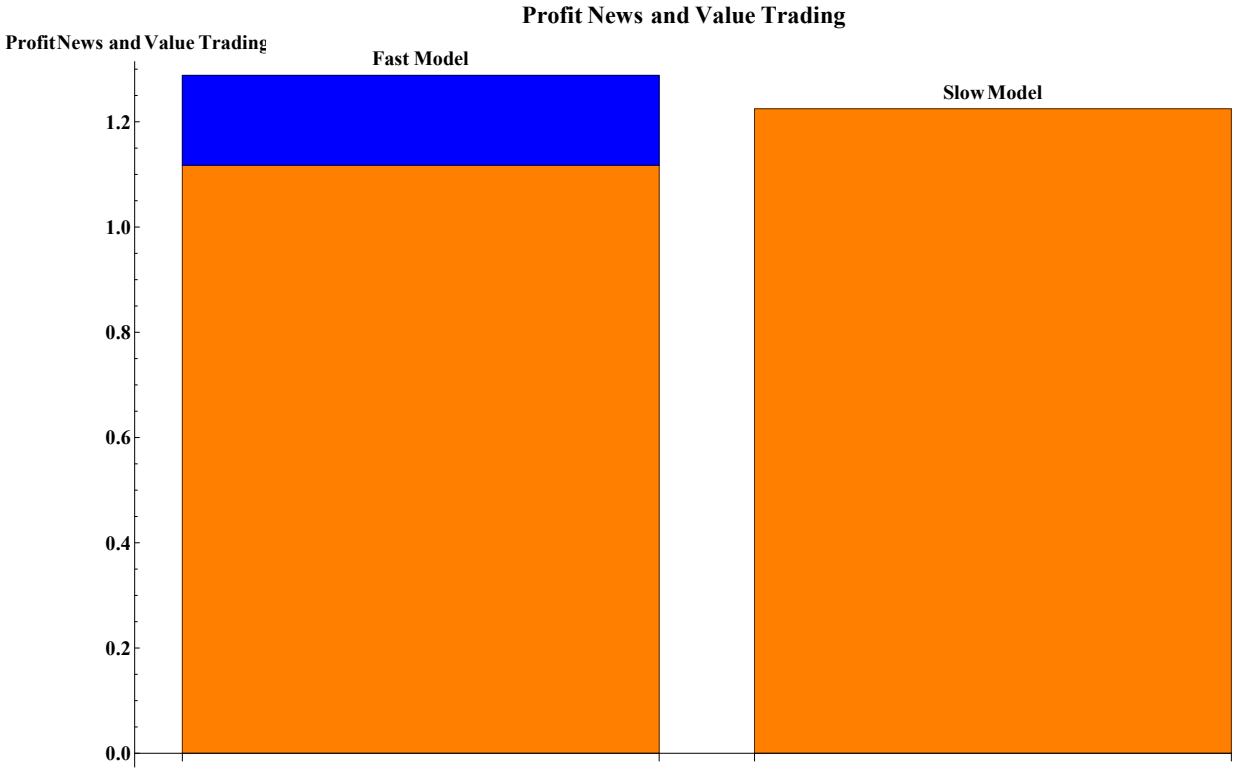


blue = informed is fast

red = informed is slow

- Correlation between the speculator's trades and news is positive when fast ($corr(dx, dz) = \frac{\sigma_v}{\sqrt{\sigma_v^2+\sigma_e^2}}$) vs. zero when slow

Total profits

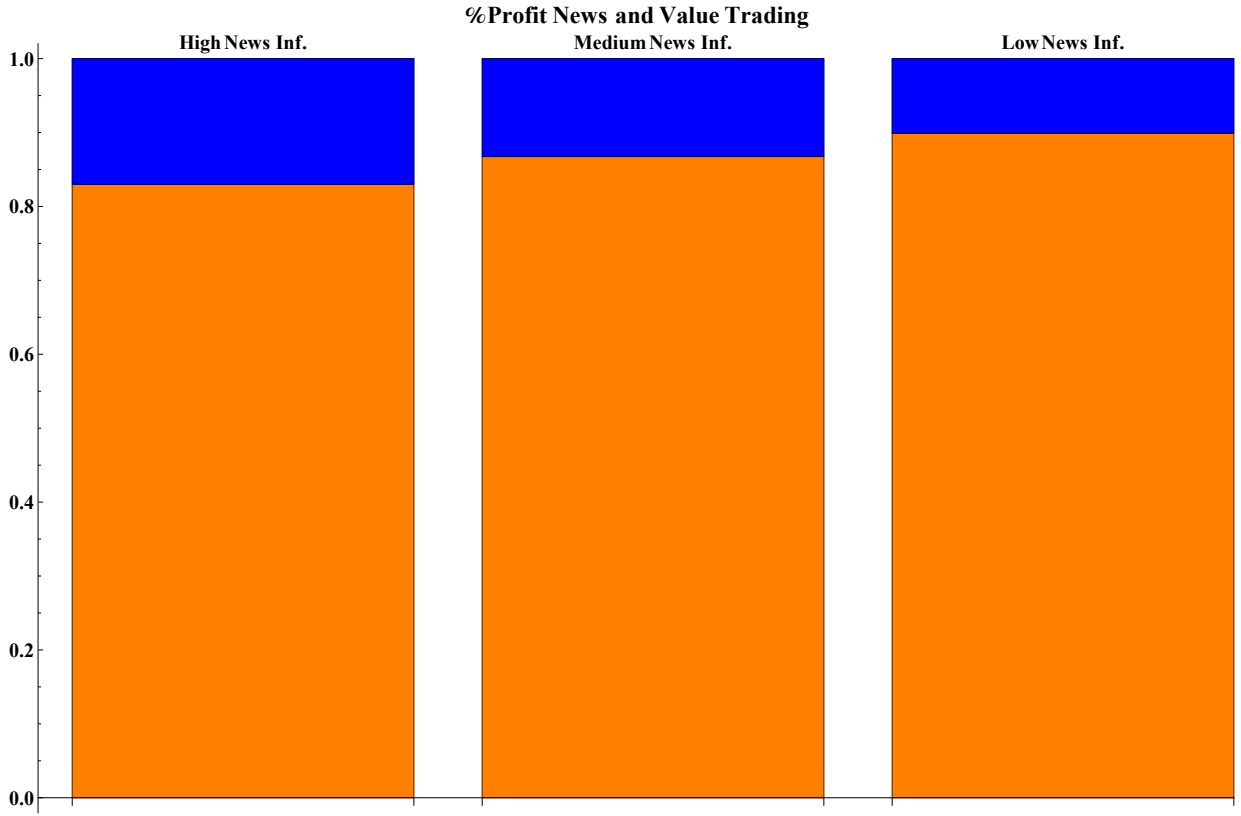


blue = Profit from news trading

orange = Profit from value trading

- **When the speculator is fast:**
  1. His profit is higher than when he is slow but...
  2. His profit from value trading is smaller; Intuition: "Substitution effect":
     - 2.1 News trading $\Rightarrow$ speculator's advantage dissipates more quickly $\Rightarrow$ Optimal reaction: trade less aggressively on long term value

Sources of speculators' profits and News Informativeness

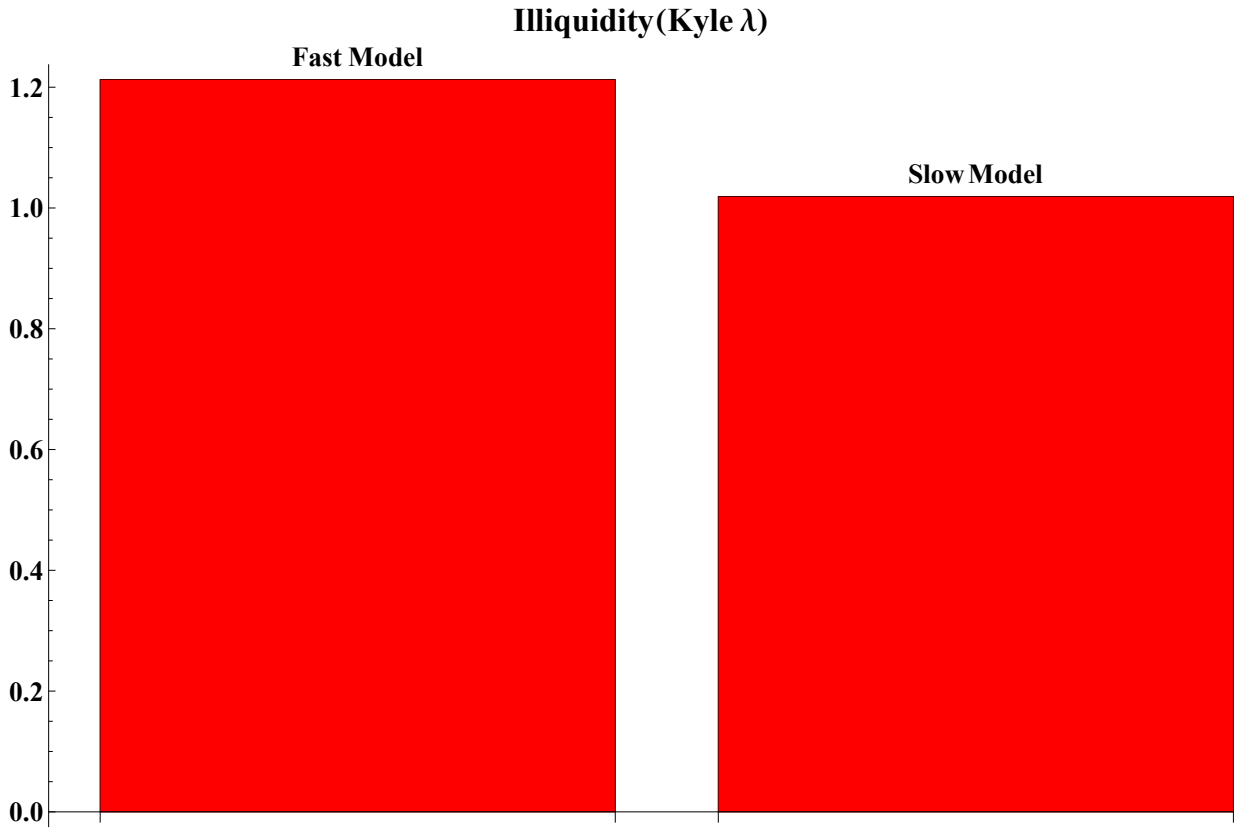


blue = % profit from news trading

orange = % profit from value trading

- The fast speculator does not derive all his profit from trading on short term price movements, even though the correlation between his trades and short term returns is very high (consistent with Carrion (2014)).

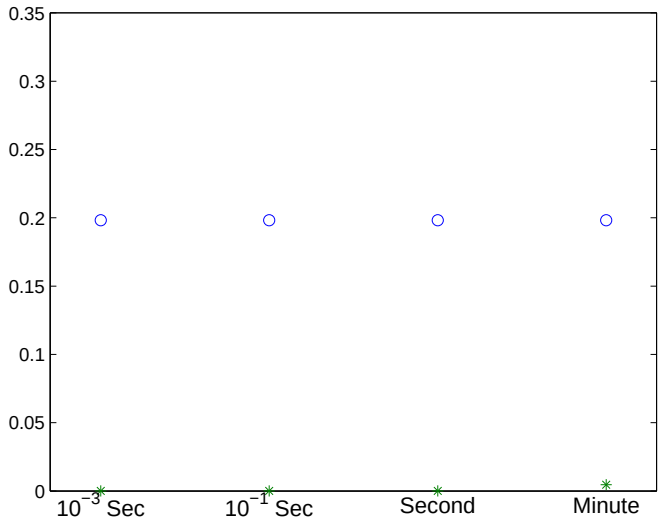
Illiquidity



- News trading $\Rightarrow$ dealers are more likely to sell before good news/to buy before bad news $\Rightarrow$ more adverse selection.
- $\rightarrow$ The price impact of trades is higher when the speculator is fast.

News traders' footprints 1/3

- **High participation rate:** Fraction of trading volume due to the speculator is an order of magnitude higher when he has a speed advantage

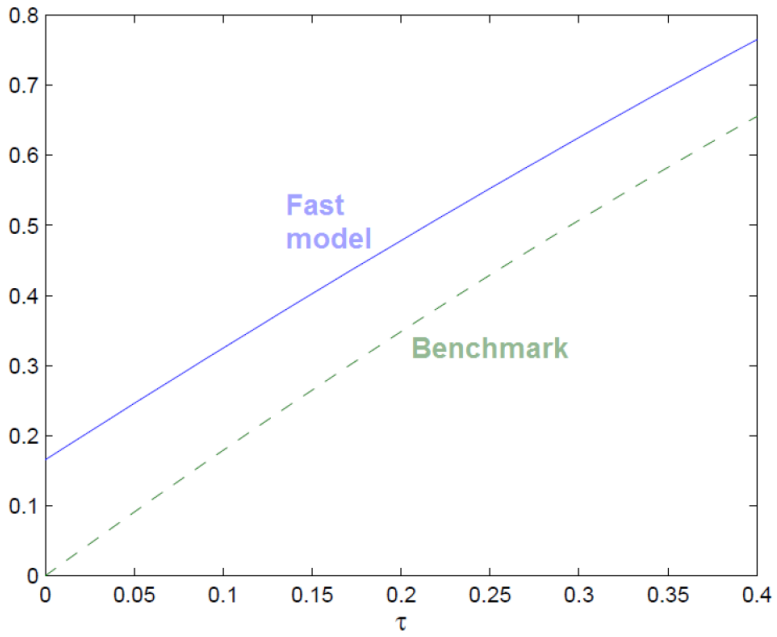


circles = Speculator is fast
stars = Speculator is slow

- **Intuition:** News induces the speculator to rebalance its portfolio in much larger amount when he reacts to news faster (volatility vs. drift component)
- Consistent with the large trading volume of HFTs, e.g., aggressive HFTs $\approx$ 40% of volume on Nasdaq

News traders' footprints 2/3

- **Anticipatory trading:** The speculator's trades are positively correlated with short-run returns
- Covariance between speculator's trade rate and subsequent returns at various horizons: $Cov\left(\frac{dx_t}{dt}, p_{t+\tau} - p_t\right)$



- Consistent with Brogaard, Hendershott, Riordan (2014) and Hirschey (2013)

News traders' footprints 3/3

- **Whether fast or slow, the speculator's trades are positively autocorrelated (consistent with Hirschey (2013) and Benos and Sagade (2014)).**
- **But autocorrelation in the speculator's order flow** is an order of magnitude lower when the speculator has a speed advantage
- **Intuition:** News trading has zero autocorrelation and it account for the bulk of the speculator's order flow
- Consistent with Hirschey (2013)

Making inferences from HFTs' transactions

- **Common wisdom:** HFTs must be trading on very short-lived info because:
  1. Their trades are correlated with short term returns
  2. There is no persistence in the direction of their trades
- **One must be cautious with this type of inference.** In our model:
  - The speculator's trades have these two properties
  - Yet, the speculator trades on long-lived information

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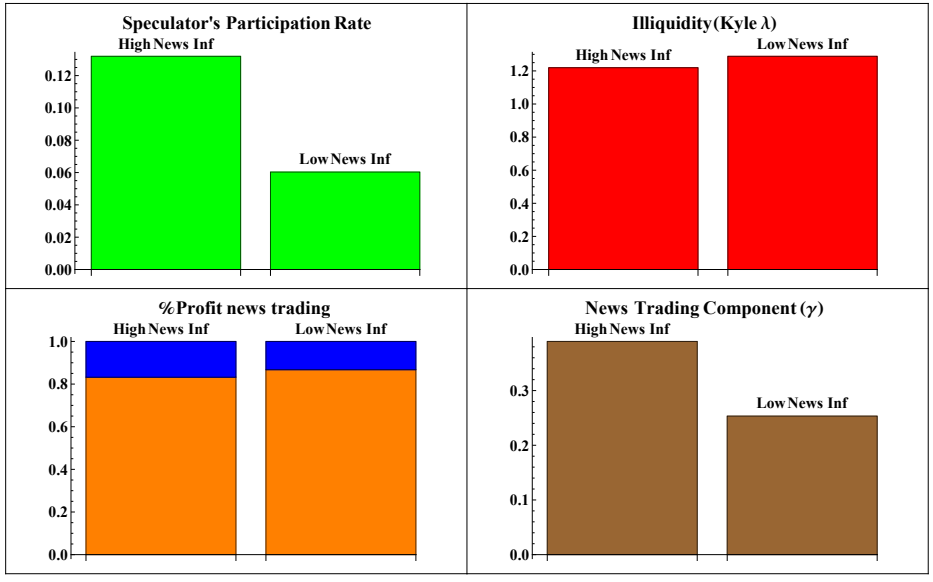
  - Yet, the speculator trades on long-lived information
- **More research is needed to really conclude that HFT only trade on very short term information.**

News informativeness

- $1/\sigma_e =$ a measure of news informativeness for dealers
- $\sigma_e = 0$: News is very accurate
- $\sigma_e \to +\infty$: News is very noisy/irrelevant
- Could be proxied using for instance news' relevance scores provided by News Analytics vendors (e.g., Reuters or Bloomberg). See Reuters NewsScope sentiment Engine

The effect of news informativeness

- **When the speculator is fast:**



- **When the speculator is slow**: One cannot simultaneously generate a greater participation rate from the informed and a more liquid market when news informativeness $\Rightarrow$ Looking at the effect of news informativeness offers a sharp way to test the model.

News informativeness and Informed Trading

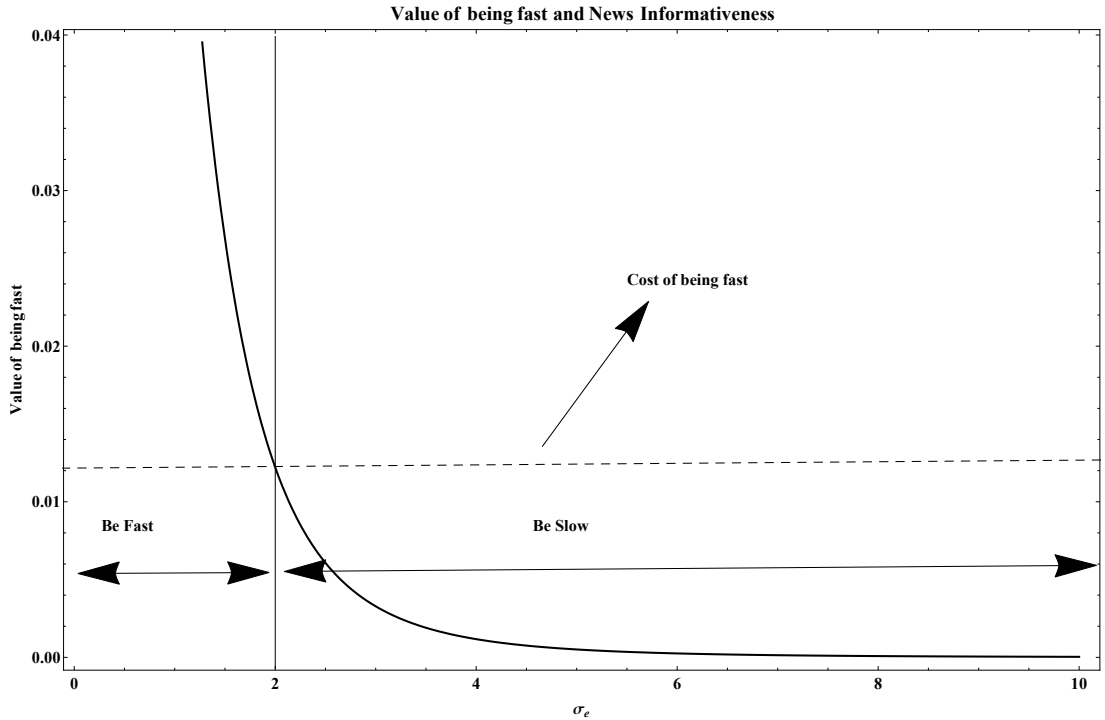
- **Common wisdom:** more precise public information $\rightarrow$ less informed trading (e.g., Kim and Verrecchia, 1994)
- **With news trading, the opposite is true:**

- **Result**: when dealers receive more precise news (lower σ_e), the speculator trades more aggressively on news (higher γ)

- **Intuition:** An increase in news' informativeness makes dealer's quote updates more sensititive to news $\Rightarrow$ more incentive to speculate on price reactions to news

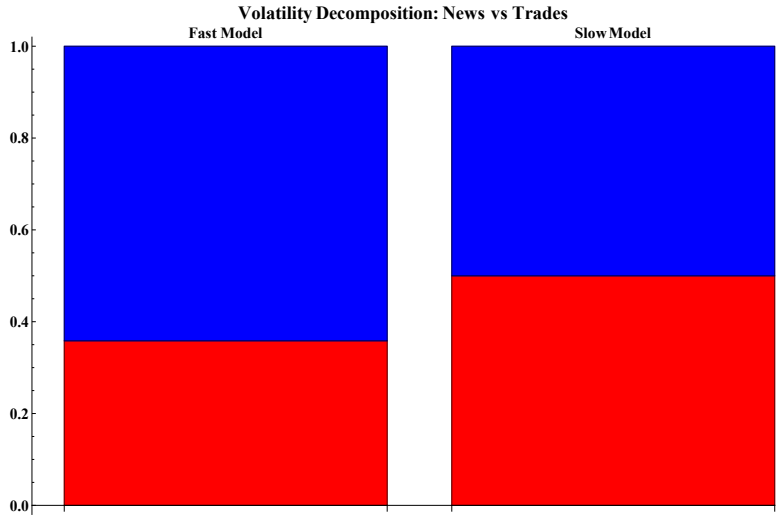
News informativeness & Speed investment

- **Result:** When the precision of public news increases (σ_e decreases), the speculator's profit decreases but the **net gain** of being fast (the difference between a fast and a slow speculator' profit) increases



- **Implication:** If there is a fixed cost (C_F) for becoming fast, we should observe fast traders in stocks with more informative news (with $\sigma_e < \sigma_e^*(C_F)$)

News trading and the sources of volatility



blue = % volatility due to quote updates following trades
orange = % volatility due to quote updates following news

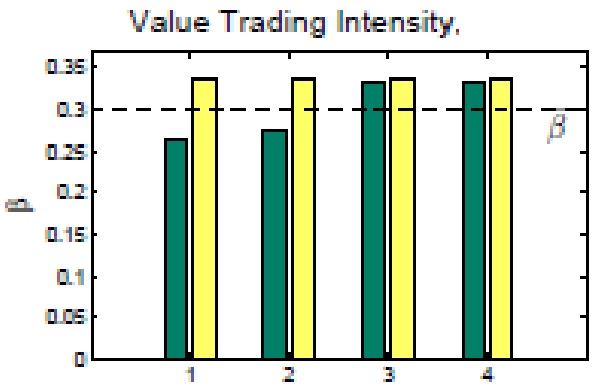
- **Result:** When the speculator has fast access to news, volatility due to trades is higher and volatility due to news is lower. Total volatility is the same
  - **Why?:** When the order flow contains information about incoming news, dealers' quotes become less responsive to news
- **Predictions:** (i) The contribution of news to price volatility should have declined over time and (ii) should decline when some investors get faster access to news (e.g., co-location)

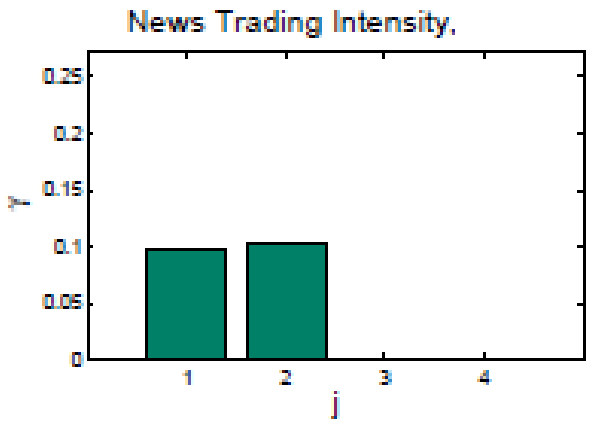
Trading frequency and news frequency

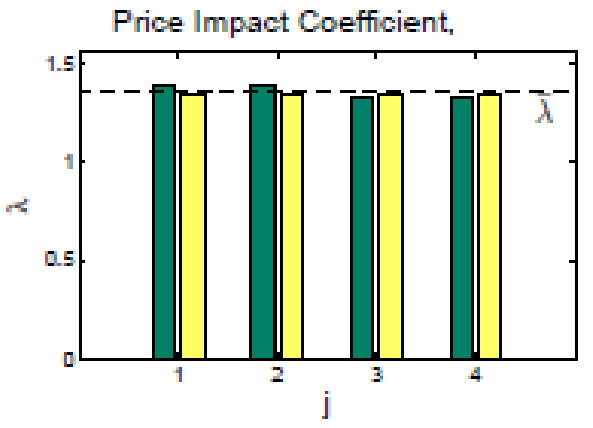
- In our model: news frequency = trading frequency
- **Extension:**
  1. $M \geq 1$ trading rounds between each innovation in the fundamental dv
  2. Speculator observes dv, $L \in [0, M]$ trading rounds before dealer observes news $dz = dv + de$
- Nests benchmark ($M = 1$, $L = 0$) and fast model ($M = L = 1$)
- **Result:**
  - $\gamma > 0$ during the L trading rounds after speculator observes dv but before dealer observes dz; $\gamma = 0$ afterwards until next innovation in fundamental

News Informativeness and Trade Patterns around News

- **Example:** Information arrives every $M = 4$ trading rounds and dealers observes the news with lag $L = 2$
- Green = Fast model Yellow = Benchmark







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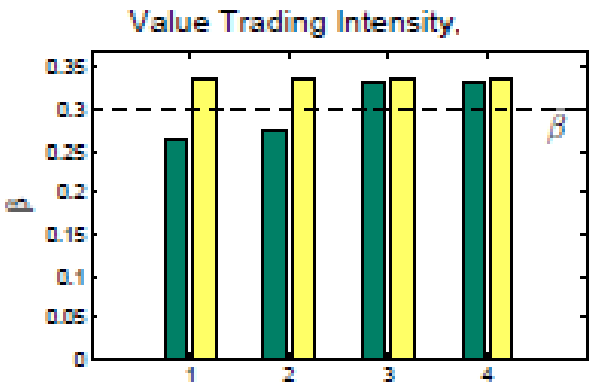
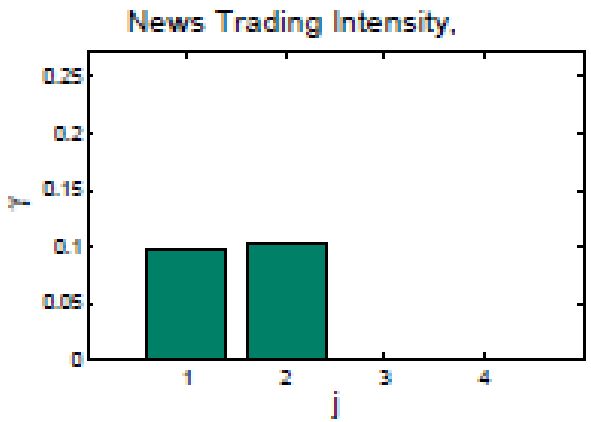
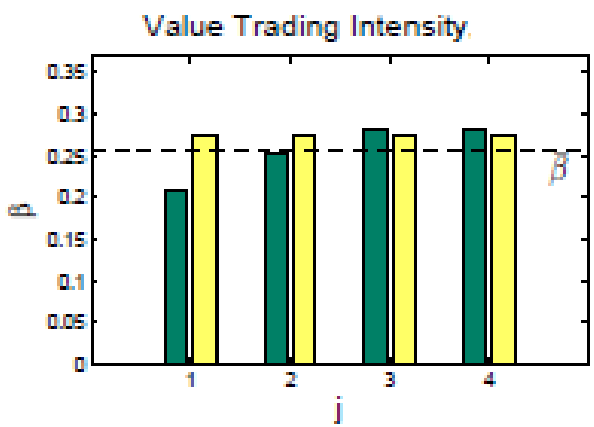
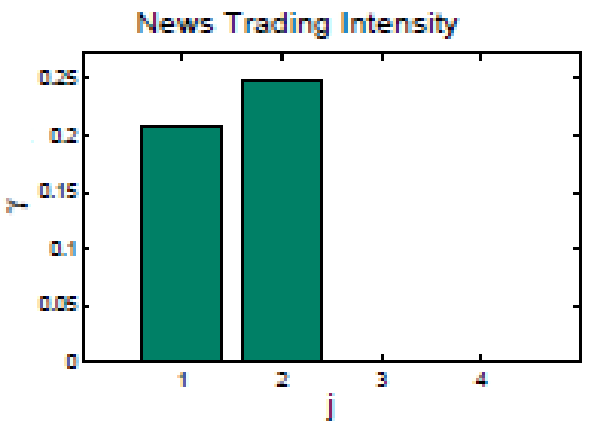




- If public news are more informative:





Take away

- Speed of access to info $\neq$ Greater processing capacity of info
- News trading enhances the contribution of an informed trader to trading volume and strengthen the correlation between his trades and short term returns.
- These patterns can be obtained even though the informed trader realizes most of his profit on long term price changes (and therefore contribute to price discovery).
- **New predictions about the role of news informativeness:**
  1. HFT should be more active in stocks with more informative news
  2. HFT should realize a larger fraction of their profit on short term price movements in stocks with more informative news
  3. and yet obtain lower profit overall in these stocks.
- Caveat: HFTs' strategies are heterogeneous. Our results apply only to one specific strategy: High Frequency News Trading

Isn't HFT all about front running the order flow?

1. Empirically, no
   - Brogaard, Hendershott and Riordan (RFS 2014) find that *"HFTs liquidity demand contains information about the efficient price above and beyond anticipating future nHFTs' liquidity demand."*
   - They also find evidence that HFTs use info contained in macro annoucements and market-wide returns
2. Not inconsistent with our analysis, if the order flow is informed. Which is true empirically (e.g., Evans and Lyons, 2008)

Isn't HFT all about market making?

- SEC (2014): *"Perhaps the most noteworthy finding of the HFT dataset papers is that HFT is not a monolithic phenomenon, but rather encompasses a diverse range of trading strategies. In particular, HFT is not solely, or even primarily, characterized by passive market making strategies [...]. For example, Carrion (2013) and Brogaard, Hendershott and Riordan (2013) find that more than 50% of HFT activity is attributable to aggressive, liquidity taking orders."*

- Baron, Brogaard and Kirilenko (2014): *"We find firm-level specialization: a majority of HFTs consistently specialize either in liquidity taking (whom we label aggressive HFTs) or liquidity provision (Passive HFT). Most importantly, Aggressive HFTs earn substantially higher returns than Passive HFTs."*

- Brogaard, Hendershott and Riordan (2014): *"HFTs' liquidity demanding strategies are consistent with the SEC's (2010) arbitrage and directional strategies, which are types of informed trading."*