News Trading and Speed

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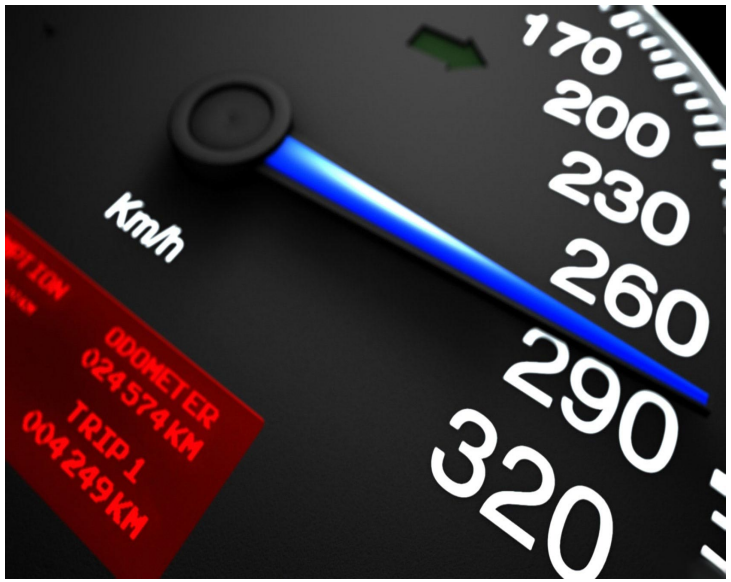
High Frequency Trading Conference

Plan

1. **Introduction - Research questions**
2. **Model**
3. **Is news trading different?**
4. **Implications**
5. **Conclusions**


NEWS
Latest news
Attracting Investors
Business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News trading

- **Market efficiency:** securities prices reflect all publicly available information instantaneously.
- **Implication:** Trading on news (corporate announcements, macro announcements, newswire, market data etc.) cannot be profitable.
- **Yet, it is profitable...**
  1. *Empirical evidence:* Tetlock, Saar-Tsechansky, and Mackassy (2008), Engelberg (2008), Tetlock (2010), Engleberg, Reed and Ringgenberg (2011).
  2. *High-Frequency Trading on News:* some investors make massive technological investments to trade on "news" (orders, quotes, etc.).

High Frequency News Trading (HFTNs)

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 decidewhat it all means for the markets.["Computers that trade on news"-New-York-Times, December 22,2010.

High Frequency News Trading (HFTNs)

Authorities are exploring potential holes in the system, including 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, [...].["FBI joins SEC in computer trading probe"-Financial Times, 2013.]

Why is news trading profitable?

- 1. **Greater processing capacity of vast amount of information:** #messages (orders) per second in U.S. equity markets ≈100,000 [Hendershott (2011)]. Only computers can process such vast amount of data to generate trading signals

  OR/AND

  2. **Faster access to information** (co-location, real-time data feed etc.)
- **Models of informed trading usually focus on the first type of advantage. Does this matter?**
- **What is the optimal trading strategy of an informed investor who is both (i) a fast and (ii) skilled information processor?**

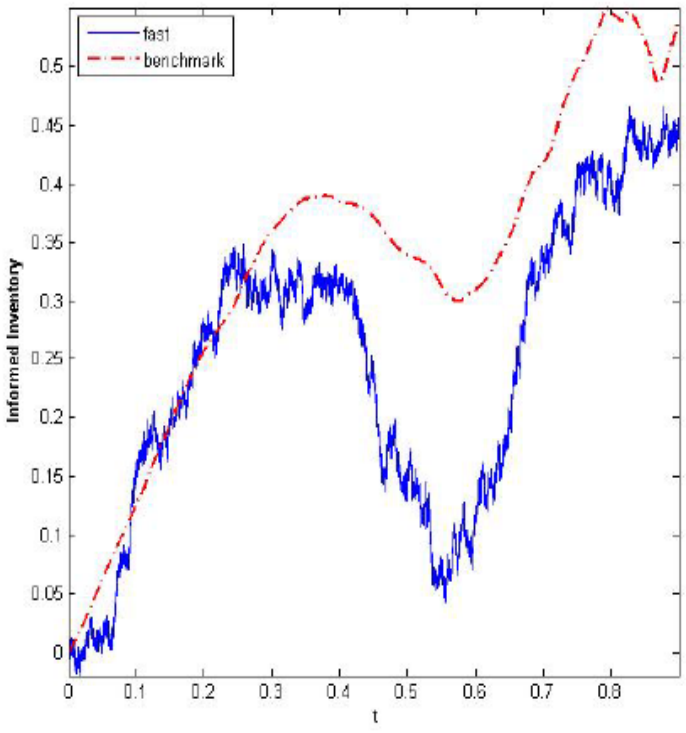
Why are these questions important?

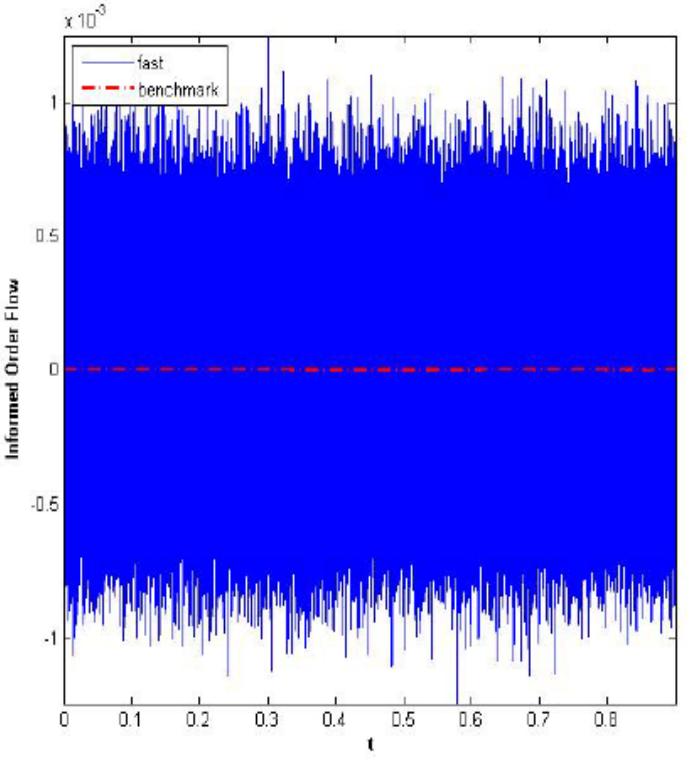
- **Disentangling the relative contributions of speed and information processing capacity is important to:**
  1. **Identify the exact sources (speed vs accuracy) of news traders' profitability.** Could be important for regulation (unfair access to information vs. skilled processing of information).
  2. **Make predictions about trades of high frequency news' traders and relate these trades to returns.**
     - 2.1 **Many empirical papers relate returns to order imbalances from high frequency traders** (e.g., Kirilenko et al.(2011), Brogaard, Hendershott, Riordan (2012), Hirschey (2011), etc.).
     - 2.2 How to interpret these findings? $\longrightarrow$Need of structural foundations
  3. **Understand the process by which news get impounded into prices** (trades or quote updates?)

Our approach

- **We use the dynamic version of Kyle (1985) with news arrivals.**
- **The informed investor in our model has two advantages:**
  1. A greater ability to process information: he extracts more precise signals than dealers from news.
  2. A faster reaction than dealers to news.
- **To isolate the effect of speed: we compare the equilibrium with and without a speed advantage for the informed investor.**
- **Main finding:** The equilibrium trading strategy of the informed investor is significantly different when he has a speed advantage and when he has not.

Equilibrium holdings and trades





- **Left panel:** informed investor's holdings of the risky asset, x_t (red in the benchmark model; blue in the fast model).
- **Right Panel:** informed investor's trade (dx_t)

Literature

- **Continuous time Kyle (1985) with news for the informed investor:**
  1. Back and Pedersen (1998): No news for dealers $\Longrightarrow$ No news trading (a special case of our model).
  2. Chau and Vayanos (2008): News for dealers but no speed advantage for the informed investor $\Longrightarrow$ No news trading.
  3. Martinez and Rosu (2012): No news for dealers but ambiguity aversion for the informed investor $\Longrightarrow$ News trading but for a different reason than in our paper.

Literature

- **Theoretical literature on HFTs:** Biais, Foucault, and Moinas (2011), Pagnotta and Phillipon (2011), Jovanovic and Menkveld (2011), Cvitanic and Kirilenko (2011), Cartea and Penalva (2012), Hoffman (2012).
  1. **Our contribution: optimal dynamic strategy for an investor who has both a fast access to news and a greater information processing ability.**
- **Empirical literature on HFTs**, especially Brogaard, Hendershott, and Riordan (2012)
- **Public information and volume** (Kim and Verrecchia (1992, 1994)

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Model

- **Kyle (1985) with:**
  1. Public information: A flow of news
  2. Speed: The possibility for the informed investor to observe news before dealers.
- **Fundamental value of the asset at date T**, $v_T = v_0 + \sum_{t=1}^{t=T} \Delta v_t$ where $v_0 \hookrightarrow N(0, \Sigma_0)$ and $\Delta v_t \hookrightarrow N(0, \sigma_v \sqrt{\Delta t})$
- $v_t = E(v_T \mid \langle \Delta v_s \rangle_{s=1}^{s=t})$ (Brownian motion) and σ_v =Fundamental Volatility.

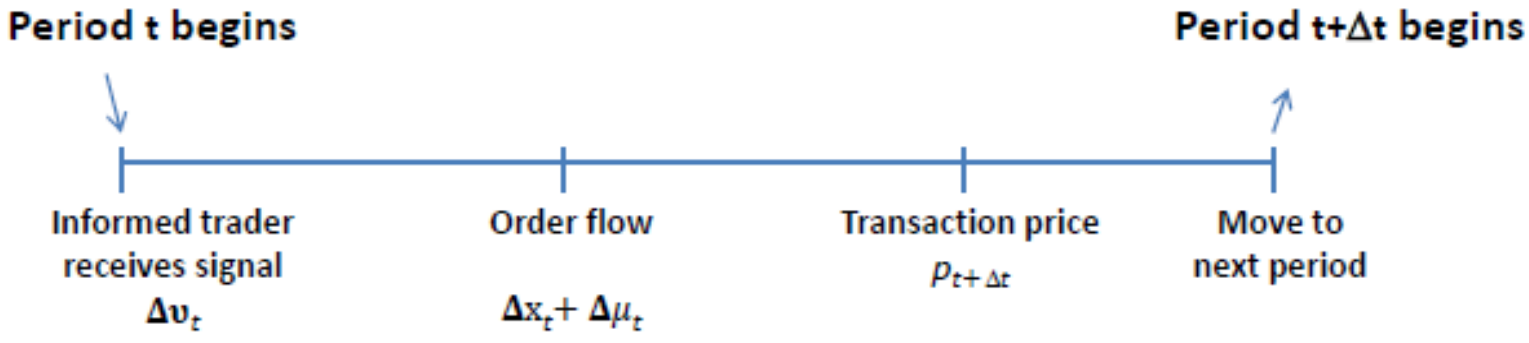
Participants

- **One risk neutral informed trader:** He knows v_0 and **NEWS:** $\Delta z_t^i = \Delta v_t + \Delta e_t^*$ where $de_t^* \rightarrow N(0, \sigma_e^* \sqrt{\Delta t})$.
  1. **Position at date** t : x_t.
  2. **Strategy:** market order for Δx_t shares traded at date t.
- **Noise traders:**
  1. Exogenous trade at date t: $\Delta u_t \hookrightarrow N(0, \sigma_u \sqrt{\Delta t})$
  2. Δu_t contains no information on the asset value.
- **Competitive Market-makers:**
  1. Dealers' **NEWS**: $\Delta z_t = \Delta v_t + \Delta e_t$, where $\Delta e_t \rightarrow N(0, \sigma_e \sqrt{\Delta t})$ and $\Delta e_t^* \perp \Delta e_t$.
  2. At date t, they absorb the net order imbalance $\Delta y_t = \Delta x_t + \Delta u_t$ at a price equal to the expected payoff of the asset conditional on their information.

Information processing and speed 1/2

- **Information processing:** The informed investor has a greater information processing capacity than dealers: $\sigma_{e^*} \leq \sigma_e$. To simplify, $\sigma_{e^*} = 0 \Longrightarrow \Delta z_t^i = \Delta v_t$.
- **Speed of access to information:**
  1. **Fast model:**Market-makers observe news **with a one period delay** relative to the informed investor.
  2. **Benchmark case:**Market-makers observe news **without delay**: the informed investor only has only an information processing advantage.

Information processing and speed 2/2



In benchmark: Market maker receives signal $\Delta z_t = \Delta v_t + e_t$

In fast model: Market maker receives news with a one period lag: $\Delta z_{t-1} = \Delta v_{t-1} + e_{t-1}$

Interpretation and Particular Cases

- $1/\sigma_e$ = a measure of **news informativeness for dealers.**
- $\sigma_e = 0$. The informed investor and the dealer observe the same news.
- $\sigma_e \longrightarrow \infty$: market-makers never receive news.

News Trading: Definition.

- **State variables for the informed investor at date t:**
  1. The dealer's forecast of the asset value before trading ("the midquote"): q_t
  2. The informed investor's forecast of the asset value **after** receiving news: v_t
  3. News: $\Delta v_t = v_t - v_{t-1}$

- **DEFINITION:** There is news trading if the investor's optimal strategy **depends on news** (Δv_t), and **not just** v_t and q_t.

Equilibrium Definition

- **Same as in Kyle (1985): At any point in time:**

  1. Prices are equal to dealers' forecast of the asset liquidation value given their information and the optimal trading policy of the informed investor (Δx^*).

  2. The trading policy of the informed investor is optimal at any point time given dealers' pricing policy.

- To obtain a closed form solution, we focus on the **continuous time** version of the model: **NOT KEY**.
- **Is it important that the problem is dynamic? YES:** no news trading in the "static" (one period) model.

Equilibrium

- **There is a linear equilibrium in which:**
  1. The informed investor's optimal trade at date t is:

$$dx_t = \underbrace{\beta_t \cdot (v_t - q_t)dt}_{\text{Pricing error}} + \underbrace{\gamma \cdot dv_t}_{\text{News Trading}}$$

     where q_t is market-maker's expectation of the asset payoff before observing the order flow at date t.

  2. Transaction prices are linear in the order flow (dy_t).The sensitivity of prices to the order flow, λ, is a measure of market illiquidity. (as in Kyle (1985)):

$$p_{t+dt} = q_t + \lambda \times dy_t$$

- We characterize in closed form β_t, γ and λ both when the informed investor has a speed advantage and when he has not.

Equilibrium trading strategy for the informed investor 1/2

- **The trading strategy has two components:**
  1. **Forecast or pricing error component** $(\beta_t(v_t - q_t)dt)$:The informed investor buys (sells) the asset if the dealer undervalues (overvalues) it. Standard in Kyle's type of model.
  2. **News Trading component** (γdv_t):The informed investor trades on news because dealers' quote updates are correlated with news.
     - If the informed investor observes good news, he anticipates an increase in dealers' quotes $\Rightarrow$ Buy more before buying becomes more expensive.

Equilibrium trading strategy for the informed investor 2/2

- **Result 1: Responsiveness of the investor's holdings to news (γ).**
  1. **No news trading without a speed advantage:** $\gamma > 0$ **iff** the informed investor has a speed advantage– An information processing advantage ($\sigma_e > 0$) is not sufficient to generate aggressive trading on news.
  2. **More aggressive trading on informative news for dealers:** γ is positively related to $1/\sigma_e$.
  3. **No news trading if dealers do not receive public information:** γ goes to zero if $\sigma_e \longrightarrow \infty$.
- **Result 2: Responsiveness of the investor's holdings to mispricing (β_t).**
  1. It is lower when the informed investor has a speed advantage ("substitution effect").

Liquidity

- **Illiquidity** $= \lambda =$ Price impact of trades.
- The ability of the informed investor to exploit news before market-makers is an additional source of adverse selection for market-makers (they are more likely to sell the asset when good news arrive and buy it when bad news arrive).
- Hence, liquidity is smaller with news trading than without.
- Not surprising.

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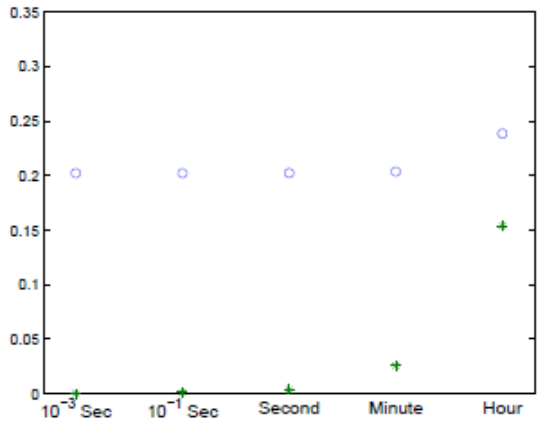
News Traders' Footprints

- **High participation rate:** The fraction of total trading volume due to the informed investor is an order of magnitude higher when he has a speed advantage (consistent with the large fraction of trading volume due to high frequency traders).
- **Anticipatory trading:** The informed informed investor trades are positively correlated with very short term returns.
  "Possibly due to their speed advantage or superior ability to predict price changes, HFTs are able to buy right as the prices are about to increase." (Kirilenko et al.(2012))
- **None of these properties are obtained if the informed investor has no speed advantage. Why?**

Informed Investor's Participation Rate

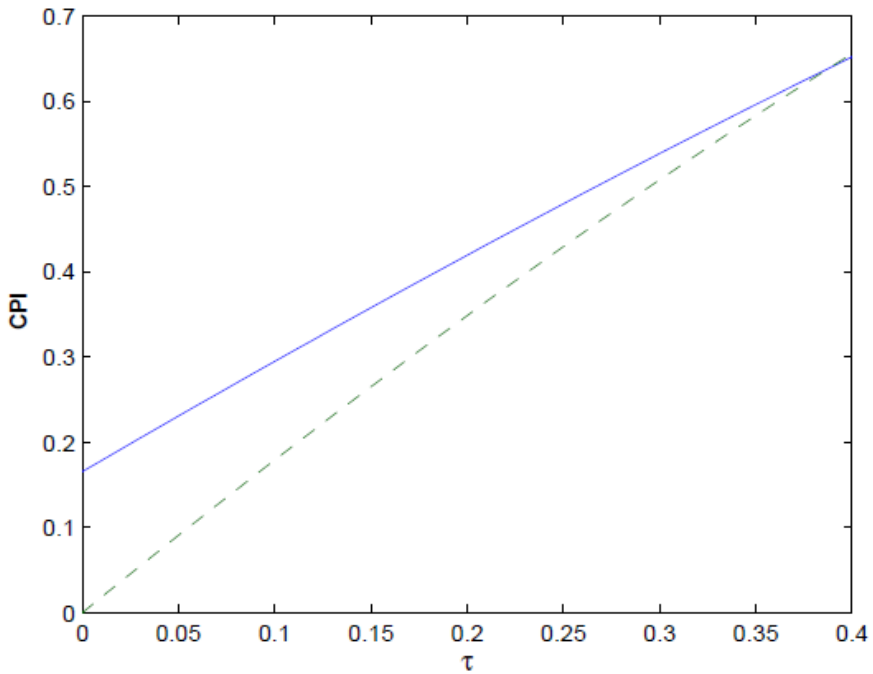


(circle= fast model; crosses=benchmark)

- **Informed investor's participation rate = Fraction of trading volume due to the informed investor at various sampling frequency .**
- Intuition: $\mathrm{Var}(\Delta x_t)=\gamma^2\sigma_v^2 dt$ and $\mathrm{Var}(\Delta u_t)=\sigma_u^2 dt$: same order of magnitude.

Anticipatory Trading

- **The covariance between the informed investor's trade rate at date t and the subsequent return over various horizons**



[Blue line: Fast model. Green line: Benchmark]

News Trading and Price discovery 1/2

- Let $s_t = p_t - v_t =$ **Pricing error at date t.**
- **Measure of informational efficiency: Average pricing error at date t:**

$$\Sigma_t = E(s_t^2 \mid \text{Dealers/Information Set at date t}).$$

- We have:

$$d\Sigma_t = \underbrace{2Cov(dp_t, s_t)}_{<0} - \underbrace{2Cov(dp_t, dv_t)}_{>0} + (2\sigma_v^2 + \Sigma_0)dt$$

- Hence, informational efficiency is higher when price changes are:
  1. more positively correlated with news($Cov(dp_t, dv_t)$ higher).
  2. more negatively correlated with pricing errors (i.e., correct pricing errors)($Cov(dp_t, s_t)$ smaller)

News Trading and Price discovery 2/2

- **Two effects of granting a speed advantage to the informed investor: Price changes are**
  1. more positively correlated with news($Cov(dp_t, dv_t)$ is higher in the fast model).
  2. but less negatively correlated with pricing errors due to the substitution effect($Cov(dp_t, v_t - p_t)$ is smaller in the fast model).
- **Net effect** on informational efficiency/price discovery ($\sum_t$): **zero at any date.**

News Trading and the Sources of Volatility

- **Prices changes because dealers receive information. Two sources of information:**
  1. Trades (Δy_t)
  2. Public signals (Δz_t)
- **Volatility of returns can be decomposed in two components (**q_t =dealer's quote after receiving public information**):**

$$Var(\Delta p_t) = \underbrace{Var(p_{t+\Delta t} - q_t)}_{Trades} + \underbrace{Var(q_t - p_t)}_{News},$$

- The first component is higher in the fast model and the second smaller; **Net effect: zero:** Volatility is identical whether or not the informed investor has a speed advantage.
- **However, the contribution of news (trades) to volatility is smaller (higher) in the fast model.**

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News Informativeness, Volume and Liquidity

- **An increase in news informativeness for dealers results in:**
  1. A higher participation rate for the informed investor
  2. A higher trading volume
  3. A more liquid market (λ declines).
- $\Longrightarrow$**Risk of spurious positive correlation between measures of news traders' activity and liquidity [**liquidity is lower (λ higher) when the informed investor has a speed advantage.]

How does trading on news affect returns?

- Brogaard, Hendershott and Riordan (2012) decompose transaction prices into a permanent and a transitory component ("pricing error"):

$$\underbrace{p_t}_{\text{Transaction prices}} = \underbrace{m_t}_{\text{Efficient price}} + \underbrace{s_t}_{\text{Pricing error}} .$$

and relate (a) innovations in m_t to innovations in order imbalances from high frequency traders and (b) pricing errors to order imbalances from high frequency traders.

How does trading on news affect returns?

- If we set $m_t = v_t$ (and assume β constant), we obtain (in the discrete time version):

$$\begin{aligned} \Delta m_t &= \kappa \widetilde{\Delta x_t} \\ s_{t+\Delta t} &= \phi s_t + \psi \Delta x_t + \eta_t \end{aligned}$$

- **The model predicts**: $\kappa > 0$, $\phi < 1$, and $\psi < 0$.
- Consistent with Brogaard, Hendershott and Riordan (2012)'s findings who estimate $\kappa = 4.13 bps$, $\phi = 0.47 bps$ and $\psi = -1.97 bps$ $(/\$10,000)$.

Interpretation

- **The model implies that:**
  1. $\kappa = \frac{1}{\gamma} \Rightarrow$ Estimate of κ can be viewed as a measure of high-frequency traders' responsiveness to news.
  2. Slow trading on the forecast error $\Longrightarrow 0 < \phi < 1$.
  3. $\psi < 0$, even though, strictly speaking news trading is not trading on the pricing error: Suppose $s_t = 0$ $(p_t = v_t)$. Positive news $(\Delta v_t > 0) \Longrightarrow$ Informed investor buys $\Delta x_t > 0$ but the price does not fully adjust because order flow is noisy $\Longrightarrow s_{t+1} = p_{t+1} - v_{t+1} < 0$.

Do we really need a dynamic model?

- **Suppose only one period ($\Delta t = 1$). At date 0:**
  1. The informed investor knows v_0 and observes **news**: $\Delta v = v_1 - v_0$ **AND**,
  2. The dealer observes news: $\Delta z_0 = \Delta v + e_0$ **before trading** in the benchmark model and **after trading** in the Fast model.
- **Benchmark: No news trading**...Informed investor's optimal trading strategy:

$$x_0^{B*} = \beta^B (v_0 + \Delta v - q_0) \text{ just as in Kyle (85)}$$

$\Longrightarrow$ **Same weights** on v_0 and news.

- **Fast model: No news trading again**...: $x_0^{F*} = \beta^F (v_0 + \Delta v - q_0)$; Only difference: $\beta^F > \beta^B$.
- $\Longrightarrow$ **News trading really requires multiple trading opportunities.**

Conclusion

- **Speed of access to information has effects distinct from greater processing capacity of information.**
- Slowing down high frequency traders may have no effect on volatility or price discovery (they will simply trade more aggressively on their long-run forecast of the asset value) but it will reduce their profits.
- Dynamic models of high frequency trading help to interpret relationships between HFTs' flows and returns.