FINANCIAL MARKET REACTIONS TO EXOGENOUS SHOCKS

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MOTIVATION

- Present stock price is given by the sum of all future cash flows that traders predict.

Financial markets do not respond to already-known news.

Even if the novelty of news is high, the markets do not respond to the news which is not important.

The goals of our presentation,

- Stylized facts of exogenous shocks
- Definition of "novelty and topicality" of news
- Relationship between change of market activity and the novelty or the topicality.
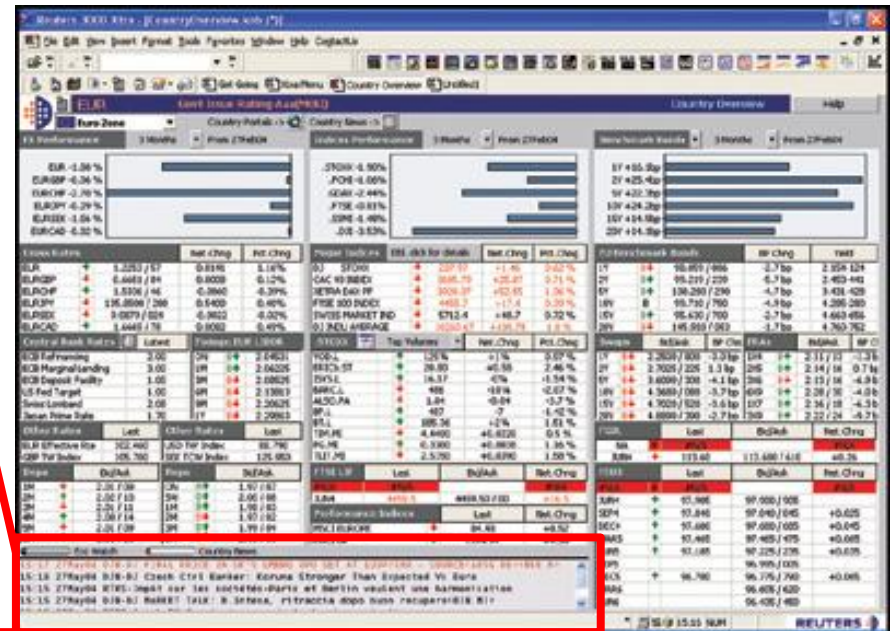- Nowcasting and Forecasting the market with news articles

OUTLINE

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NEWS DATASET

Reuters 3000 Xtra

News object

・Reuters publishes the news that market investors are interested in.
・Dataset of news on Reuters 3000 Xtra from 2003 to 2014.
 (News that are published by about 300 third parties are included.)
・Total number of news is about 300 million recodes.
・Keywords (e.g. GM.N) are included in each news by reporter.
・There are three event types for the news.

ALERT: Urgent news
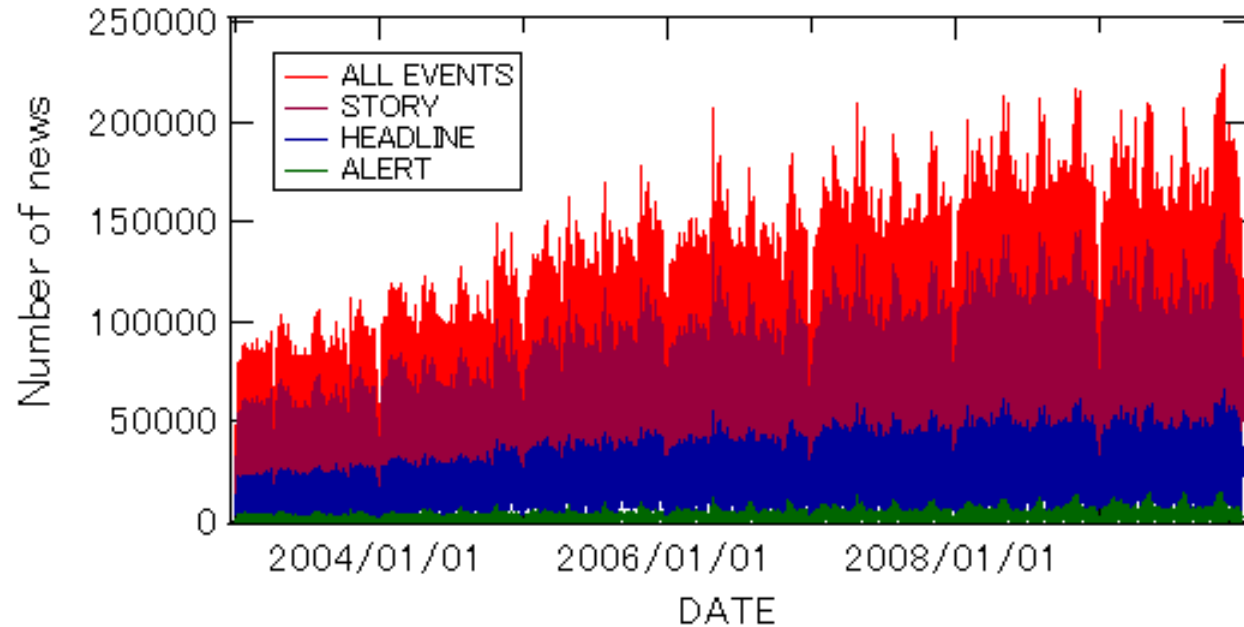HEADLINE: Title or short abstract
STORY: Article of the news

NUMBER OF NEWS

Time series of total number of news per 1 day for 8 years.

	Mean	Standard deviation
All event type	96,417	57,983
ALERT	3,319	2,667
HEADLINE	27,695	16,323
STORY	65,404	39,218

Reuters 3000 Xtra displays one news in about 0.9 second. Investors usually watch the news every time.

OUTLINE

1. Motivation
2. Detail of news dataset
3. **Stylized facts of exogenous shocks**
4. Definition of "novelty and topicality" of news, and Market reactions
5. Nowcasting and Forecasting the market with news articles

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MEASURE OF MARKET ACTIVITIES

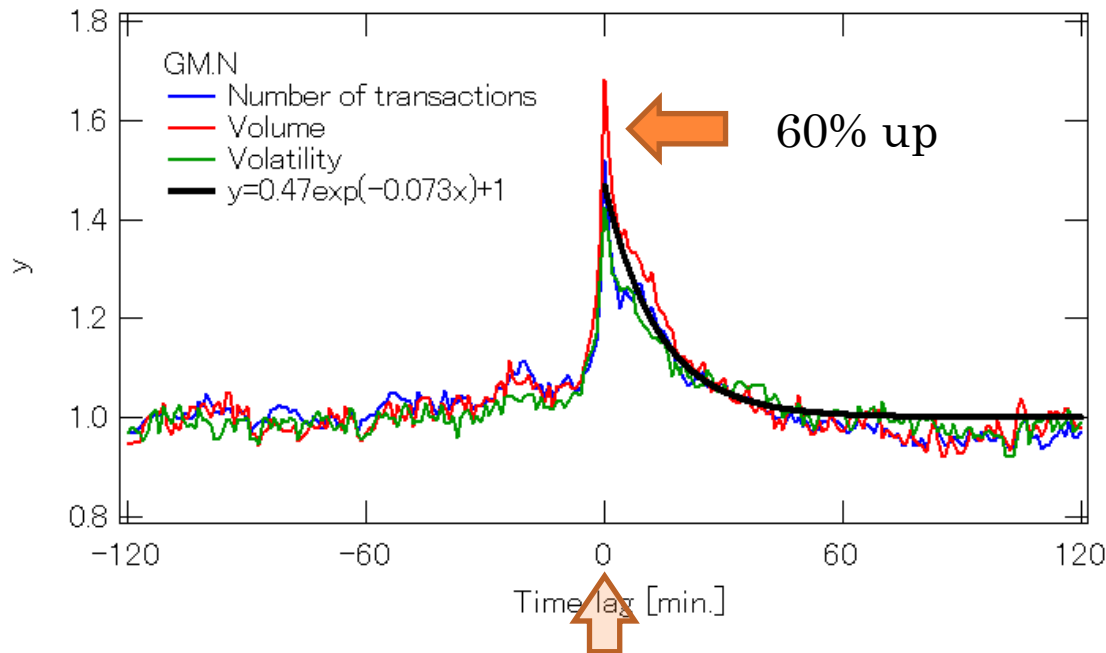Volatility, number of transaction, and transaction volume for 1 minute.

Volatility: $V'(d,t) \equiv (\log P(d,t) - \log P(d,t-1))^2$
Number of transaction: $N'(d,t)$
Transaction volume: $Vol'(d,t)$

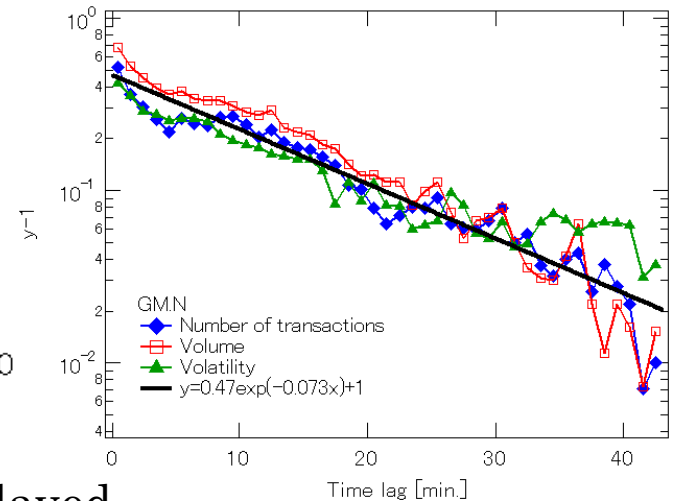The coefficients d and t express Date and Time, respectively.

- Normalized volatility, number of transactions, and volume
  - Adjustment for average seasonal variations
  - Adjustment for average daytime variation
  - Focusing on only continuous session for N.Y. 9:30-15:39

$$V(d,t) \equiv 370 \cdot \frac{V'(d,t)}{\sum_d V'(d,t)} \Big/ \sum_t \frac{V'(d,t)}{\sum_d V'(d,t)}$$

$$N(d,t) \equiv 370 \cdot \frac{N'(d,t)}{\sum_d N'(d,t)} \Big/ \sum_t \frac{N'(d,t)}{\sum_d N'(d,t)}$$

$$Vol(d,t) \equiv 370 \cdot \frac{Vol'(d,t)}{\sum_d Vol'(d,t)} \Big/ \sum_t \frac{Vol'(d,t)}{\sum_d Vol'(d,t)}$$

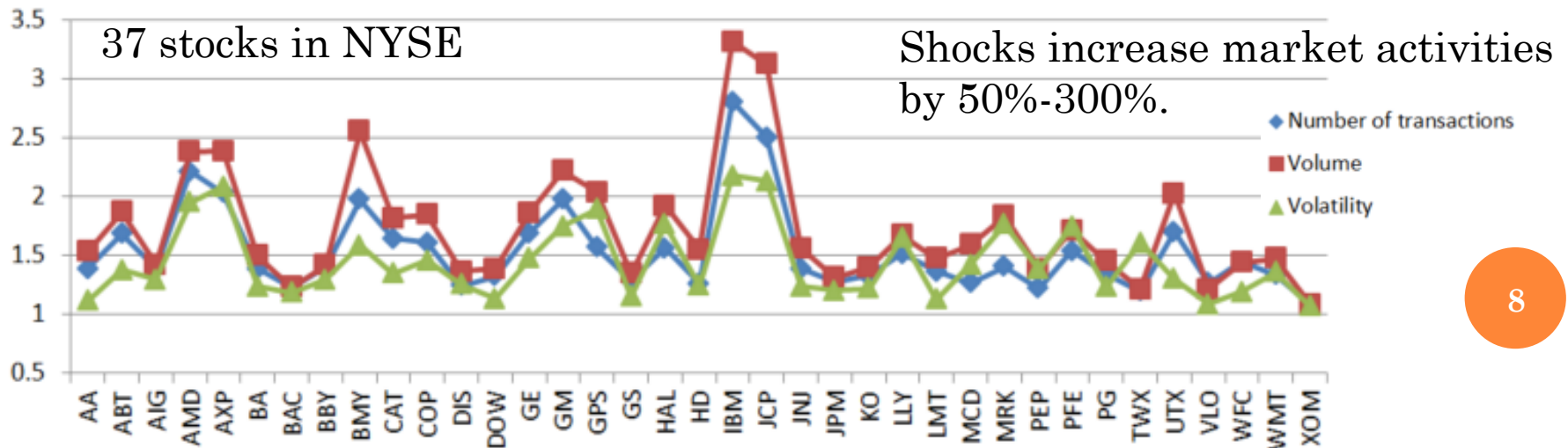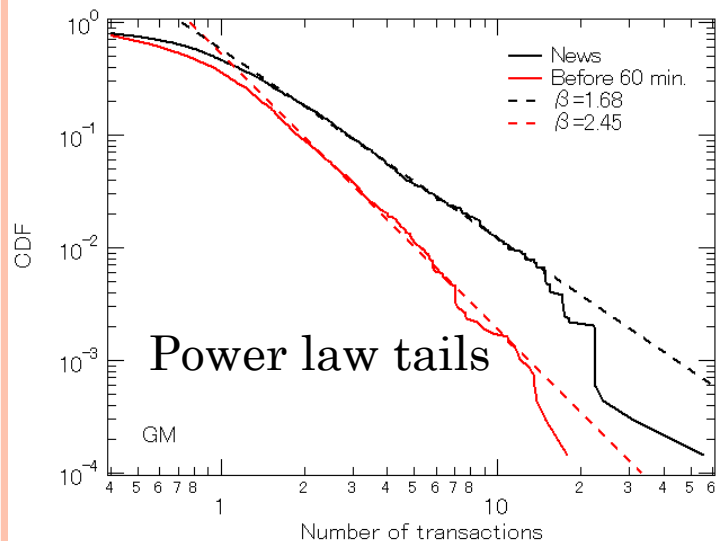# MARKET REACTIONS

60% up

Market activities slowly decrease as follows the exponential function.

Alert news with a keyword "GM.N" was displayed.

37 stocks in NYSE

Shocks increase market activities by 50%-300%.

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INFLUENCE ON DISTRIBUTION

Power law tails

GM

Power law tails

GM

─── Counter cumulative distributions of Number of transaction, Volume, and Volatility 60 min. before alert news are displayed.

─── Distributions just after the alert sounds.

Power law tails

GM
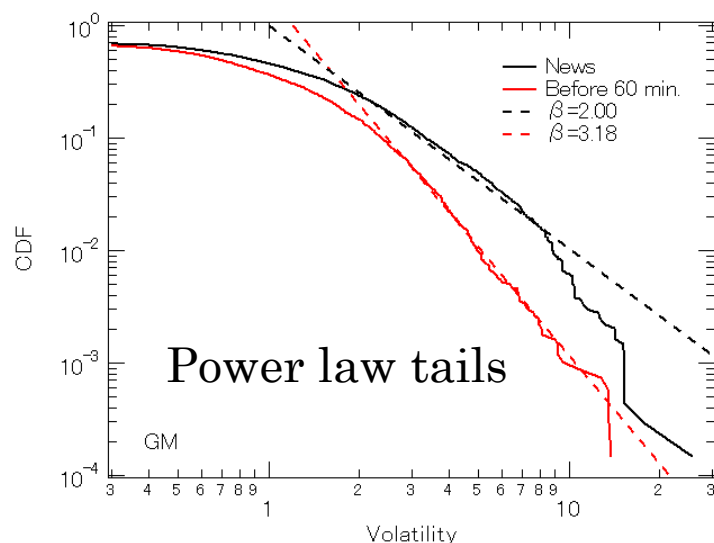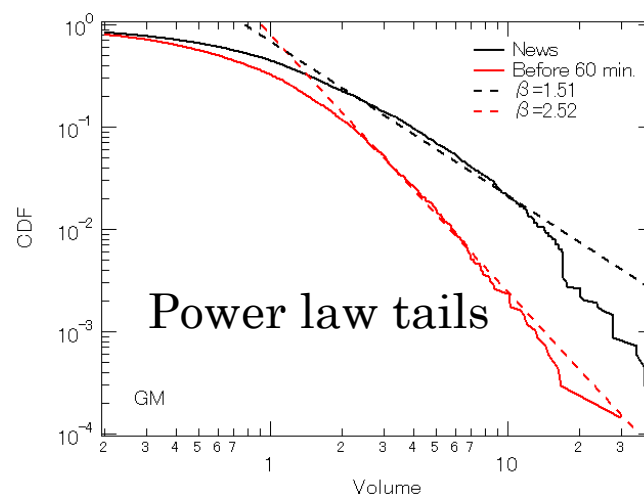
Power law indexes become small by news shocks.

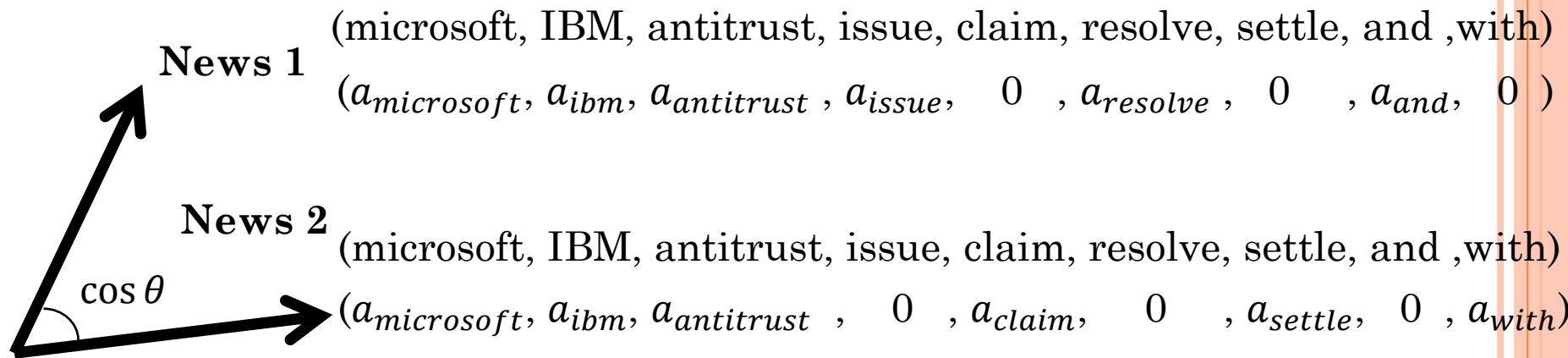|	Before	After
# of transactions	2.45	1.68
Volume	2.52	1.51
Volatility	3.18	2.00

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CORRELATION (SIMILARITY) BETWEEN NEWS ARTICLES

News 1: Microsoft and IBM resolve antitrust issues.
News 2: Microsoft settles antitrust claims with IBM.

News 1 (microsoft, IBM, antitrust, issue, claim, resolve, settle, and ,with)

$(a_{microsoft}, a_{ibm}, a_{antitrust}, a_{issue}, \quad 0 \quad , a_{resolve}, \quad 0 \quad , a_{and}, \quad 0)$

News 2 (microsoft, IBM, antitrust, issue, claim, resolve, settle, and ,with)

$(a_{microsoft}, a_{ibm}, a_{antitrust}, \quad 0 \quad , a_{claim}, \quad 0 \quad , a_{settle}, \quad 0 , a_{with})$

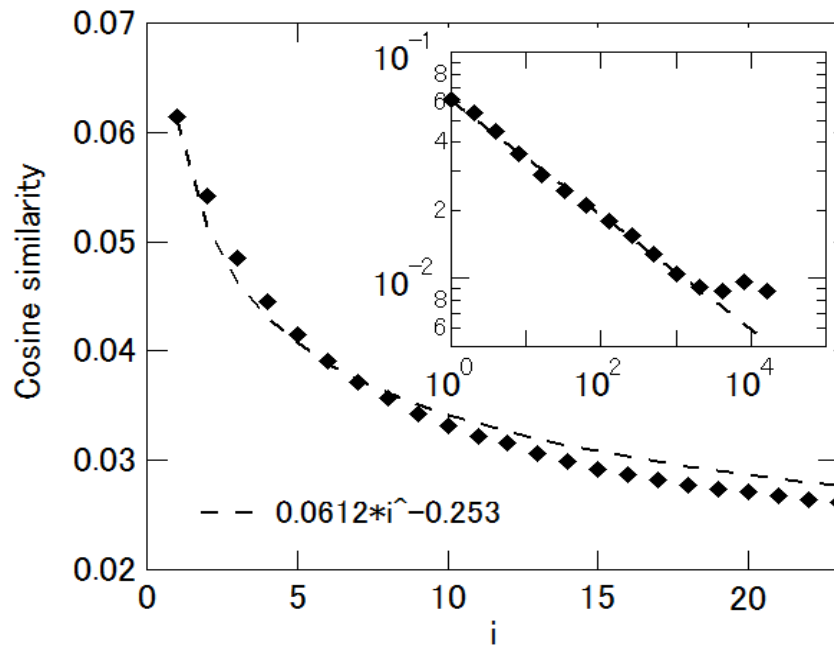$\cos\theta$

Cosine similarity if all $a = 1$

$$c(\textbf{News 1}, \textbf{News 2}) \equiv \cos\theta = \frac{\textbf{News 1} \cdot \textbf{News 2}}{\|\textbf{News 1}\|\|\textbf{News 2}\|} = \frac{3}{\sqrt{6}\sqrt{6}} = 0.5$$

Stop-words(i.e. and, with, the...) are not good keyword to measure similarity, unlike the less common words "IBM" and "antitrust".

All a set IDF values, respectively. The IDF is a popular measure of whether the term is common or rare across all documents in NLP.
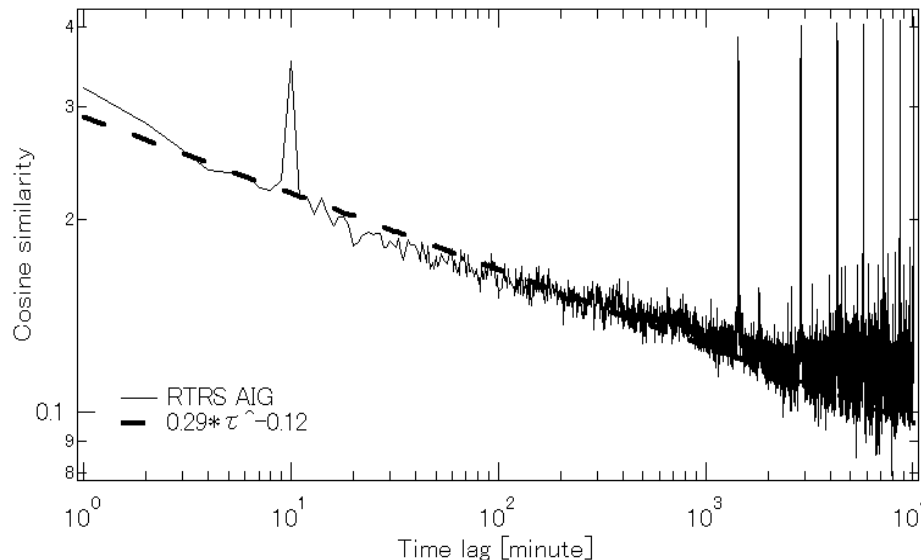
AUTO-COSINE SIMILARITY

Tick time

  The term "tick" refers to the appearance of news.

Mean of similarity between Reuter's news at tick time t and $t + i$.

$$c(i) = 0.0612 \cdot i^{-0.253}$$

Real time

  Mean of similarity between Reuter's news for AIG at time t and $t + \tau$.
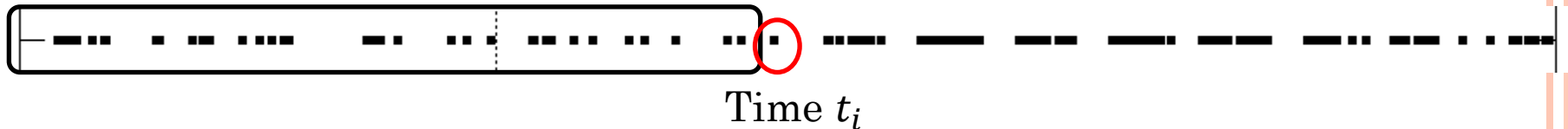
$$c(\tau) = 0.29 \cdot \tau^{-0.12}$$

News has long memory for some days.

NOVELTY AND TOPICALITY

Novelty of news i

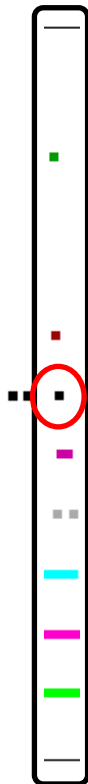$$N(i) \equiv \frac{1}{\sum_{t_i-7\text{days}\leq t_j<t_i} c(i,j)}$$

Reciprocal of sum of auto-similarity values of news before time t_i.

Time t_i

Topicality of news i

$$T(i) \equiv \sum_{k'} \sum_{t_j,k_j=k'} \frac{c(i,j)}{\exp(\gamma|t_i - t_j|)}$$

Sum of cross-similarity values between news around time t_i.

Time t_i
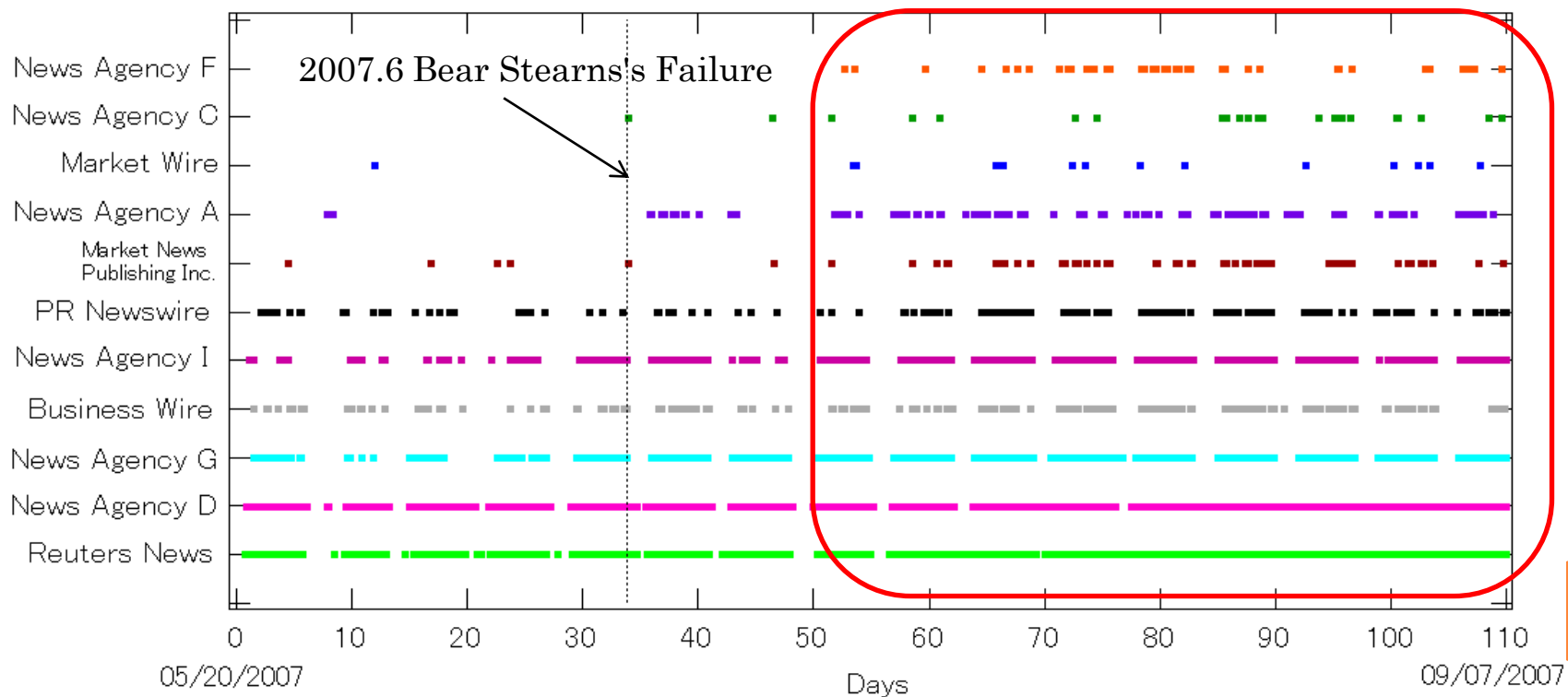News Agency k_i

Each news agency has subscribers.
The sum of cross-similarity values means potential number of subscribers which are interested in news i.

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RELATIONSHIP BETWEEN NEWS AGENCIES

When big incident occurs, many news agencies report similar news.

Similar terms appear frequently in the news articles of many agencies after the big incident occurs.

Example: English news articles where the term "subpprime" appeared from 05/20/2007 to 09/07/2007.

CROSS-COSINE SIMILARITY WITH TIME LAG τ

Mean of similarity between Reuter's news at time t and news of other news agency D at time $t + \tau$.
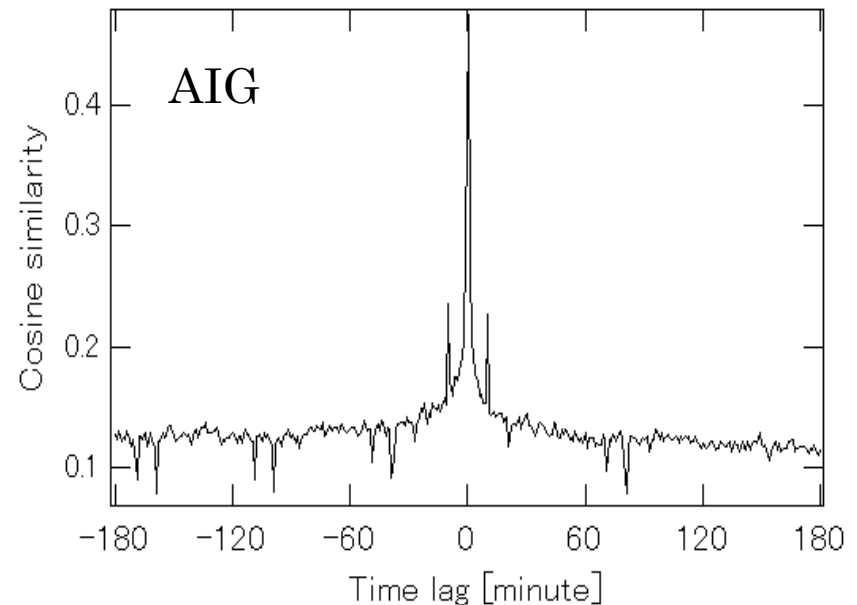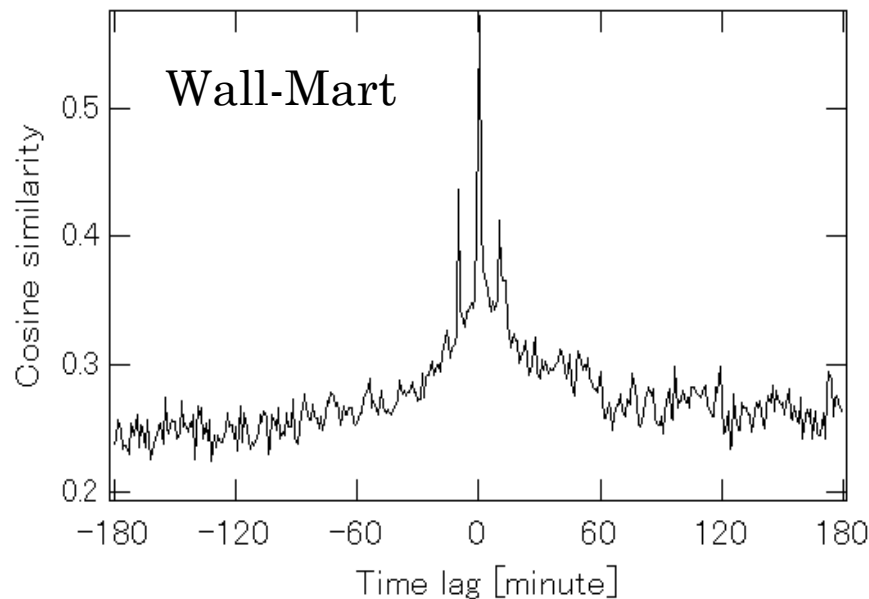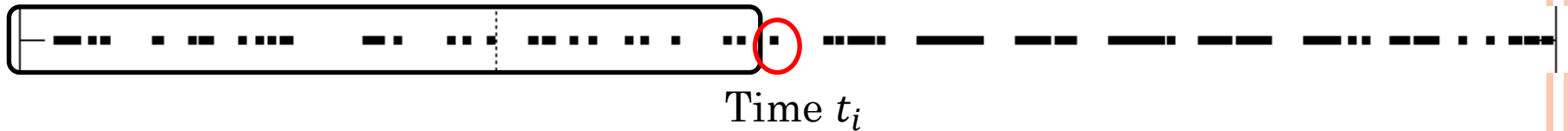

- When the time lag $\tau=0$, strongest similarity is observed.
- The similarity is almost symmetrical on either side of the time lag $\tau = 0$.

NOVELTY AND TOPICALITY

Novelty of news i

$$N(i) \equiv \frac{1}{\sum_{t_i-7\text{days}\leq t_j<t_i} c(i,j)}$$

Reciprocal of sum of auto-similarity values of news before time t_i.

Time t_i

Topicality of news i

$$T(i) \equiv \sum_{k'} \sum_{t_j, k_j = k'} \frac{c(i,j)}{\exp(\gamma|t_i - t_j|)}$$

Sum of cross-similarity values between news around time t_i.
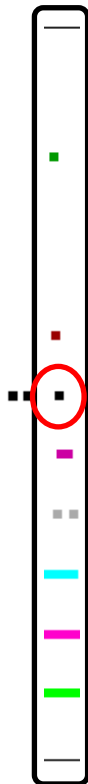
Time t_i
News Agency k_i

Each news agency has subscribers.
The sum of cross-similarity values means potential number of subscribers which are interested in news i.

MARKET ACTIVITIES AND NEWS

High novelty ← → Low novelty

High topicality
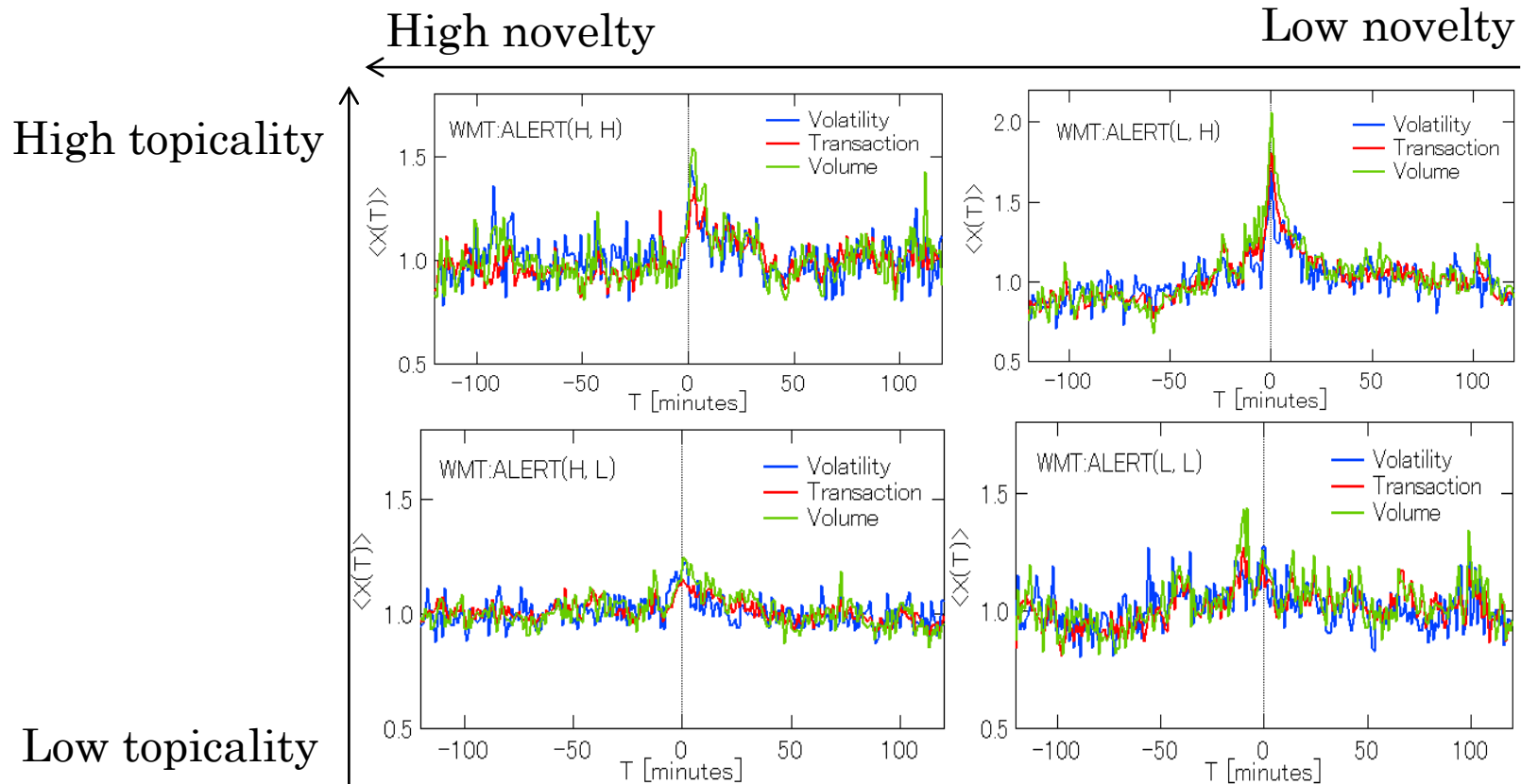
Low topicality

- When news has high novelty, market activities respond immediately after news appeared at time $T = 0$.
- Change of market activities depend on the size of topicality of news.

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WORDS FOR PRICE INCREASE/DECREASE

Stock price of a company often increases(or decreases) just after the following terms and its company name appeared in news article.

Words for price increase

repurchase, companies, immelt, continues, reduce, **worth**, common, conoco, **add**, **asset**, jpmorgan, month, aircraft, expect, regular, quarterly, air, increase, dividend, cash, work, orders, forecast, through, sets, additional, stock, billion, vehicles, share, program, stores, up, raises, ...

Words for price decrease

attorney, plants, further, wachovia, banking, **bankruptcy**, cola, head, gmac, sources, restructuring, directors, fire, **negative**, **moody**, **senior**, manufacturing, high, mortgage, debt, union, cuts, lawsuit, long-term, agreement, procter, chairman, gamble, hold, **commercial**, court, ...

SentiWordNet 3.0.0 is a database of sentiment corpus

Strong positive words, Positive words, Neutral words, Negative words, Strong negative words

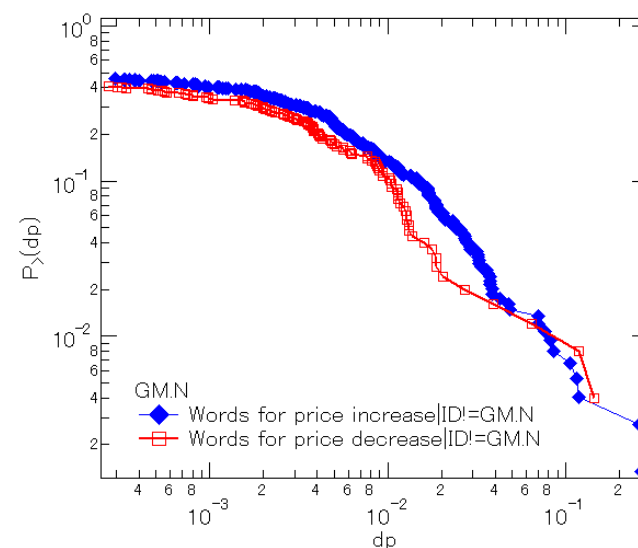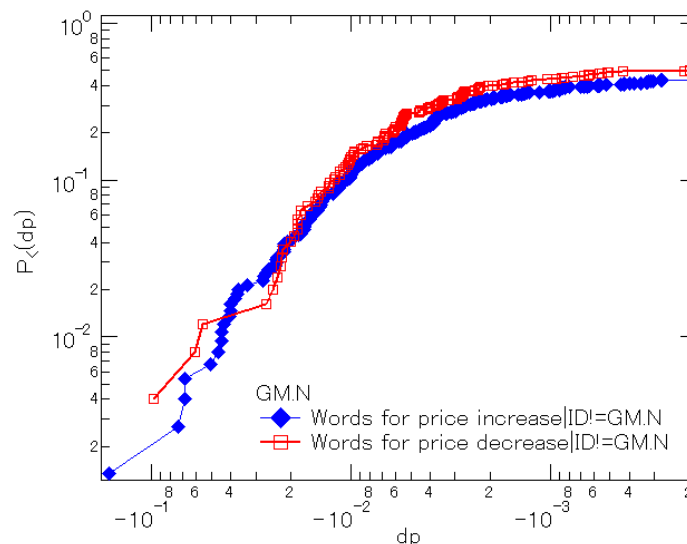Correlation coefficient is about 0.15.

CROSS-VALIDATION

We make a list of words for price increase or decrease from the news articles without keyword's GM.N, and analyze change of GM's stock price.

	Price up	Price down
GM.N		
Words for increase	51.3%	48.7%
Words for decrease	44.9%	55.1%

Distribution of price changes when the words are appeared in news article for GM.N.

GM.N

SYNONYMS IN NEWS ARTICLES

Every news have the primary code that is a name for which all news message relating to the same story is transmitted.

nBAY237976	Hero honda \<hroh.bo> dec total sales **rise** 2.1 pct to 125,116 bikes vs yr ago.
nBAY237976	Hero honda \<hroh.bo> dec total sales **up** 2.1 pct.

We can find synonyms from similer news articles with same code.

The term "increase" can be restated in different terms.
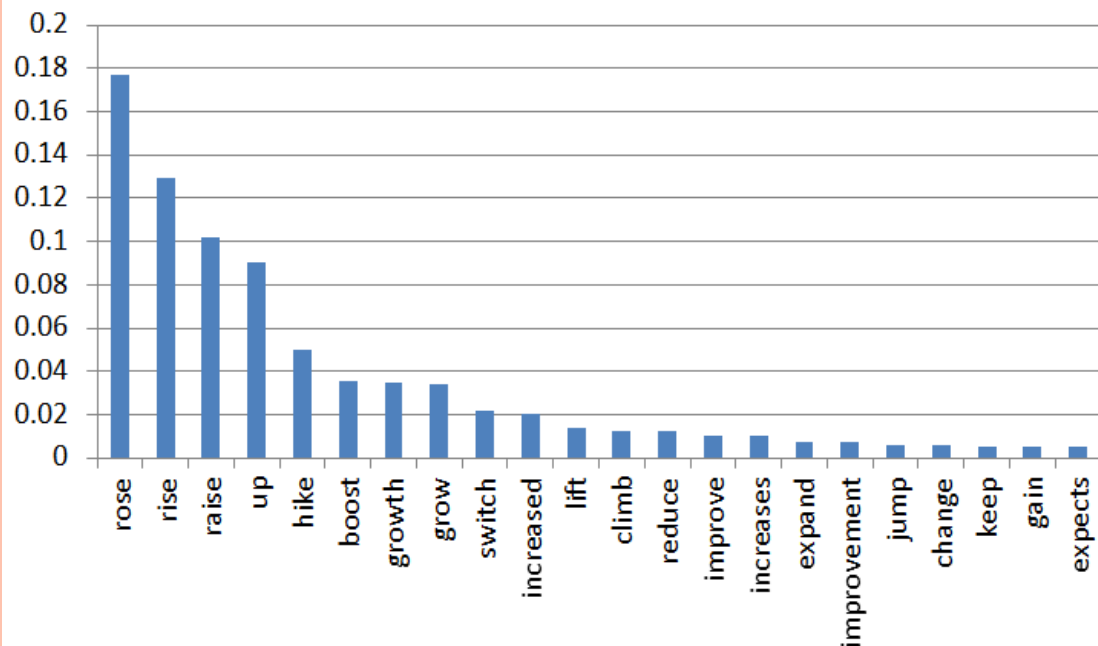
	Probability of price up
increase	62.2%
rose	55.6%
rise	52.6%
raises	56.1%
up	56.9%
boost	59.1%
growth	58.2%

The synonyms have similar probability of price up.

CONCLUSION

1. Motivation
2. Detail of news dataset
3. Stylized facts of exogenous shocks
   - Impact on market decays exponentially.
   - Exogenous shocks reduce the power law index of distribution.
4. Definition of "novelty and topicality" of news, and Market reactions
   - Novelty and topicality are defined by weighted cosine similarity.
   - Market activities (volatility, number of transaction, trade volume) are depend on the novelty and topicality of news.
5. Nowcasting and Forecasting the market with news articles
   - There are terms which are strongly related in price movements statistically.
   - Positive/negative sentiment terms often appear when price increase/decrease.
   - The probability that price goes up can be predicted by applying characteristics of synonym.

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THANK YOU

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