Natural Language Processing:

Deciphering the Message within the Message – Stock Selection Insights using Corporate Earnings Calls

March 27, 2019

S&P Global
Market Intelligence

Today's Speakers

Moderator:
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Agenda

1. The ABCs of Natural Language Processing (NLP)

    1.1 Motivation – what is NLP and why is it important?

    1.2 General NLP Steps

2. Stock Selection Insights using Earnings Call Transcripts

    2.1 Motivation

    2.2 Descriptive Statistics

    2.3 Signal Construction and Intuition

    2.4 Empirical Results

3. Transcripts Offering

The ABCs of NLP

Motivation – What is NLP?

What is **Natural Language Processing (NLP)?**

- Leveraging computers and statistics to process and make sense of language in a systematic and sensible way without human intervention besides coding.

What are **Machine Learning Algorithms (ML)**?

- Tools to do NLP

- Statistics - what data scientists call applied statistics

- Two major categories
  - **Supervised**
    - Researchers provide rules
    - E.g., linear regression, Bayesian statistics
  - **Unsupervised**
    - Let the algorithms find patterns (more black-box)
    - E.g., clustering, principal component analysis

See **NLP I - Primer** for details.

Motivation – Why is NLP Important?

- **Forty zettabytes (10^21 bytes) of data** are projected to be on the internet by 2020, out of which more than eighty percent of the data are unstructured in nature, requiring NLP to process and understand[1]

- "In the past two days, the amount of unstructured data that was created (on the internet) is equivalent to the the same amount that was created **from the beginning of human civilization through the end of 2003**"[2] – Eric Schmidt, Executive Chairman of Alphabet/Google 2001 - 2017

- NLP can read through documents at a rate far more rapidly than humans. This allows textual data to be **more efficiently** processed, consumed and made sense at a **much larger scale**.

[1] Mearian, L. (2012, Dec. 11). By 2020, there will be 5,200 GB of data for every person on Earth. Retrieved from http://www.computerworld.com.
[2] DeAngelis, S. F. (2014, Feb.). The Growing Importance of Natural Language Processing [Web log post]. Retrieved Aug 8, 2017, from http://www.wired.com/

NLP General Steps

- **Step 1: Text Preprocessing**
  - Noise Removal
  - Lexicon Normalization (e.g., plays, played => play)
  - Object Standardization (e.g., Luv => love)

- **Step 2: Text to Features**
  - N-grams
    - Bag-of-words (i.e., unigram)
  - Syntactical parsing
    - Grammar tree or part-of-speech tagging
  - Statistical features
    - E.g., # of tokens (words, numbers , abbreviations), # of sentences

- **Step 3: Testing, Refinement and Efficacy**
  - Where a model is calibrated, refined and tested.

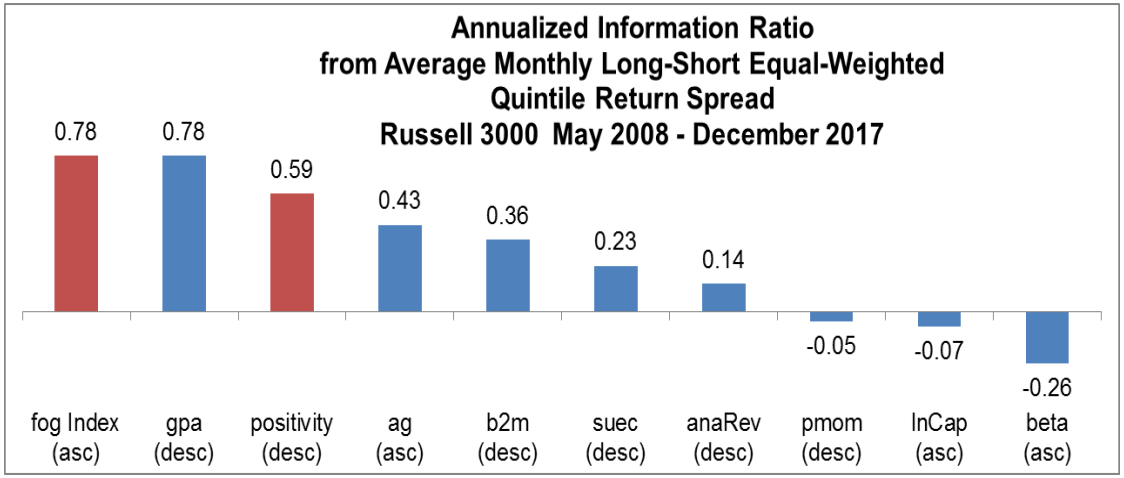
- See **NLP I - Primer** for details

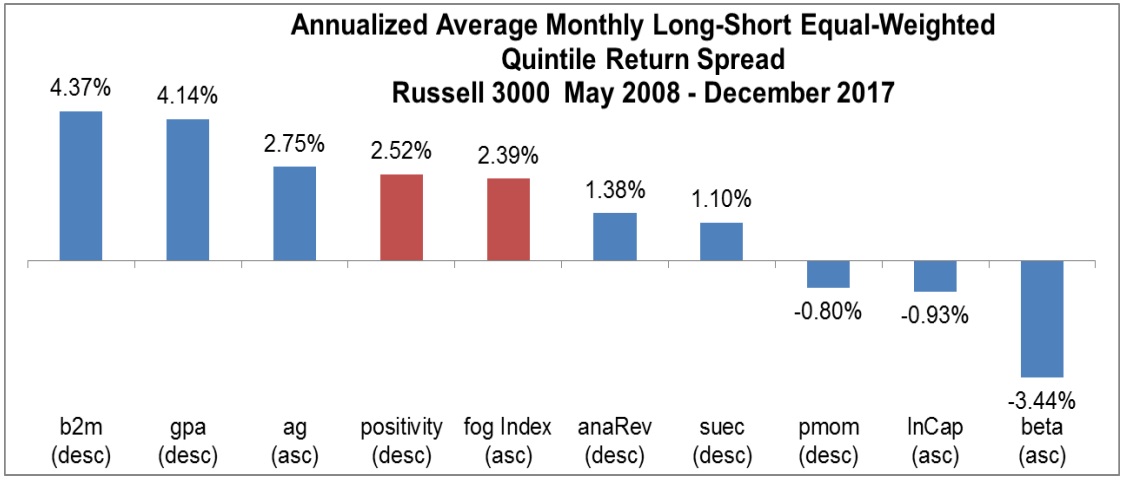
Stock Selection Insights Using Earnings Call Transcripts

Motivation – Historical Performance Comparison of Strategies

Takeaway:

- Stock selection strategies using content from earnings call transcripts were among the best performing strategies in terms of risk-reward trade-off between May 2008 and December 2017 in the Russell 3000 universe. All signals are GICS industry-relative.





Strategies using content from earnings calls

positivity:	positive sentiment level (desc)
fog index:	Gunning fog index (desc)

Commonly used strategies not from earnings calls

beta:	CAPM beta 60-month (asc)
lnCap:	natural log market cap (asc)
b2m:	book-to-market (desc)
pmom:	price momentum 12m-1m (desc)
ag:	one-year asset growth % change (asc)
gpa:	gross profitability to assets (desc)
anaRev:	3-month analyst revision FY1 EPS (desc)
suec:	standardized earnings surprise (desc)

Abbreviations and meaning

asc:	signal sorted ascending
desc:	signal sorted descending

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

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Earnings Call – Introduction

Description	A conference call between the management of a publicly traded company, sell-side analysts and other attendees to discuss the firm's latest financial results
Major Sections	Three major sections: i) **prepared remarks** by executives ii) **questions** by sell-side analysts iii) **unscripted responses** by executives to analysts' questions
Major Participants	Executives (predominately CEOs and CFOs) and analysts; Executives say about 83% of all words (43% in the prepared remarks). Analysts say about 16% of the words in the form of questions.
Length	Average length is 48 minutes.
Sentiment	Average sentiment on calls is positive since calendar Q1 2008 and as of Q4 2017 it is at the highest level in the past 10 years.

See **NLP II – Stock Selection** for details

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

Text Preprocessing prior to Signal Construction

Use NLP to convert language into features

- Speaker blocks, segmentation (prepared remarks vs. Q&A) and meta-tagging (professional IDs) are done in the data set already

- Examples: Tokens, numerical tokens, word tokens, sentences

Text preprocessing specific to earnings calls

- Irrelevant speaker types removed (e.g., operator remarks removed)

- Generic phrases removed (e.g., good morning, good/great question(s) removed)

- Positive and negative negation
  - Positive negation: *We didn't have a good quarter* (not counted as a positive instance)
  - Negative negation: *We didn't have a bad quarter* (highly unlikely to appear, so untreated)

See **NLP II – Stock Selection** for details

Two Main Categories of Signals

Ex-Ante/Intuition

- **Sentiment-Based**
  - Intuition: Firms whose calls exhibit the most positivity should outperform historically
  - How is sentiment defined? Leveraging Loughran & McDonald (2011) – Journal of Finance (LM)[3]

- **Behavioral-Based**
  - Intuition: When firms experience financial distress (whether transitory or otherwise), executives may soften the bad news by providing different degrees of transparency that are telegraphed directly or indirectly in ways that can be captured quantitatively

  - Examples: language complexity, the abundance/scarcity of references to numbers and analyst favoritism

[3] Loughran, T. and B. McDonald. "When is a Liability not a Liability? Textual Analysis, Dictionaries, and 10-Ks." *Journal of Finance* 66, no. 1 (2011): 35-65.

Construction of Sentiment-Based Signals: Sentiment Level

- Leverages Loughran & McDonald (2011) positive and negative sentiment word lists to construct four proxies of sentiment level

Signal	Construction	Sort Order	Intuition
Positivity	# positive words / # total words	D	The frequency of usage of positive words by executives in an earnings call may reveal their (true) sentiment about their firm's future prospects
Negativity	# negative words / # total words	A	Executives use negative words in an earnings call when compelled to fulfill legal or fiduciary obligations; the absence of negative words is viewed favorably in our narrative
Net Positivity	(# positive words - # negative words) / # total words	D	Takes into account both positive and negative words
Positivity to Negativity	# positive words / # negative words	D	Similar to net positivity but amplifies the magnitude of the difference between positive and negative word frequency

Note: D = descending sort; A = ascending sort
Source: S&P Global Market Intelligence Quantamental Research, as of 02/01/2018.

Construction of Sentiment-Based Signals (continued): Change in Level and Change in Trend

- Use the four base metrics (from the previous slide) in the following three ways

Signal	Construction	Sort Order	Intuition
Sentiment Level	Percent of Loughran & McDonald's sentiment words in a call	D/A	Positivity (or the absence of negativity) reflects bright prospects ahead. See the four base measures of sentiment
Change in Sentiment Level	$Sig_{i,t} = (Sig_{i,t} – Sig_{i,t-4}) / Abs(Sig_{i,t-4})$ where t is in calendar months and i is for stock i	D	It is the change in the level that is more informative than the level itself
Change in Sentiment Trend	$Sig_{(i,t)} = (Sig_{(i,t)} – SMA) / abs(SMA)$ where $SMA = average(Sig_{i,t-1,\ t-8})$ and t is in calendar months and i is for stock i and $Sig_{i,t-1,\ t-8}$ needs to have a minimum of six calls in the past 24 months	D	Easier to identify inflection points and accelerations

Note: D = descending sort; A = ascending sort
Source: S&P Global Market Intelligence Quantamental Research, as of 02/01/2018.

Construction of Behavioral-Based Signals

- Intuition: When firms experience financial distress (whether transitory or otherwise), executives may soften the bad news by providing different degrees of transparency that are telegraphed directly or indirectly in ways that can be captured quantitatively

Signal	Construction	Sort Order
Transparency: Language Complexity	Gunning Fog Index = 100 * (average words per sentence + % of polysyllabic words in a call) where the polysyllabic cutoff is 3+ syllables	A
Transparency: Presenting Using More Numbers	Ratio = Numerical Tokens / Total Word Tokens	D
Transparency: Analyst Favoritism	% Difference = (A – B) / Abs(B) • A = average metric of analysts called on • B = average metric of analysts not called on • metric = {FY1 EPS estimate, price target, numerical stock recommendation}	A

Note: D = descending sort; A = ascending sort
Source: S&P Global Market Intelligence Quantamental Research, as of 02/01/2018.

Description of Empirical Results

Description of analysis:

- Monthly rebalancing at month-end: Look-back window - 4 months
- Assessed each signal using spearman correlation, long less benchmark, long-short, information ratio and portfolio hit rate
- Industry-neutral signals to mitigate industry tilts at the GICS industry level
- Performance values that are shaded in green are statistically significant at least at the 10% level (i.e., 90+% confident that the results aren't zero)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Sentiment-Based Signals	Signal Sort Order	Strategy Start Date	Average Firm Count in Each Quintile Bin	Average Monthly Spearman Correlation	Hit Rate Monthly Spearman Correlation	Annualized Average Monthly Long - Market	Annualized Monthly IR (Long - Market)	Hit Rate Average Monthly Long - Market	Annualized Average Monthly Long - Short	Annualized Monthly IR (Long - Short)	Hit Rate Average Monthly Long - Short
[1]	Positive Level	-1	200805	483	0.013	66.4%	1.81%	0.72	61.2%	2.52%	0.59	62.9%
[2]	p-value	NaN	NaN	NaN	0.000	0.000	0.028	NaN	0.012	0.070	NaN	0.004

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

Sentiment-Based Signals Empirical Results

Sentiment Based Signals – Entire Transcripts

Takeaway:

- Sentiment level, change in sentiment level and change in sentiment trend are predictive historically with good economic contribution from the long-side of the strategies (i.e., 50+% column 7 versus 10)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Sentiment-Based Signals	Signal Sort Order	Strategy Start Date	Average Firm Count in Each Quintile Bin	Average Monthly Spearman Correlation	Hit Rate Monthly Spearman Correlation	Annualized Average Monthly Long - Market	Annualized Monthly IR (Long - Market)	Hit Rate Average Monthly Long - Market	Annualized Average Monthly Long - Short	Annualized Monthly IR (Long - Short)	Hit Rate Average Monthly Long - Short
[1]	Positive Level	-1	200805	483	0.013	66.4%	1.81%	0.72	61.2%	2.52%	0.59	62.9%
[2]	p-value	NaN	NaN	NaN	0.000	0.000	0.028	NaN	0.012	0.070	NaN	0.004
[3]	YoY Change in Positive Level	-1	200903	437	0.008	60.4%	1.47%	0.64	60.4%	2.41%	0.77	57.5%
[4]	p-value	NaN	NaN	NaN	0.001	0.025	0.061	NaN	0.025	0.024	NaN	0.098
[5]	Change in Positive Trend from previous 8 calls	-1	201005	425	0.011	67.4%	2.48%	1.27	60.9%	3.96%	1.48	65.2%
[6]	p-value	NaN	NaN	NaN	0.000	0.001	0.001	NaN	0.028	0.000	NaN	0.002

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

Behavioral-Based Signals Empirical Results

Behavioral-Based Signals

Takeaway:

- Firms whose executives use simpler language (row 1) and use more numbers outperform historically (row 3)
- Firms whose executives seem to play favoritism by selectively calling on more bullish analysts (using average EPS estimates, recommendations or price targets) do not underperform historically[4]
- Firms where the collective forecasts of analysts, who are called on to ask questions, have the least discordance outperform historically (row 5)
  - One plausible explanation is that firms whose executives provide more transparency result in a smaller discordance in analysts forecasts because analysts need to make less (subjective) assumptions[5]

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Behavioral-Based Signals	Signal Sort Order	Strategy Start Date	Average Firm Count in Each Quintile Bin	Average Monthly Spearman Correlation	Hit Rate Monthly Spearman Correlation	Annualized Average Monthly Long - Market	Annualized Monthly IR (Long - Market)	Hit Rate Average Monthly Long - Market	Annualized Average Monthly Long - Short	Annualized Monthly IR (Long - Short)	Hit Rate Average Monthly Long - Short
[1]	Language Complexity - Gunning fog index	1	200805	483	0.009	61.2%	0.82%	0.40	54.3%	2.39%	0.78	57.8%
[2]	p-value	NaN	NaN	NaN	0.000	0.012	0.221	NaN	0.307	0.017	NaN	0.077
[3]	Tangibility - % numerical tokens in a call prep	-1	200805	483	0.013	70.7%	1.76%	0.99	58.6%	4.28%	1.28	66.4%
[4]	p-value	NaN	NaN	NaN	0.000	0.000	0.003	NaN	0.051	0.000	NaN	0.000
[5]	Conviction - dispersion in FY1 EPS estimates	1	201005	280	0.011	65.2%	-0.38%	-0.14	44.6%	3.45%	0.83	55.4%
[6]	p-value	NaN	NaN	NaN	0.022	0.002	0.706	NaN	0.251	0.023	NaN	0.251

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

[4] Contrary to Cohen, L., Lou D. and Malloy C. J. "Playing Favorites: How Firms Prevent the Revelation of Bad News." SSRN August 13 2014 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2479542

[5] Ali, A., Liu, M., Xu, D., and Yao, T., "Corporate Disclosure, Analyst Forecast Dispersion, and Stock Returns" (August 2012 2001). SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=556704

Controlling for Risk and Alpha Signals

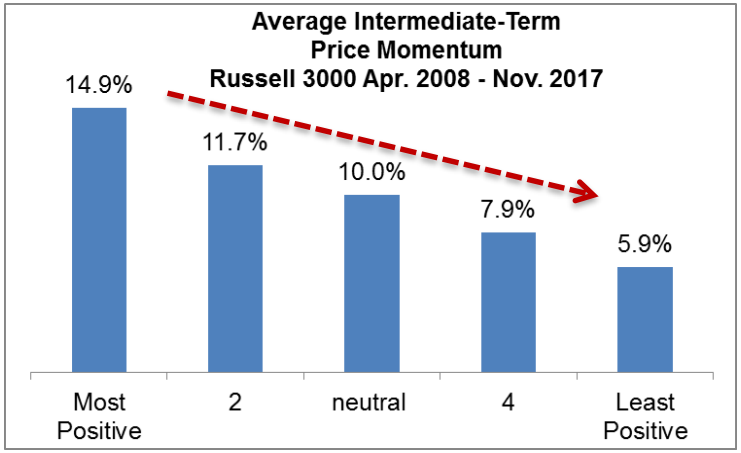
Natural Tilts of Sentiment-Based Signals

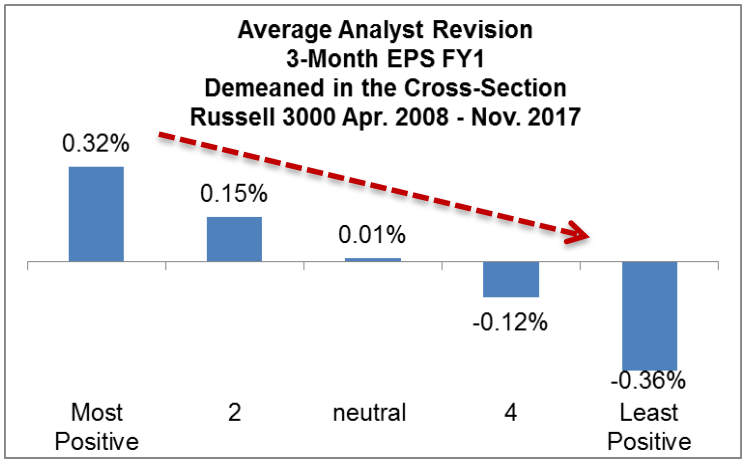
Description:

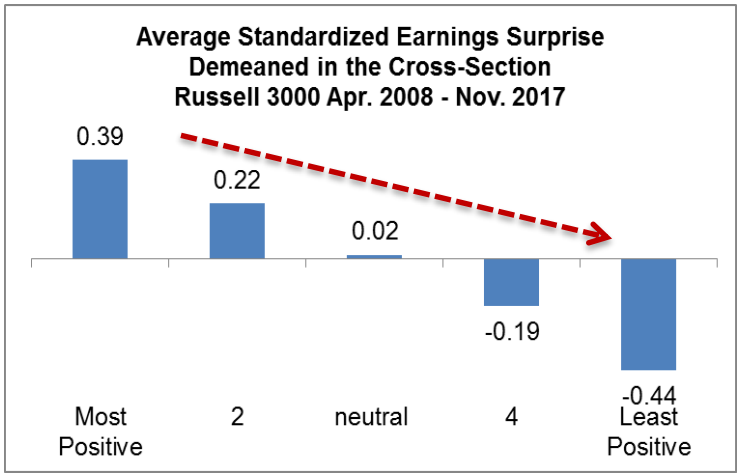
- Using positive sentiment level strategy as an example
- Natural tilts to
  - Price momentum 12m – 1m (upper right)
  - Analyst revision (middle chart)
  - Earnings Surprise (lower chart)

Takeaway:

- Need to adjust for the tilts to ensure the predictive power isn't just a manifestation of or is subsumed by these natural tilts







Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

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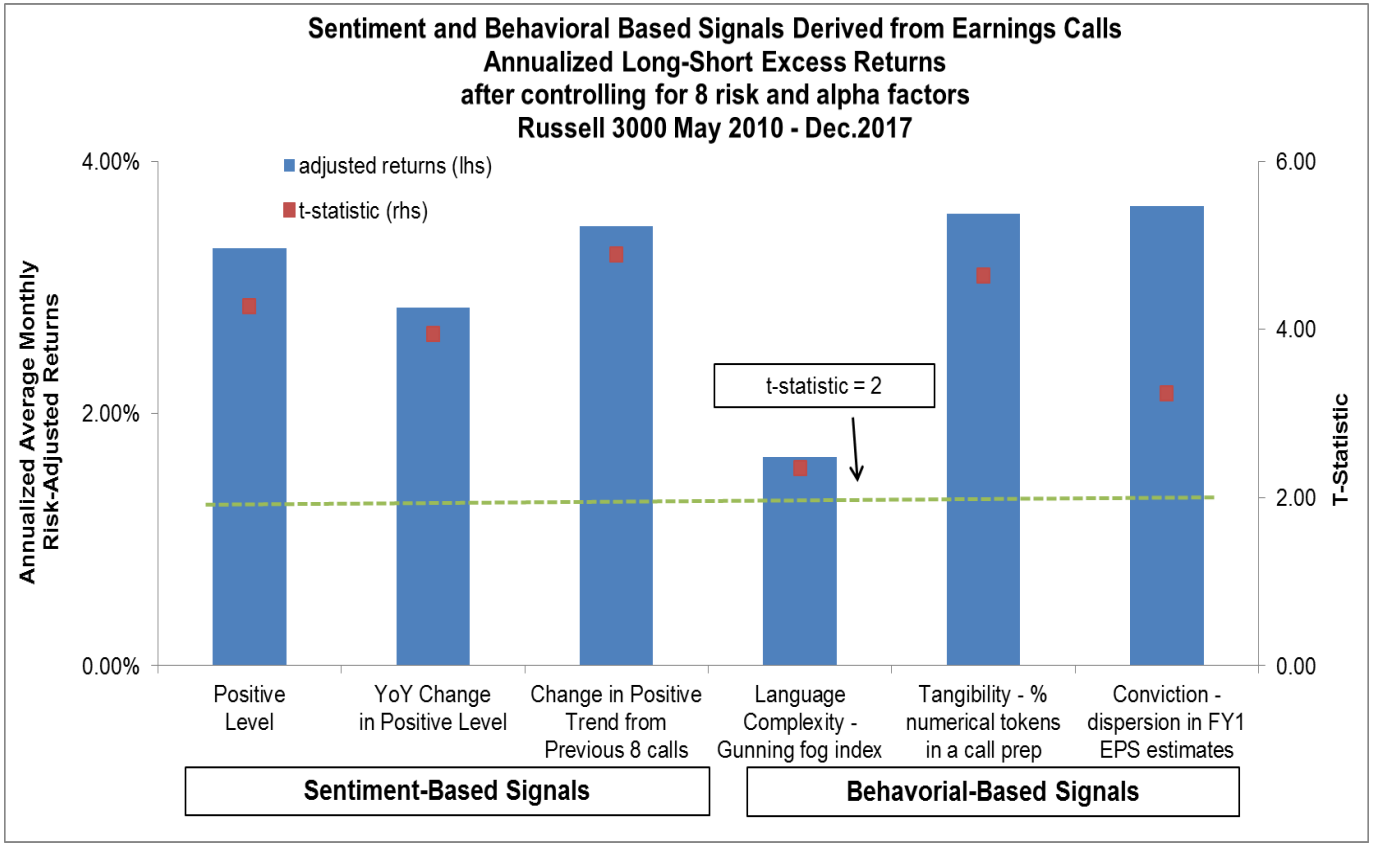
Results after control for risk and alpha factors

Takeaway:

- Stock selection strategies that are constructed using the content from earnings call transcripts show historical economic and statistical significance after controlling for (CAPM) beta, size, value, price momentum, asset growth, gross profitability, analyst revision and earnings surprise between May 2010 and December 2017 in the Russell 3000 universe. All signals are relative at the GICS industry level.



Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

Correlations

Description:

- Correlations of long-short equal-weighted quintile return spreads between May 2010 and December 2017 inclusive in the Russell 3000 universe

Takeaway:

- **Sentiment- and behavioral-based signals are lowly-/negatively-correlated**
- There are diversification benefits to be had when the two types of signals are blended together

		[1]	[2]	[3]	[4]	[5]	[6]
[1]	Positive Level		0.43	0.49	0.23	-0.06	0.17
[2]	YoY Change in Positive Level			0.71	-0.07	-0.14	-0.09
[3]	Change in Positive Trend from previous 8 calls				-0.09	-0.19	-0.09
[4]	Language Complexity - Gunning fog index					0.28	0.08
[5]	Tangibility - % numerical tokens in a call prep						0.53
[6]	Conviction - dispersion in FY1 EPS estimates						

Source: S&P Global Market Intelligence Quantamental Research as of 02/01/18 (charts are for illustrative purposes only)

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Information Horizon & Turnover

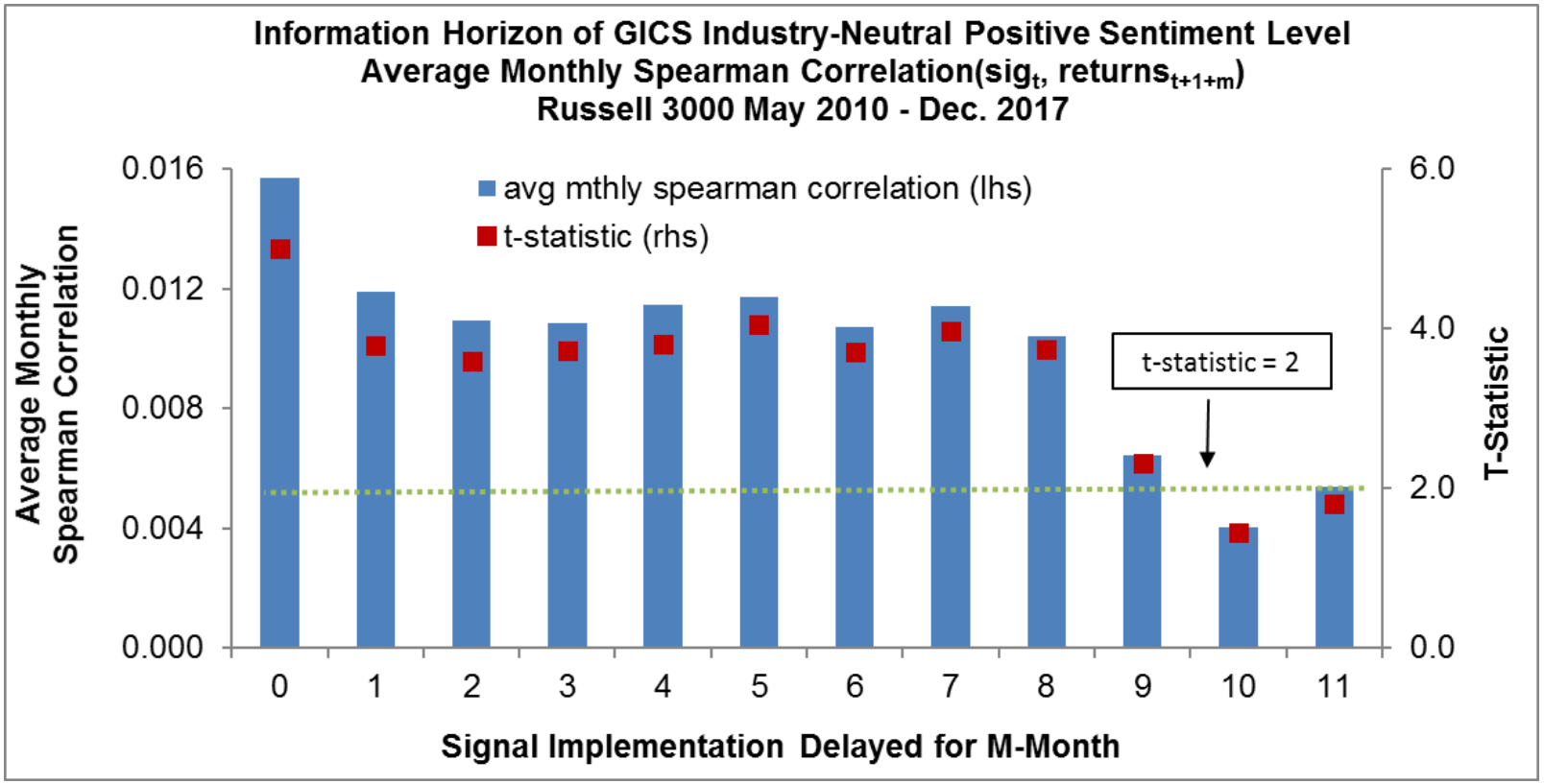
Information Horizon

Description:

- Signal: positive sentiment level
- Average monthly spearman correlation (a gauge to measure a stock selection signal's predictiveness) where the signal implementation is delayed for m-calendar month
- Spearman Correlation(sig_t, $returns_{t+1+m}$) where t and m are calendar month

Takeaway:

- Positive sentiment level strategy does not seem to be a very fast-moving signal (i.e., does not seem to require immediate implementation within days or weeks)



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Source: S&P Global Market Intelligence Quantamental Research as of 08/21/18 (charts are for illustrative purposes only)

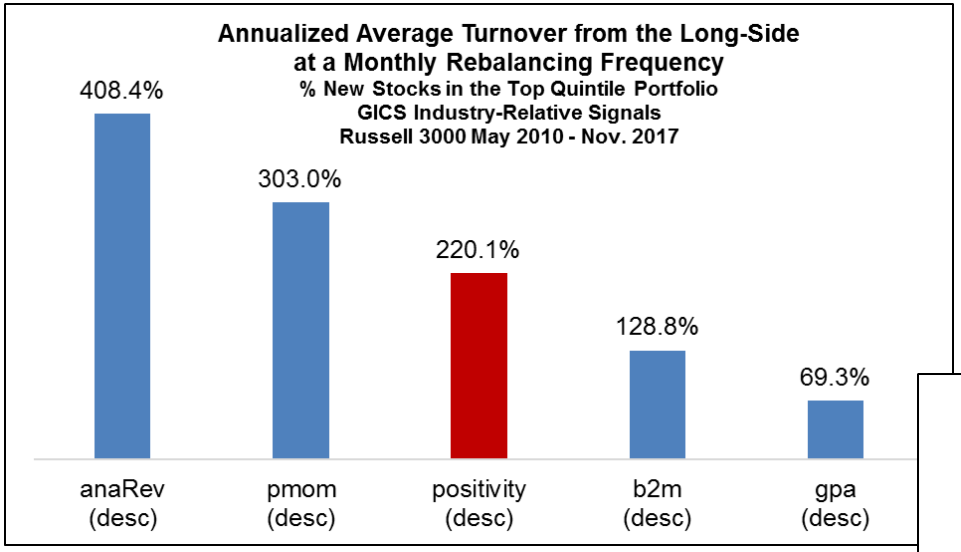
Turnover

Description:

- Annualized average turnover from the long-side at monthly (top chart) and 6-month (bottom chart) rebalancing frequencies
- Turnover = % of new stocks introduced to the portfolio of buys (i.e., the top quintile portfolio) as a proxy

Takeaway:

- The turnover rate for positive sentiment level strategy seems to be moderate
- Turnovers on the short-side are approximately the same magnitude

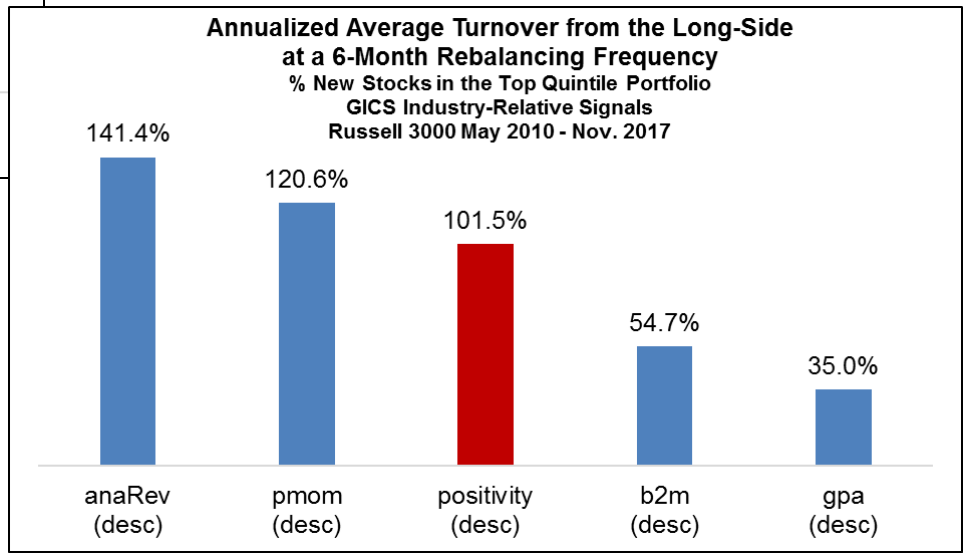


Strategy Definitions

positivity:	positive sentiment level (desc)
b2m:	book-to-market (desc)
pmom:	price momentum 12m-1m (desc)
gpa:	gross profitability to assets (desc)
anaRev:	3-month analyst revision FY1 EPS (desc)

Abbreviations and meaning

asc:	signal sorted ascending
desc:	signal sorted descending



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Source: S&P Global Market Intelligence Quantamental Research as of 10/21/18 (charts are for illustrative purposes only)

Takeaways - Empirical Results

- Historically, sentiment- and behavioral-based signals that are constructed from the content in earnings call transcripts are among **the best strategies in terms of risk-reward trade-off** (i.e., information ratio) in the last 10 years in the U.S. equity market with decent **economic performance ranging from 2% - 5% per annum**.

- Historically, sentiment- and behavioral-based signals have had **incremental predictive power** above and beyond common risk and alpha factors.

- Sentiment- and behavioral-based signals that are derived from the content in earnings call transcripts are **lowly correlated**. A multi-factor strategy that blends the two categories of signals should yield a composite signal that is more predictive yet with a lower volatility.

- Sentiment- and behavioral-based signals **do not seem to be (overly) fast moving signals** that require immediate implementation within days or weeks and their **turnovers seem to be moderate**.

Transcripts Offering

Unstructured/Alternative Data

METADATA Pieces It All Together

Gregory R. Friedman Vice President of Investor Relations

"As you know, Trian Fund Management has invested in DuPont stock and proposed a plan to break up the company, a spin upon a spin. Our Board of Directors and management are unanimous in their belief that the plan we are pursuing will continue to deliver superior value for all DuPont shareholders."

26222634

768440

Ellen J. Kullman Former Chairwoman and Chief Executive Officer

"Yes, Jeff. So you have a knack for going to a very specific place, and Nick has just now told me he's figured it out. So Nick? "

25051680

538648891

26858581

Jeffrey John Zekauskas JP Morgan Chase & Co, Research Division

"I was looking at the funds flow statement, and your change in operating assets and liabilities was a use of $1.3 billion, and the previous year was $1.4 billion. What's behind that change? In that your receivables and inventories don't really change that much, but there's something that's using up cash. And do you have a forecast for 2015 for that number? "

658776

Nicholas C. Fanandakis Chief Financial Officer and Executive Vice President

"Jeff, I think the biggest thing there is the absence of the tax payment for the coatings sale. We had about $700 million of tax payment that shows as part of that free cash flow, but the inflow of cash is below the free cash flow line in the investments area. So that's the biggest reason for the delta on a year-over-year basis"

25912184

Estimates	Ownership	Cap Structure	Cross Reference	Professional Data
Financials	Events	Key Devs	People	Transcripts

Source: S&P Global Market Intelligence as of 2/1/18

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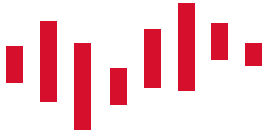
Transcripts – Coverage Stats

- **Event Types**
  - Earnings Calls
  - Guidance/Update Calls
  - M&A Calls
  - Sales/Trading Statement Calls
  - Special Calls
  - Shareholder/Analysts Calls
  - Company Conference Presentations
  - Analyst/Investor Day
  - Operating Results Calls
  - Interim Management Statement Calls
  - Fixed Income Calls

- **Current Coverage –** 9000+ global public companies
- **History** – back to 2004



- **Timeliness** – Significant number of all calls are transcribed in real-time. All other calls are completed within 24 hours
- **Instances of Calls –** Preliminary, Edited, Proofed, Audited

- **Timestamps –** Call start time/end time, audio length, database date

Transcripts – Packages and Road Ahead

Delivery

- Package delivery frequency consists of Full Files and Change Files:
  - **Full Files**: Delivered weekly and applied once to initialize the database
  - **Change Files:** Real time updates are generated throughout the day within our span technology
- Future Events and People Basic file inclusive within the service
- Note: Additional delivery available for real-time consumption and XML files

Coming Soon

- Sentiment Scores- 20+ backtested scores and factors including;
  - Positive sentiment
  - Litigious sentiment
  - Fog index level
  - Strong modal
  - Numeric transparency score

Q&A

Moderator:
Daniel J. Sandberg, PhD, CFA
Director, Quantamental Research
S&P Global Market Intelligence

Frank Zhao
Senior Director, Quantamental Research
S&P Global Market Intelligence

Michael Patton
Senior Director, Data Management Solutions
S&P Global Market Intelligence