UCLAAnderson
SCHOOL of MANAGEMENT

MGMTMFE 431:

Data Analytics and Machine Learning

Topic 8b:
Textual Analysis: Predicting Mergers

Spring 2019

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UCLAAnderson
SCHOOL of MANAGEMENT

Using text for prediction

- Predicting Merger Targets and Acquirers from Text
  - Routledge, Sacchetto, and Smith (2018)

Abstract

We explore the use of a U.S. firm's SEC filings to predict whether the firm will be an acquirer or a target of an acquisition within a year of the filing. Our approach uses text regression, in which frequencies of words and phrases in the document are used as independent variables in a logistic regression model. We find that word and phrase features have significant predictive power in models of being an acquirer or a target. In each case, the best performing models involve a different use of text alongside standard financial variables.

Predict Mergers with Text

- Mergers are (sort of) rare : $\approx 5\%$ of listed companies per year
- Usually interesting and news worthy
- Announcements typically have large price impact
  - Offer premiums $\approx$ 40%-50% (e.g. Eckbo (2014))
  - Target CAR's at bid announcement $\approx 15\%$. (e.g. Betton, Eckbo, and Thorburn (2008))
- Hard to predict
  - Hasbrouck (1985) Palepu (1986) Morck, Shleifer, and Vishny (1988) Ambrose and Megginson (1992) Shivdasani (1993) Comment and Schwert (1995) Cremers, Nair, and John (2009) Hoberg and Phillips (2010) Edmans, Goldstein, and Jiang (2012) Chatterjee, John, and Yan (2012) Cocco and Volpin (2013) Macias and Pirinsky (2015)

Predict Mergers with Text - MD&A section of 10K

- MD&A
  - in 10K annual report
  - 5,000 – 10,000 words

    `...provide a narrative explanation, through the eyes of management, of how an entity has performed in the past, its financial condition, and its future prospects....` wikipedia

Text as Data

- Why use text?
  - There is lots of it
  - (Most required disclosure is non-numeric)
- Why connect text to quantitative data?
  - Quantitative data insights into language models

Predict Mergers with Text - Timing

Predict	Using
y_{i,t_+}	$x_{i,t}$
$\begin{cases} \textbf{WAS BUYER} \\ \textbf{NOT} \end{cases}$	$\begin{cases} \text{text of md\&a} \\ \text{financial metrics (cash, size, Q)} \end{cases}$
i = Firm	i = Firm
t_+ = year following 10K filed	t date 10K filed at SEC date
example t_+=2.1.2015 – 1.30.2016	example t =1.31.2015

Predict Mergers with Text - Timing

Predict	Using
y_{i,t_+}	$x_{i,t}$
$\begin{cases} \textbf{WAS TARGET} \\ \textbf{NOT} \end{cases}$	$\begin{cases} \text{text of md\&a} \\ \text{financial metrics (cash, size, Q)} \end{cases}$
i = Firm	i = Firm
t_+ = year following 10K filed	t date 10K filed at SEC date
example t_+=2.1.2015 – 1.30.2016	example t =1.31.2015

Predict Mergers with Text - Data Size

Dataset	Firm-Year Observations	Number of Acquirers	Number of Targets
Training (for parameter estimation)	33,085	2170	2145
Development (for hyper-parameter tuning)	5,687	369	240
Test (for measuring R^2)	5,647	1013	400

Predict Mergers with Text - Encoding Text Data

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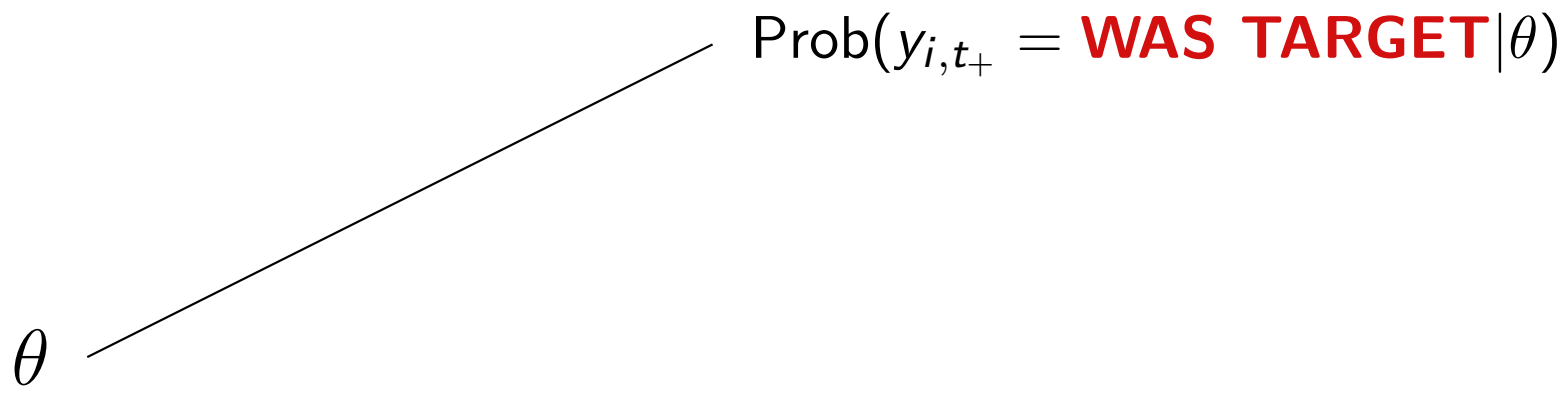
Predict Mergers with Text - Encoding Text Data



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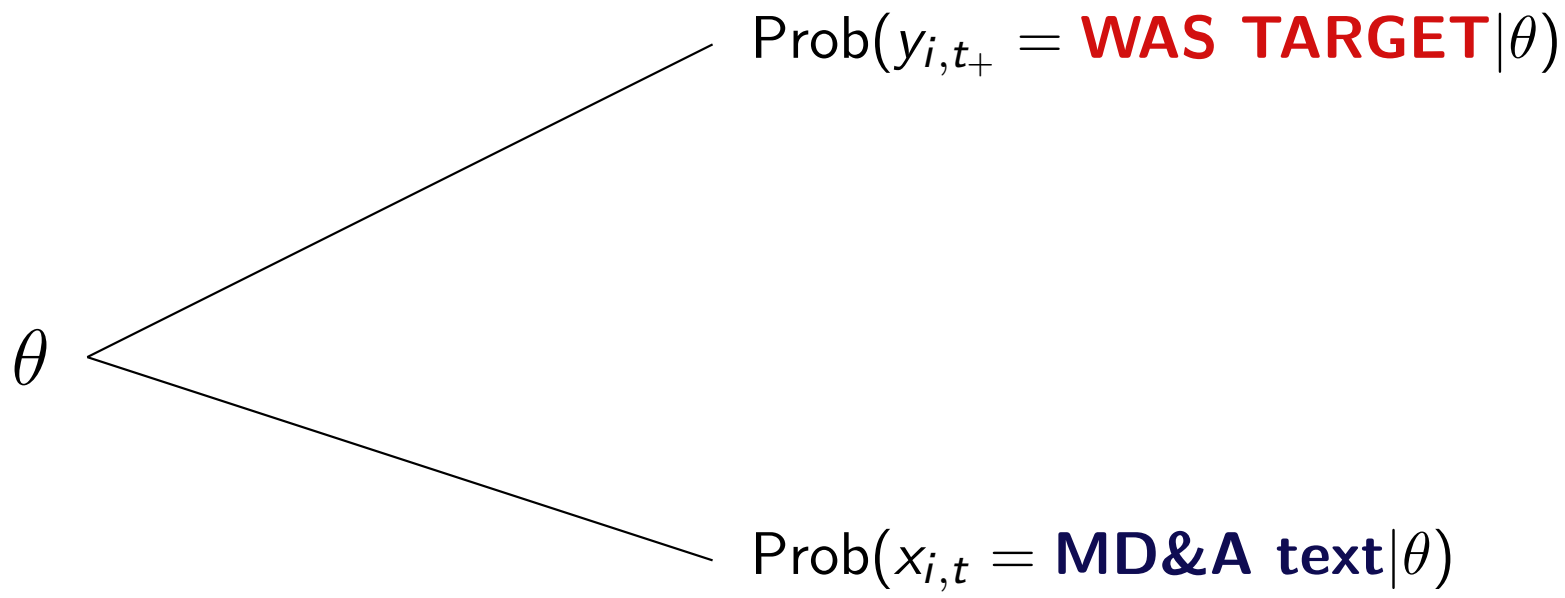

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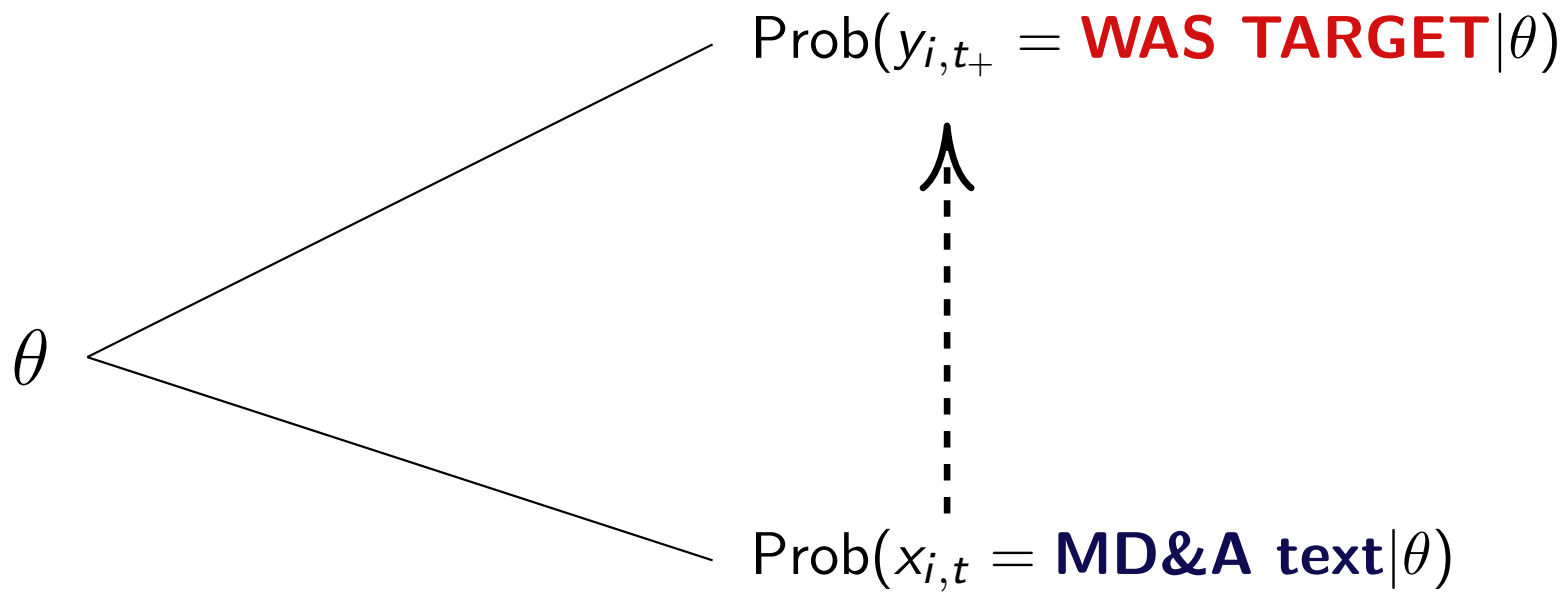

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text} | \theta)$$

... The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods ...

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

$$p(w_1|\theta)$$

... The

...

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

$$p(w_1|\theta)p(w_2|w_1,\theta)$$

... The amendment

...

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

$$p(w_1|\theta)p(w_2|w_1,\theta)...p(w_{7,989}|w_1,w_2,....,\theta)$$

... The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods ...

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

$$p(w_1|\theta)p(w_2|\theta)...p(w_{7,989}|\theta)$$

The amendment to the senior credit facility increased the maximum consolidated total allowed for certain quarterly periods

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text} | \theta)$$

The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text}|\theta)$$

commercial	**investment**
commercial_bank	investment_activities
commercial_banks	investment_balances
commercial_ commitments	investment_bank
commercial_customers	investment_company
commercial_launch	investment_gains
commercial_paper	investment_grade
commercial_production	investment_income
commercial_products	investment_losses
commercial_quantities	investment_opportunities
commercial_sale	investment_performance
commercial_sales	investment_policy
commercial_substance	investment_portfolio
commercial_success	investment_returns

Predict Mergers with Text - Encoding Text Data

$$\text{Prob}(x_{i,t} = \textbf{MD\&A text} | \theta)$$

... The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods ...

The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods

$$x_{i,t} = \log(1 + \text{word and phrase count})$$

Text Regression

Code at: `https://github.com/redpony/creg`
Zou and Hastie (2005), Tibshirani (1996)

:: Logistic regression

$$\log \text{prob}\,(y_{i,t_+} = \textbf{WAS BUYER} \;|x_{i,t}) \propto \beta_0 + \beta' x_{i,t}$$

$$\hat{\beta} = \arg\max_\beta \sum_{(i,t)\in T} \log p(y_{i,t_+}|x_{i,t})$$

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:: Logistic regression **Regularized "elastic-net"**

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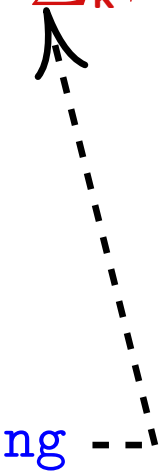

I am not really listening

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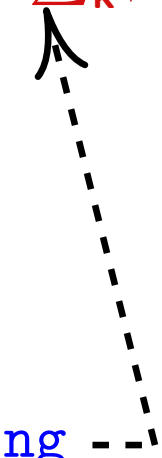

`I am not really listening`

All $\beta_k \approx 0$

Text Regression

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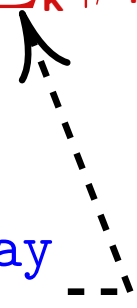

Almost everything you say is meaningless

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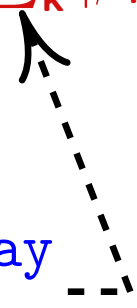

`Almost everything you say is meaningless`

Most $\beta_k = 0$

Text Regression - Evaluation

- Test statistic: "Pseudo R2"
  - Measured out-of-sample
  - Likelihood relative to baseline of in-sample frequency

$$R^2(m) = 1 - \frac{\sum_{i,t \in O} \log p(y_{i,t_+} | x_{i,t}, \beta_m)}{\sum_{i,t \in O} \log p(y_{i,t_+} | \beta_0)}$$

Results - Baseline

	Acquirer		Target	
	Pseudo R^2	$\#\beta$'s	Pseudo R^2	$\#\beta$'s
Financial (baseline)	**6.96%**	25	**2.62%**	25

Results – Baseline

	Acquirer	Target
	Coefficient	Coefficient
Intercept	-2.8549	-4.6228
Year (max. coeff.)	(1995) 0.2459	(1998) 1.3441
Year (min. coeff.)	(2011) -1.0954	(2011) -0.9374
Q	0.0041	-67.9058
PPE	-0.2201	-0.0303
log Cash	0.0986	0.0256
Leverage	-0.0175	0.3660
Size	0.7867	-0.0300
ROA	-0.0603	-0.0029
Pseudo R^2 (Out-of-Sample)	**6.96%**	**2.62%**

Results - With Text

	Acquirer		Target	
	Pseudo R^2	$\#\beta$'s	Pseudo R^2	$\#\beta$'s
Financial (baseline)	**6.96%**	25	**2.62%**	25
Phrase Only	3.69%	4394	2.33%	1816
All Text	5.28%	118	2.67%	481
Text + Financial	**7.75%**	240	2.74%	622
Text $\times$ Financial	5.36%	108	**3.42%**	1071
Text $\times$ Time	5.46%	157	1.79%	972

Results - With Text

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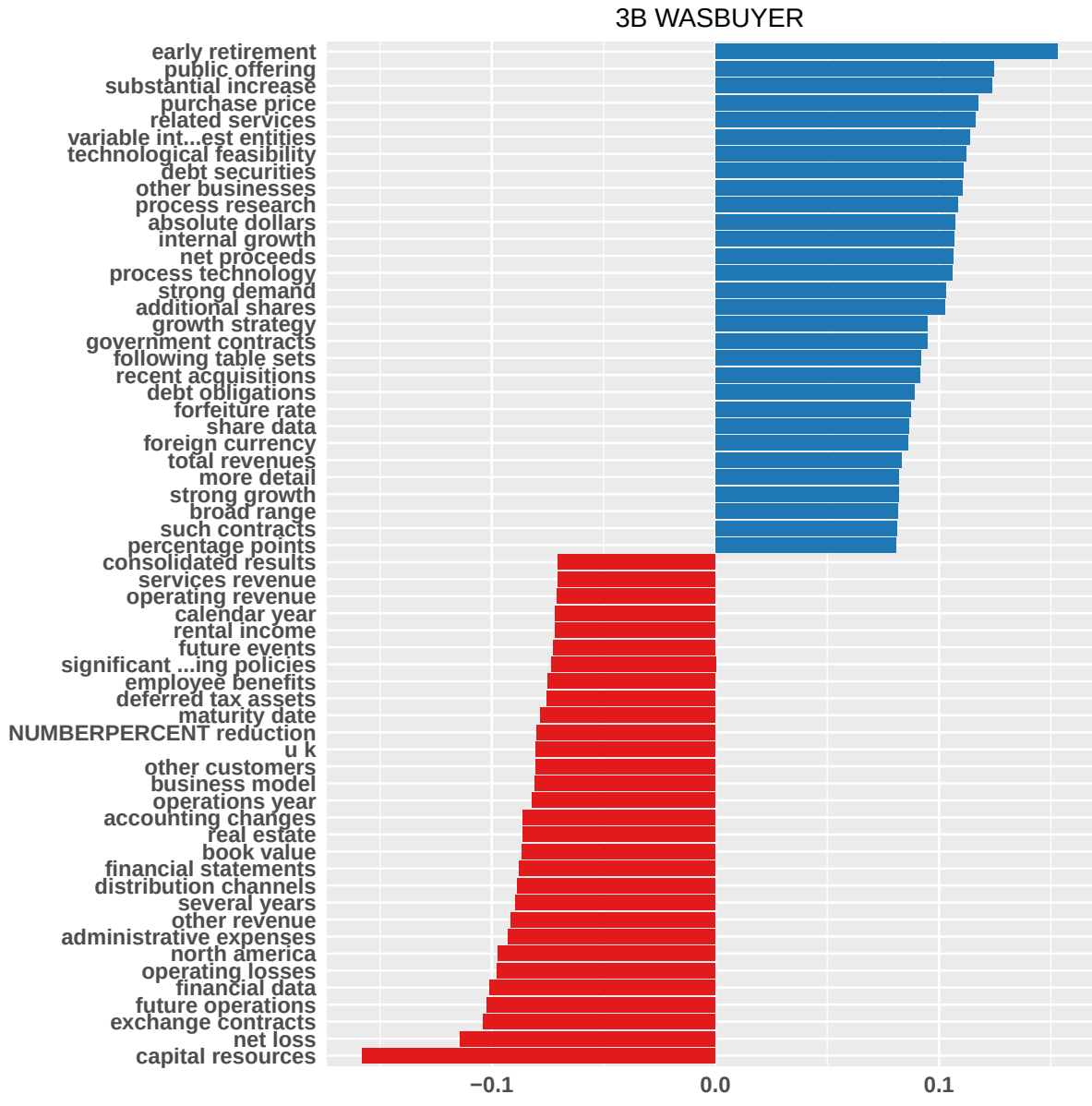
Insights - Phrase-Only Model Weights β_w



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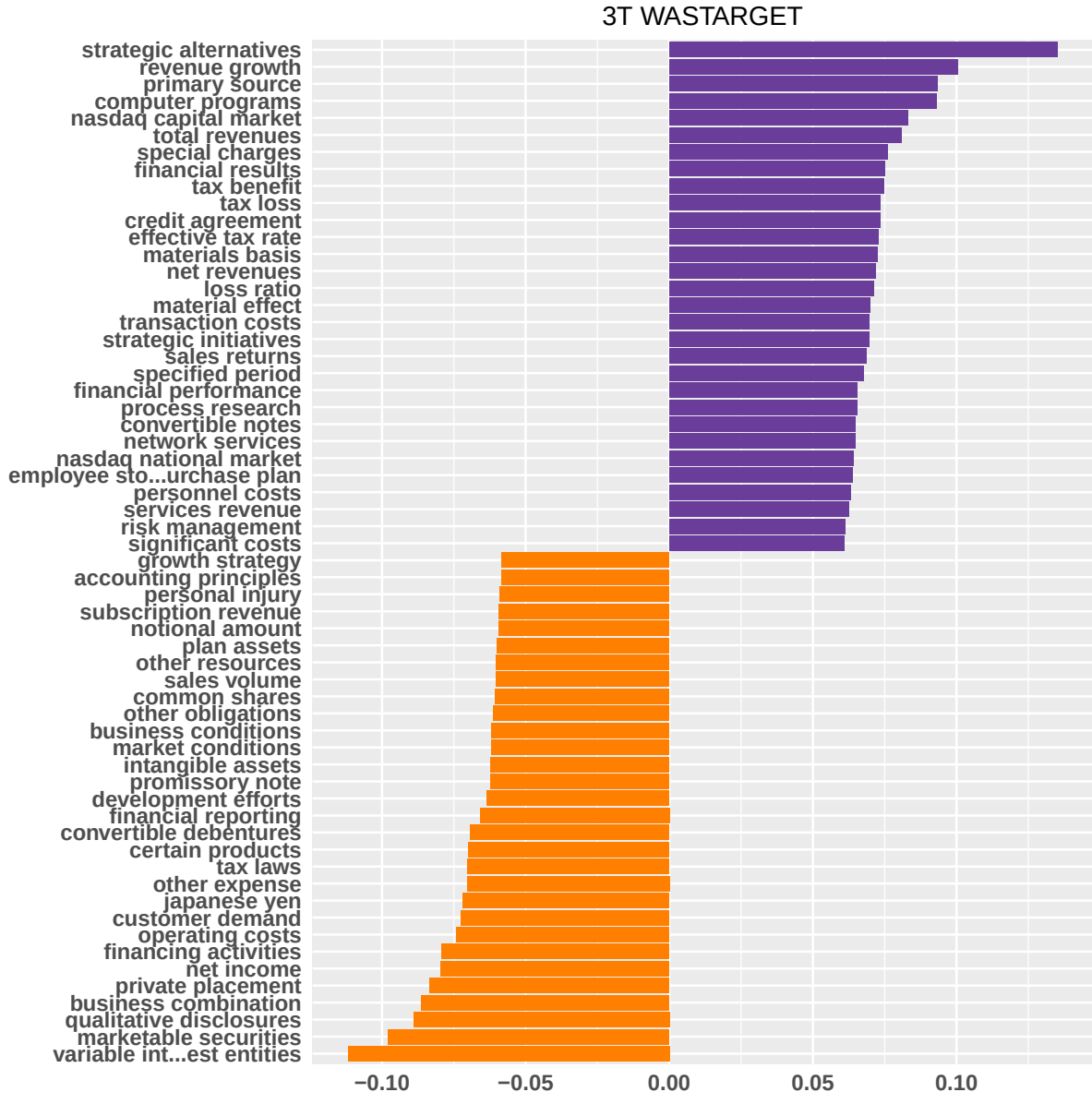

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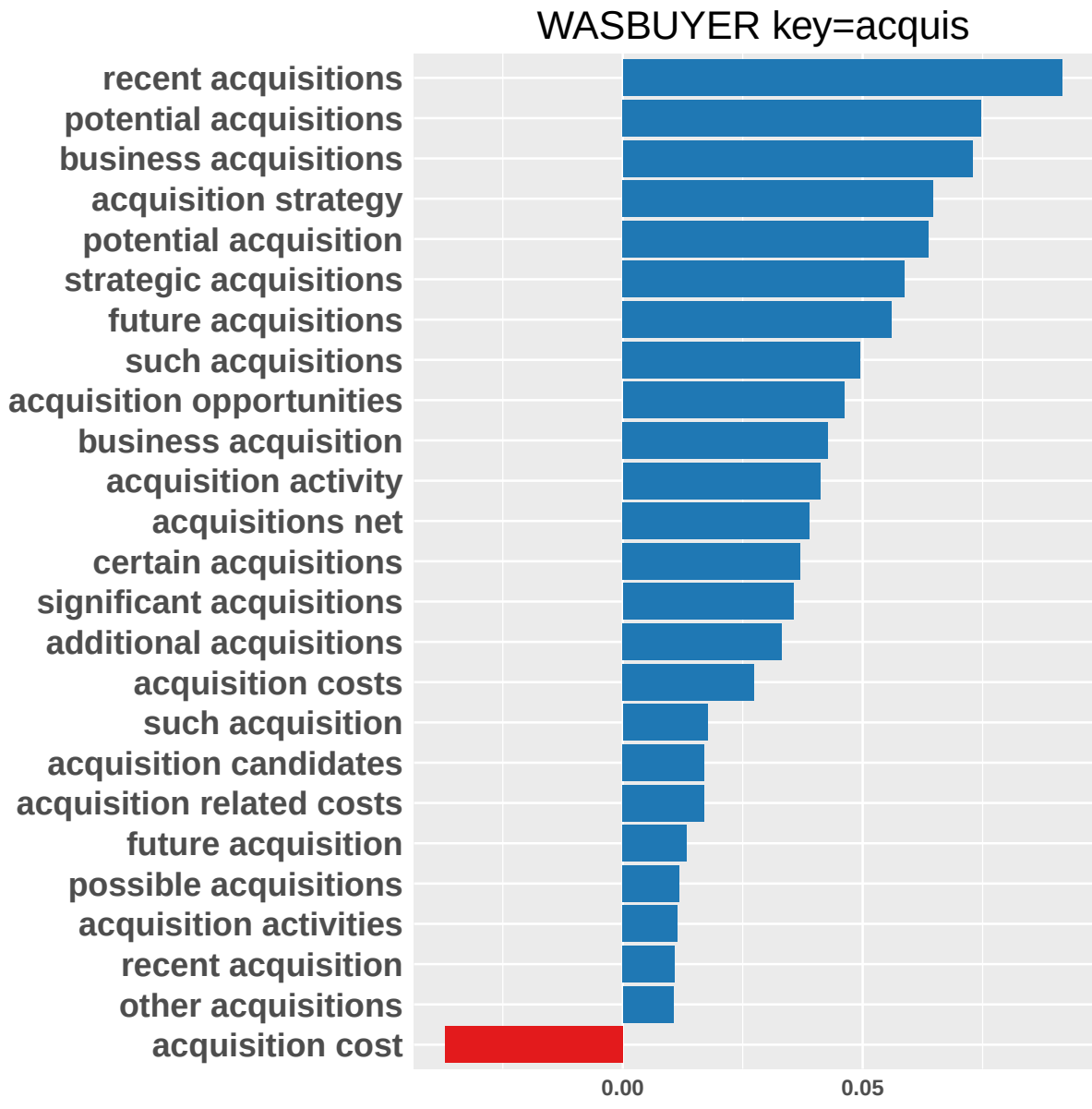

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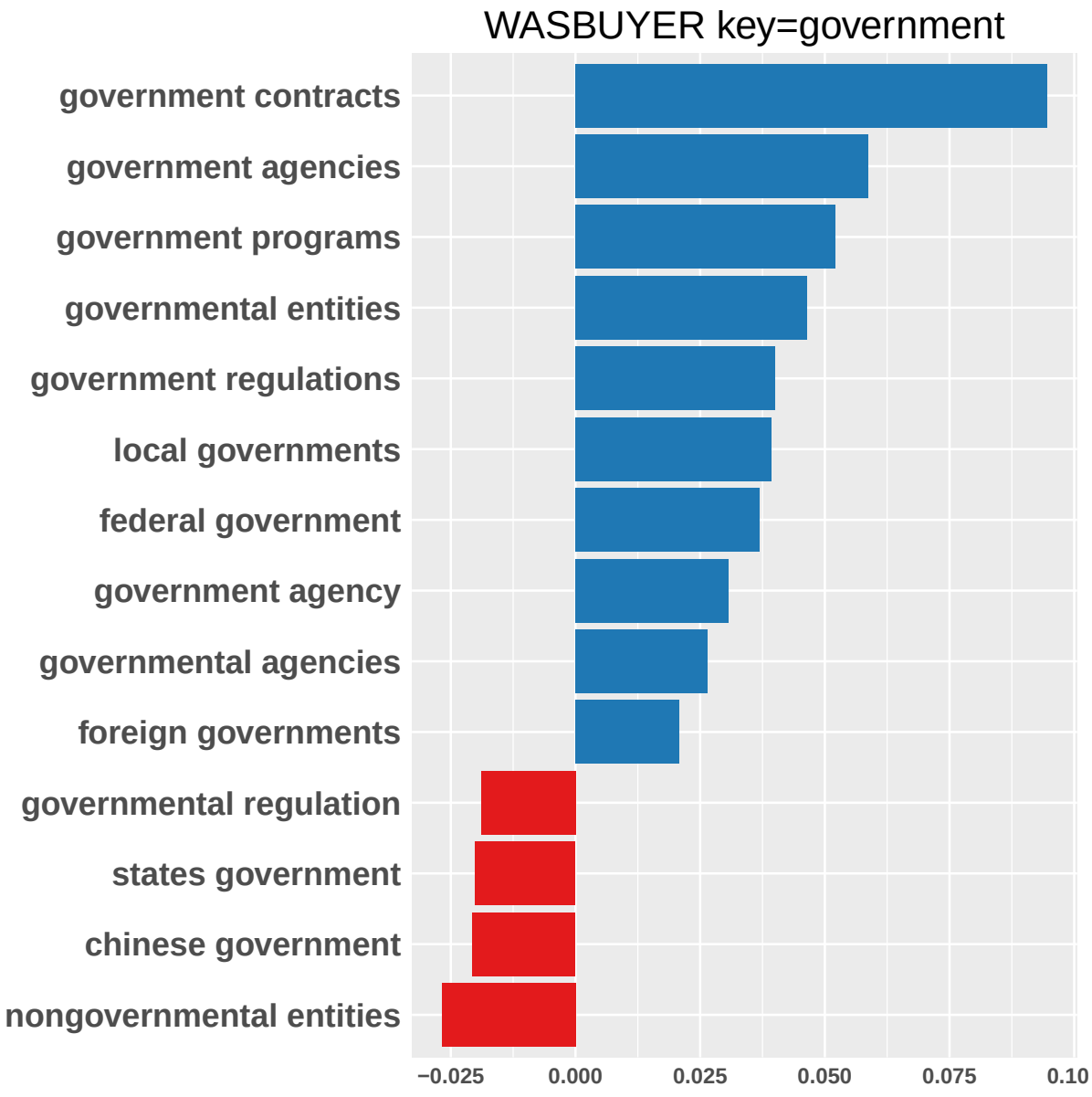

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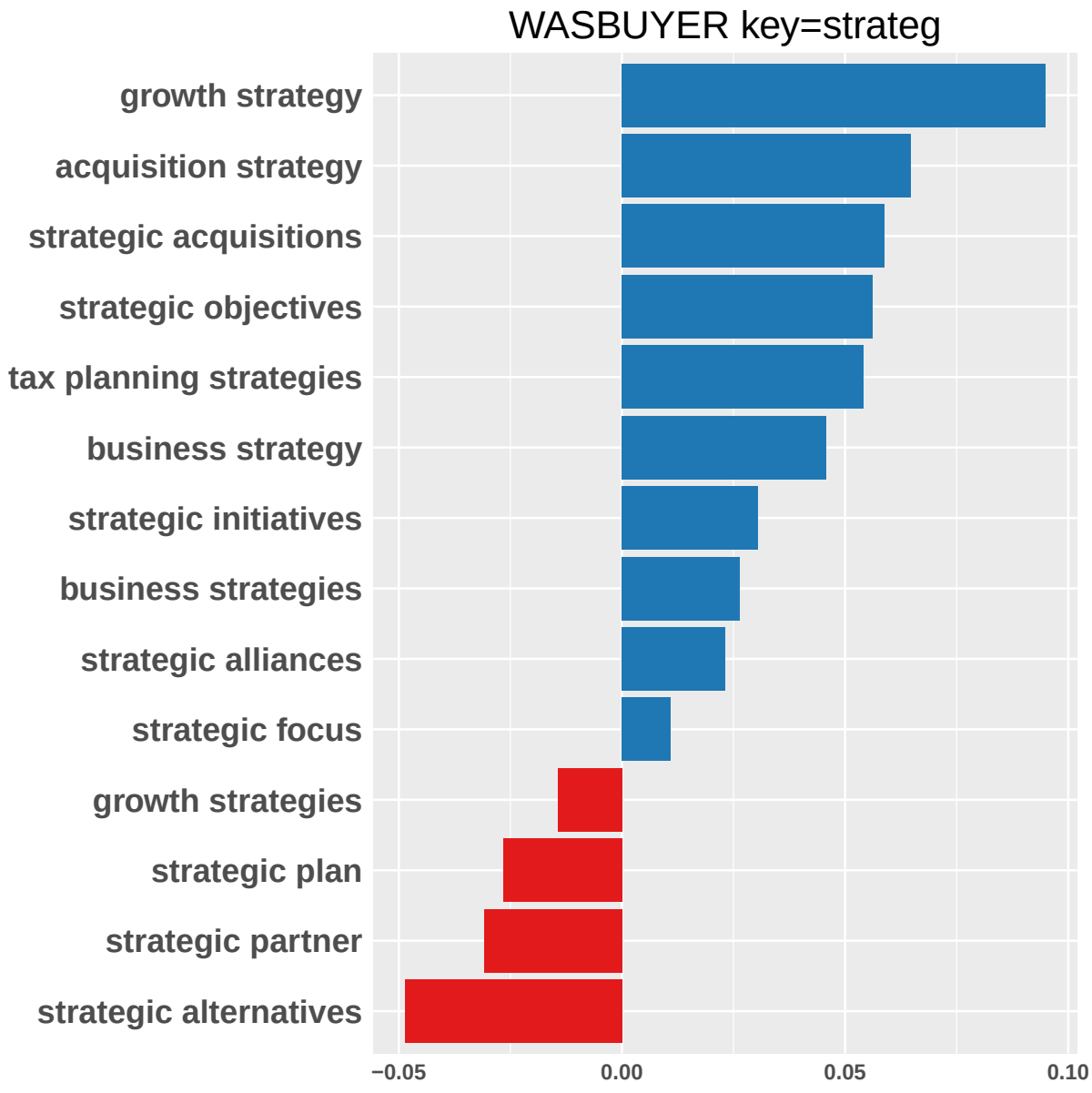

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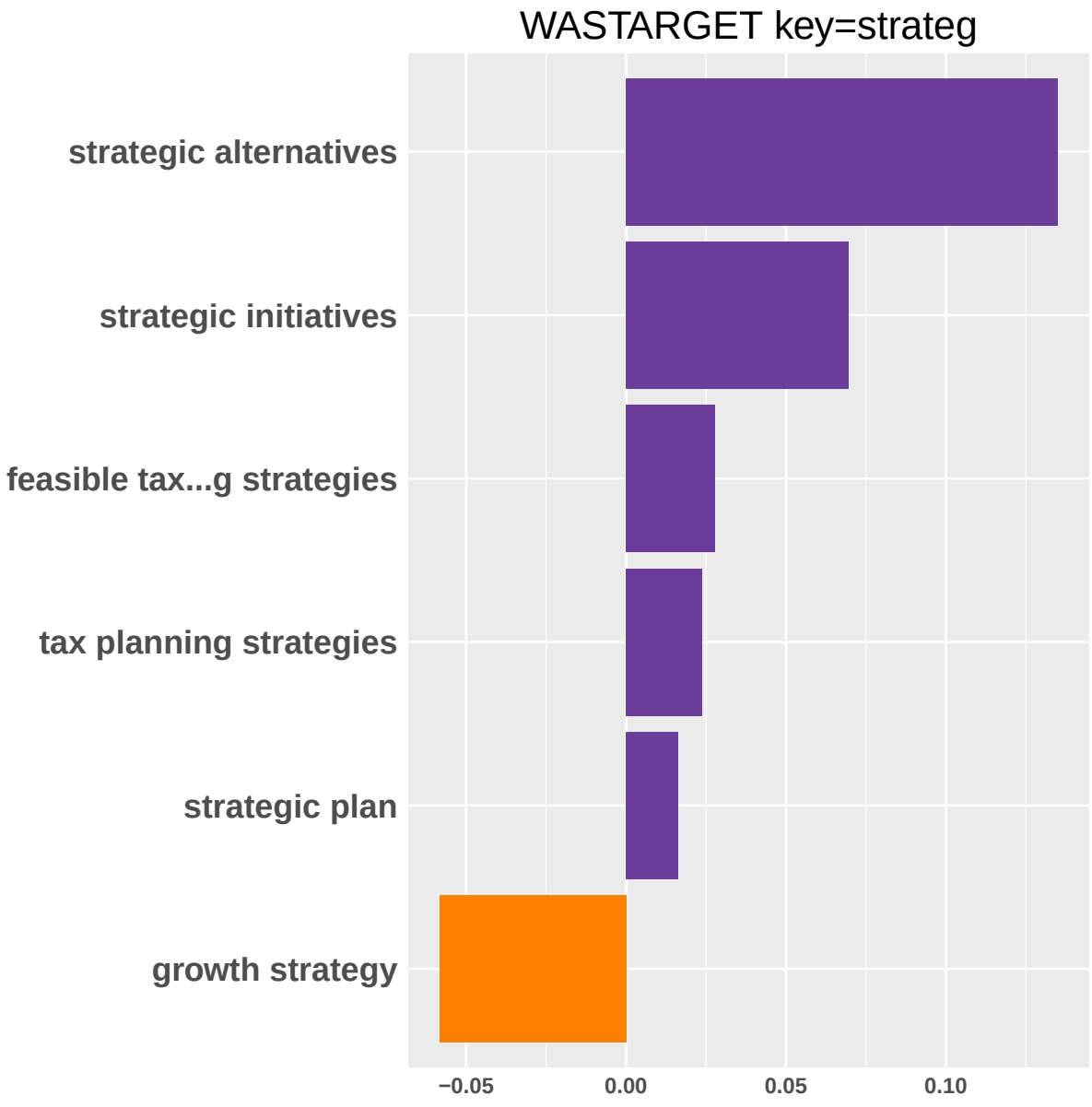

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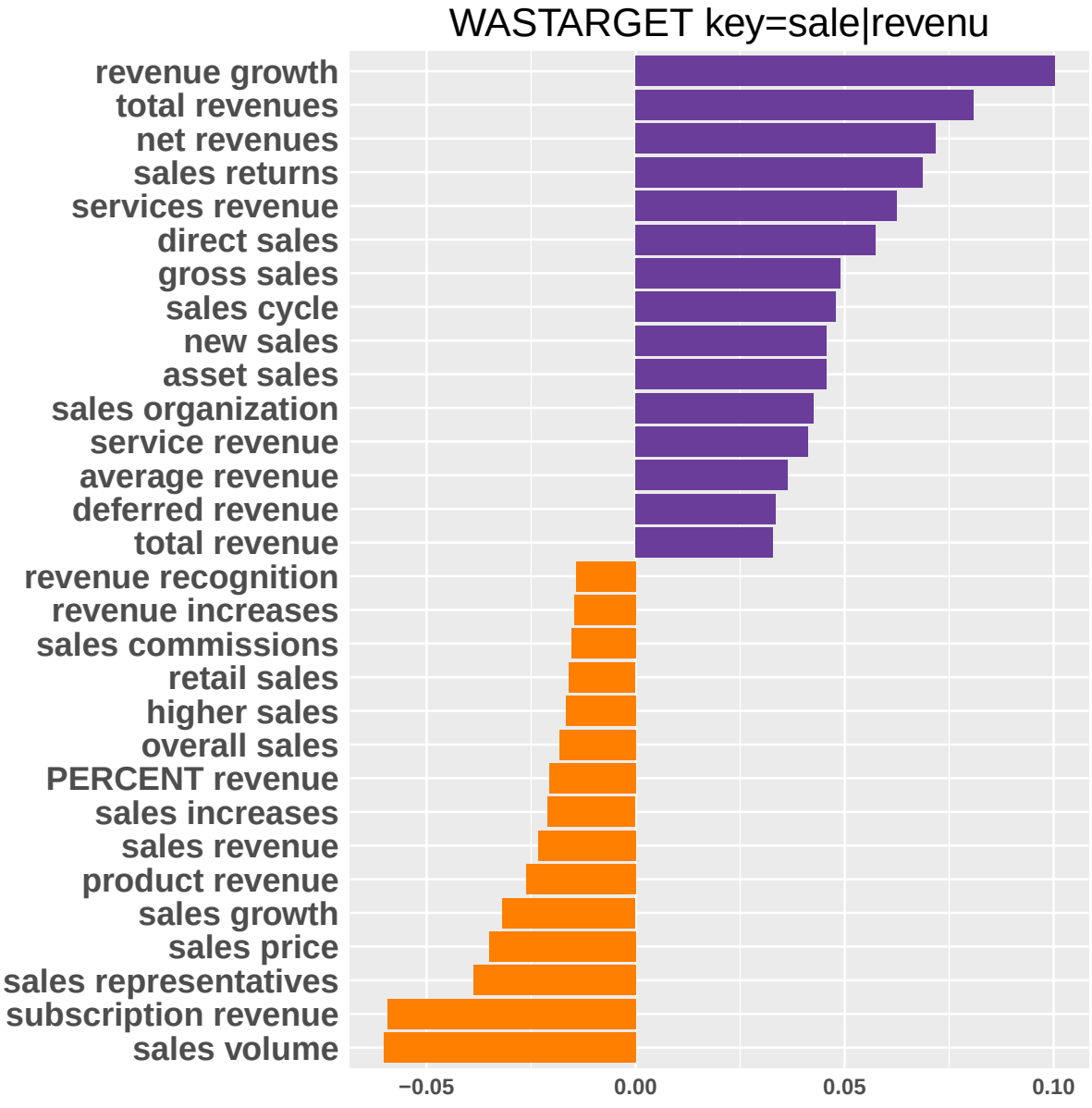

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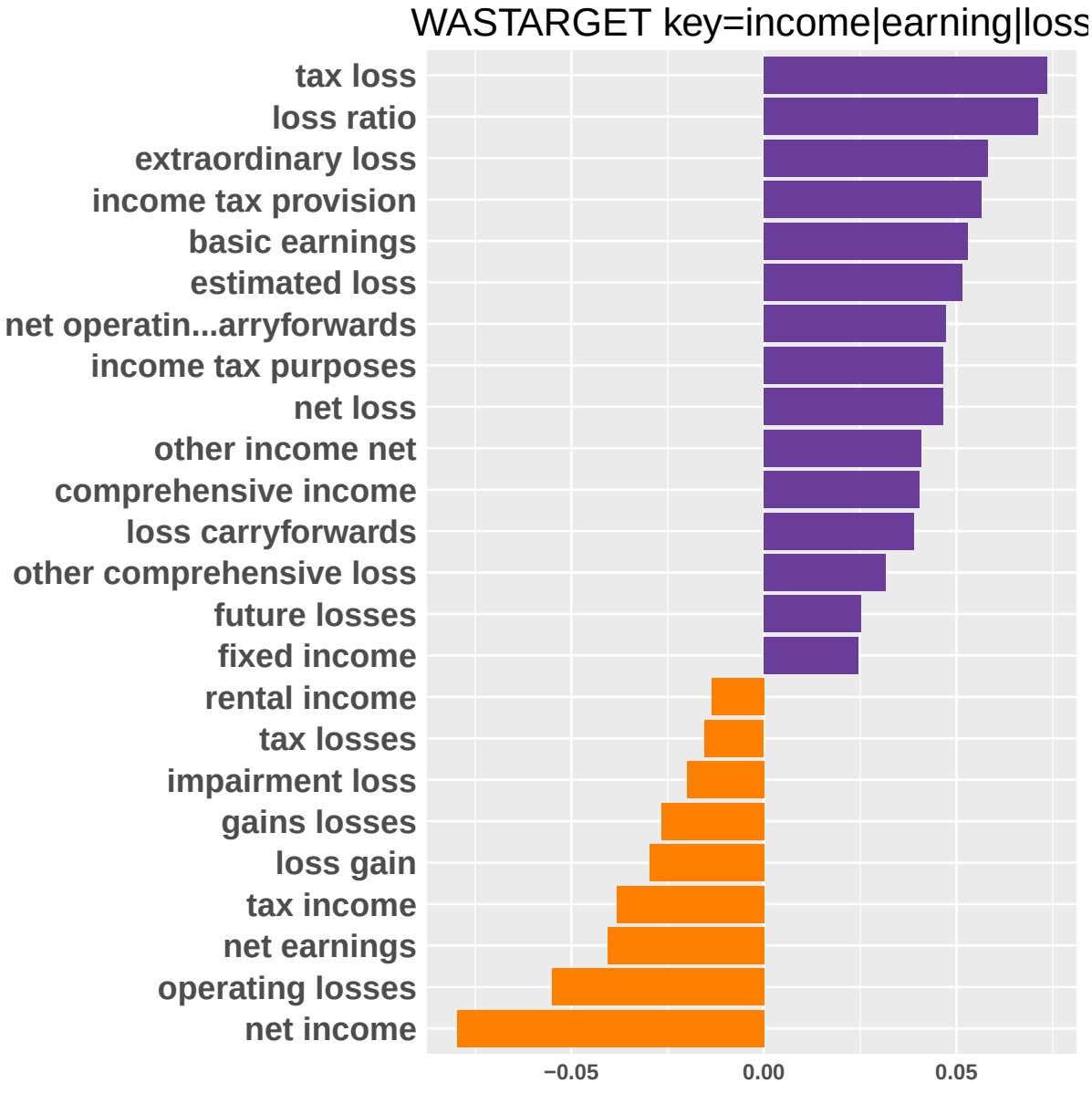

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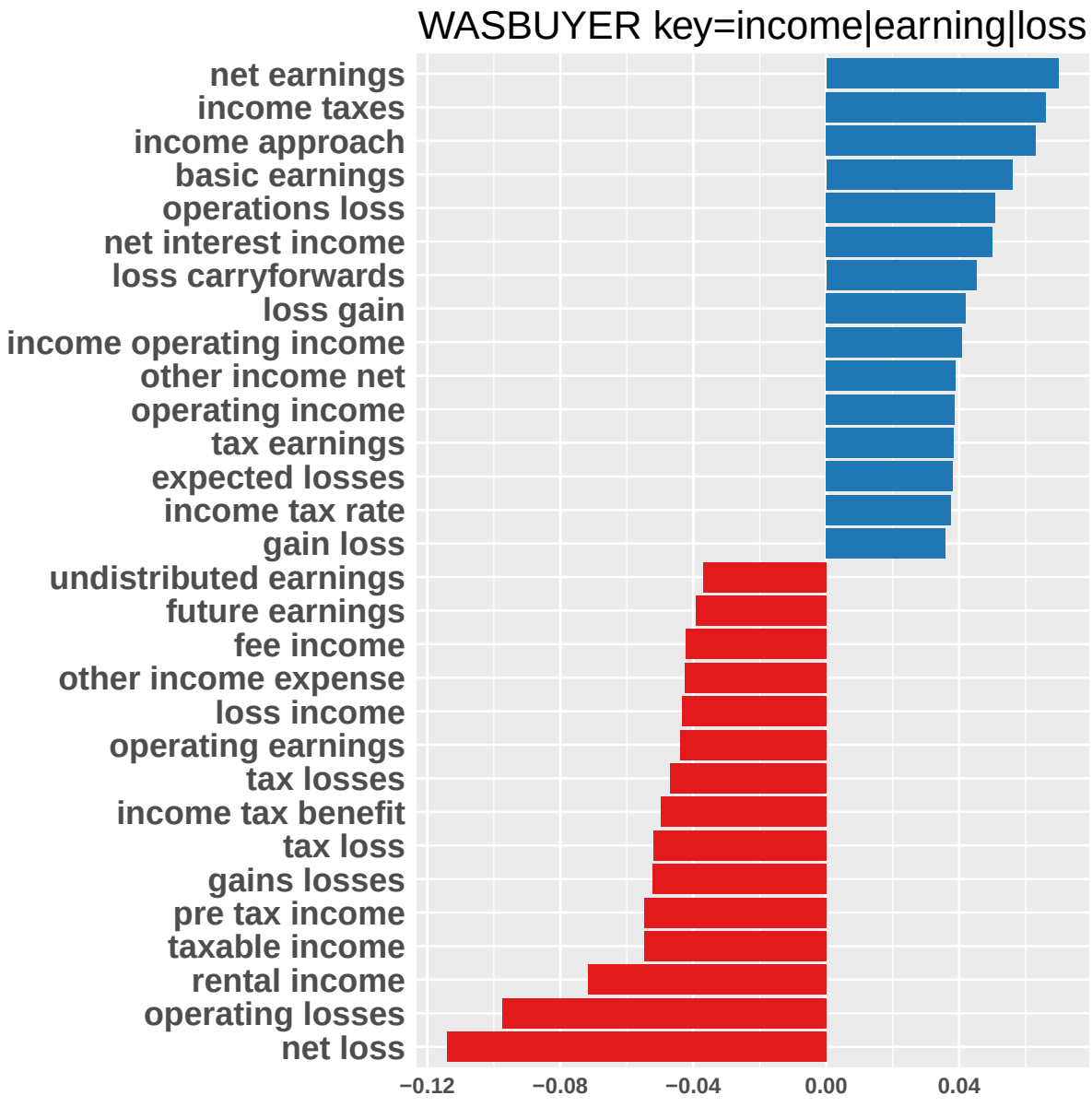

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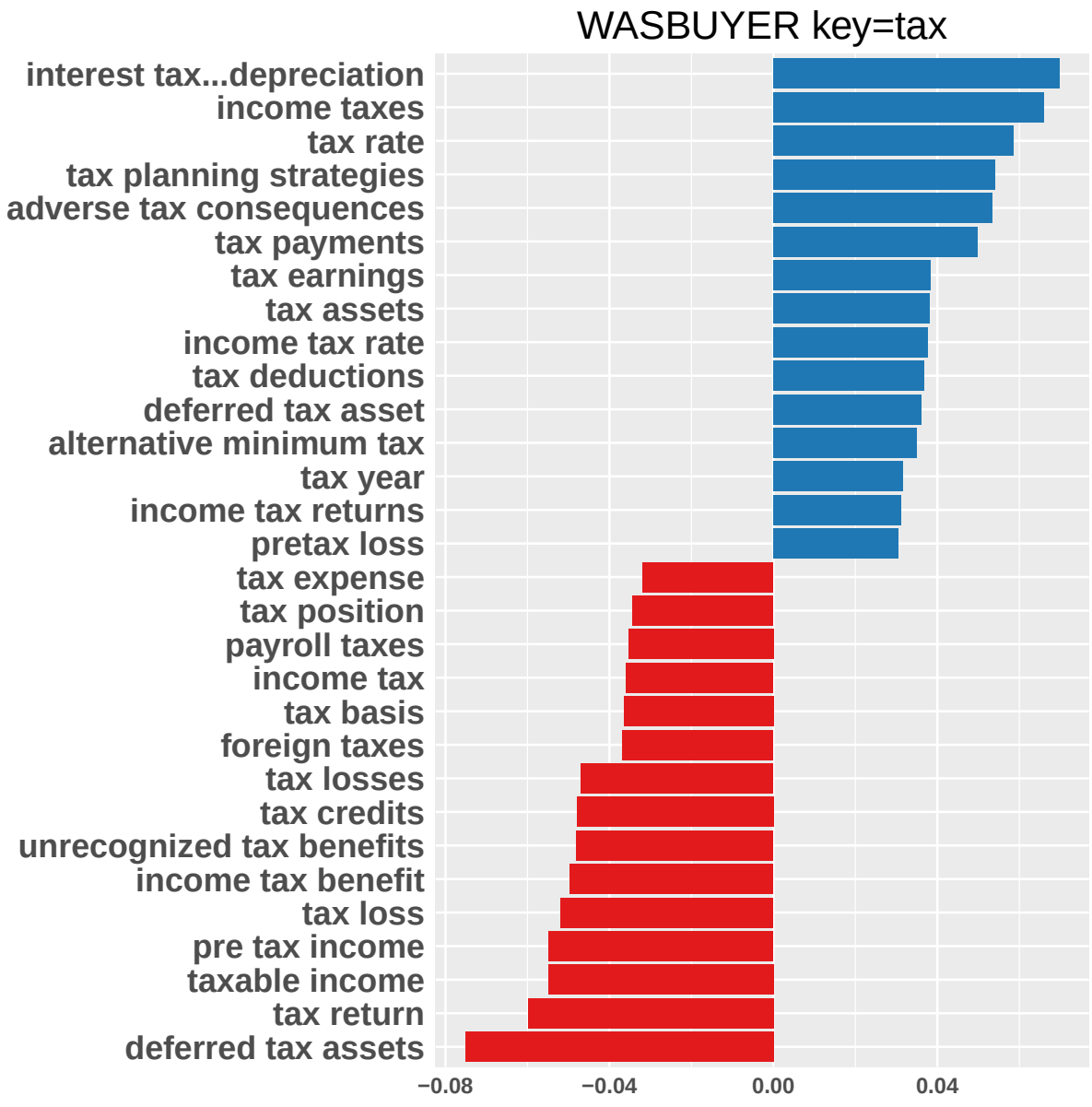

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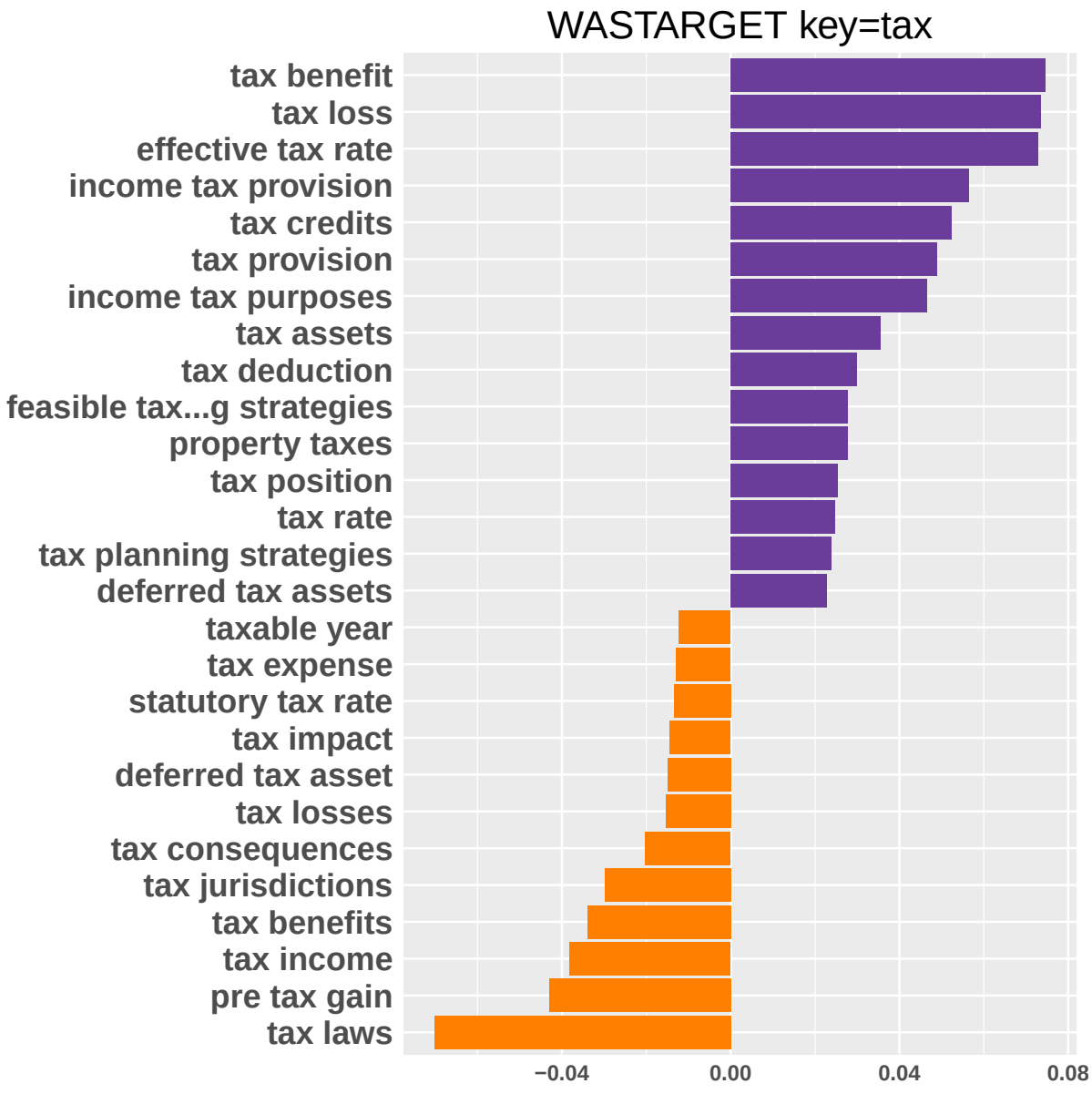

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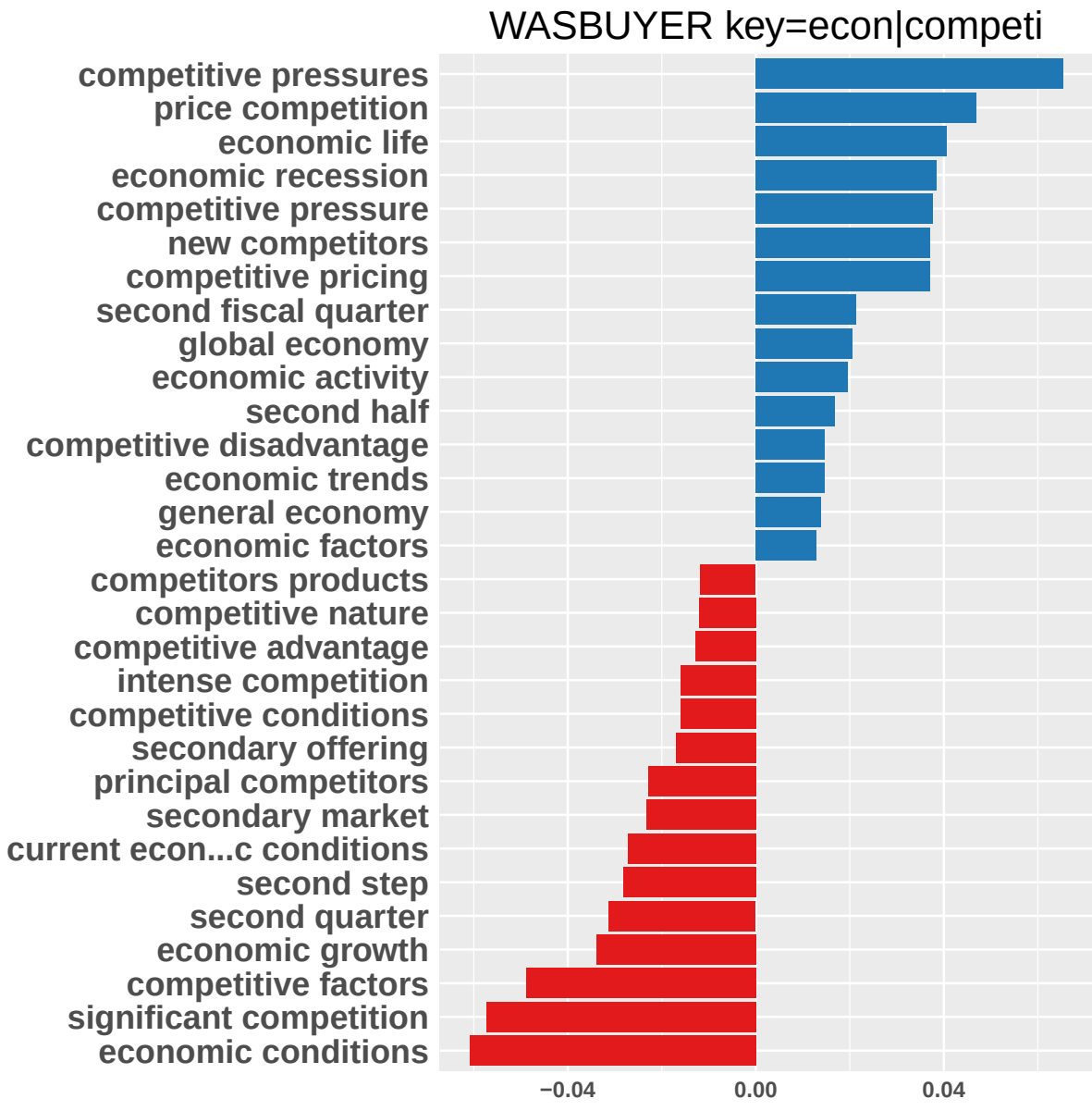

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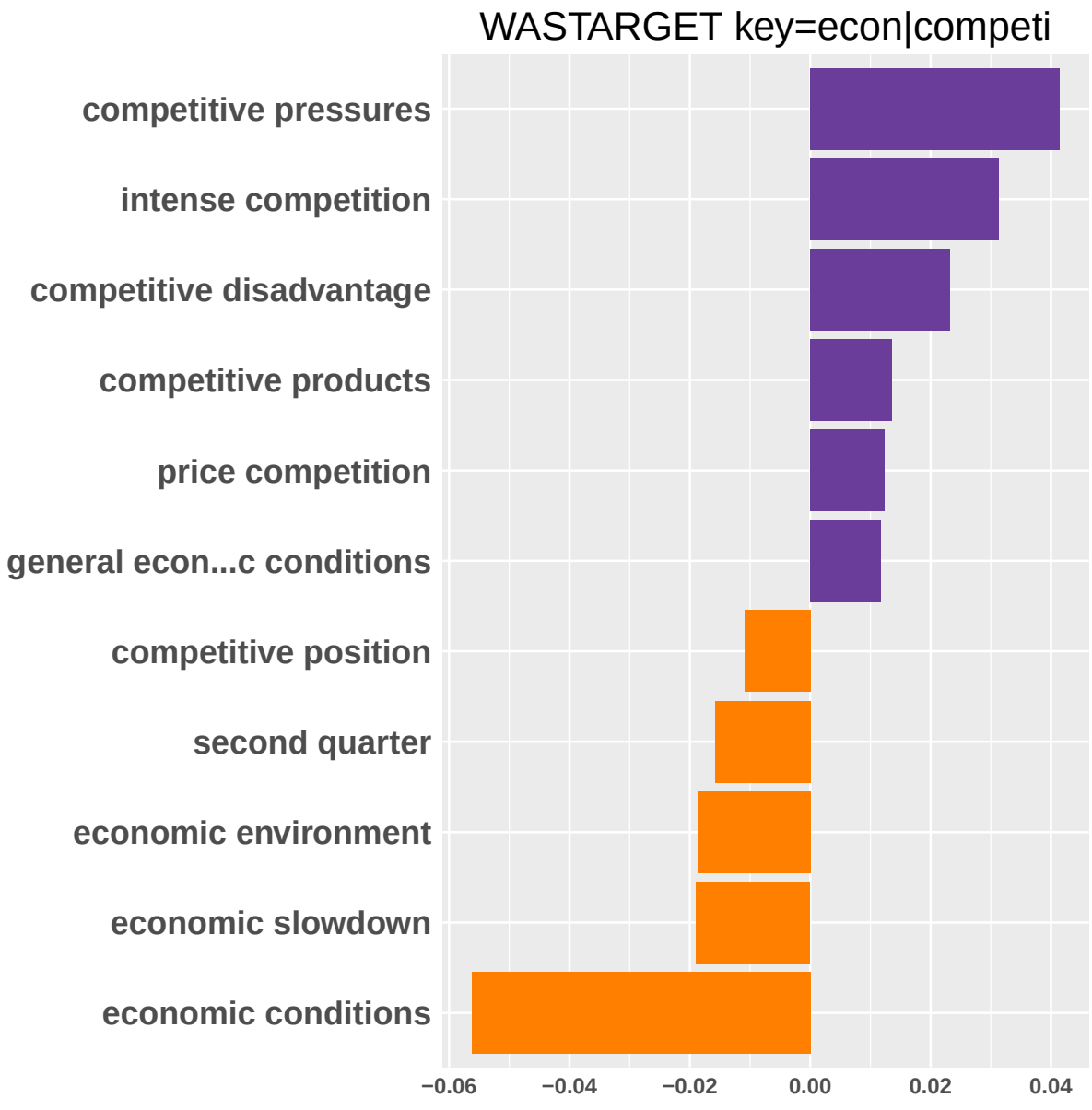

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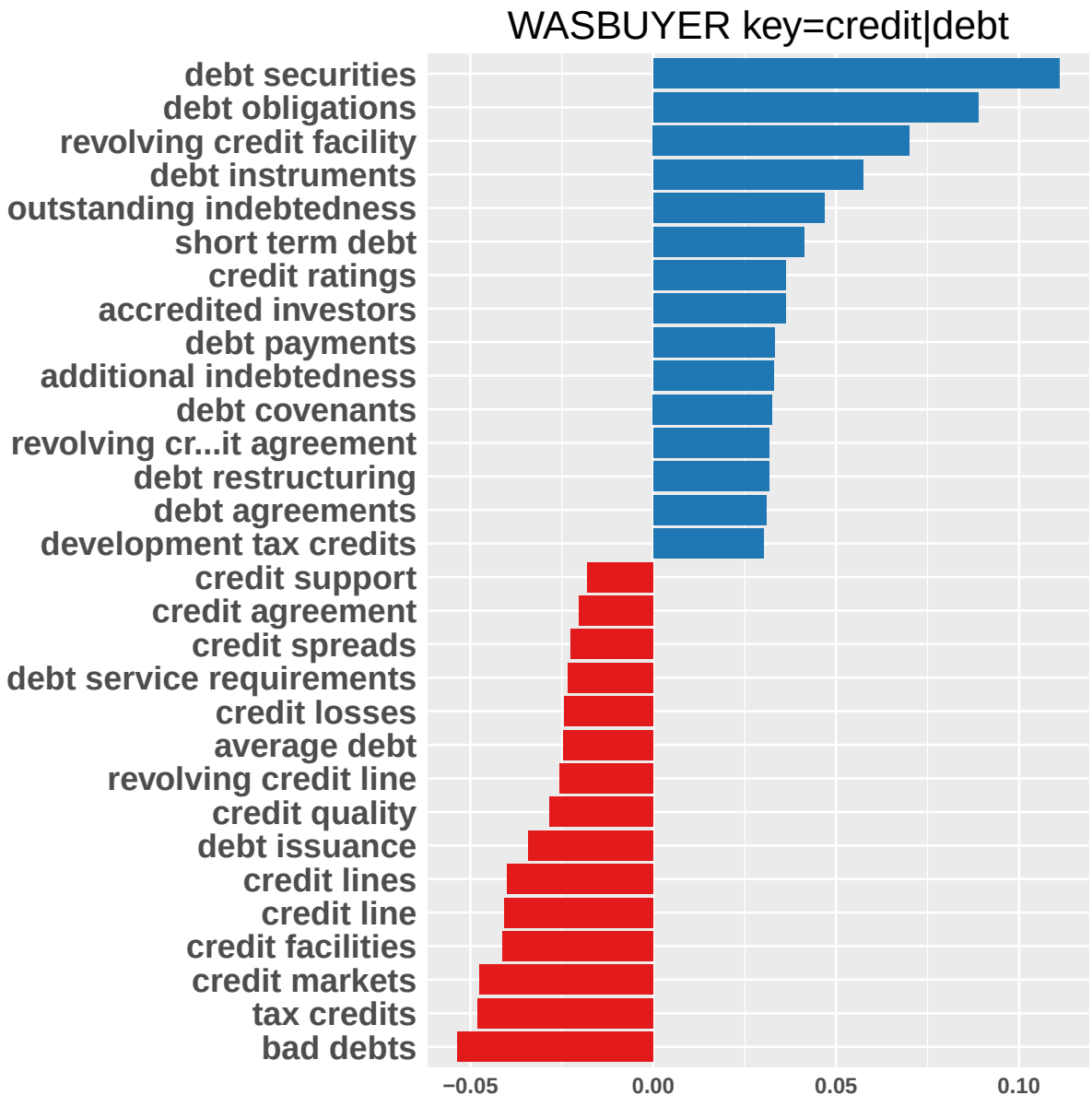

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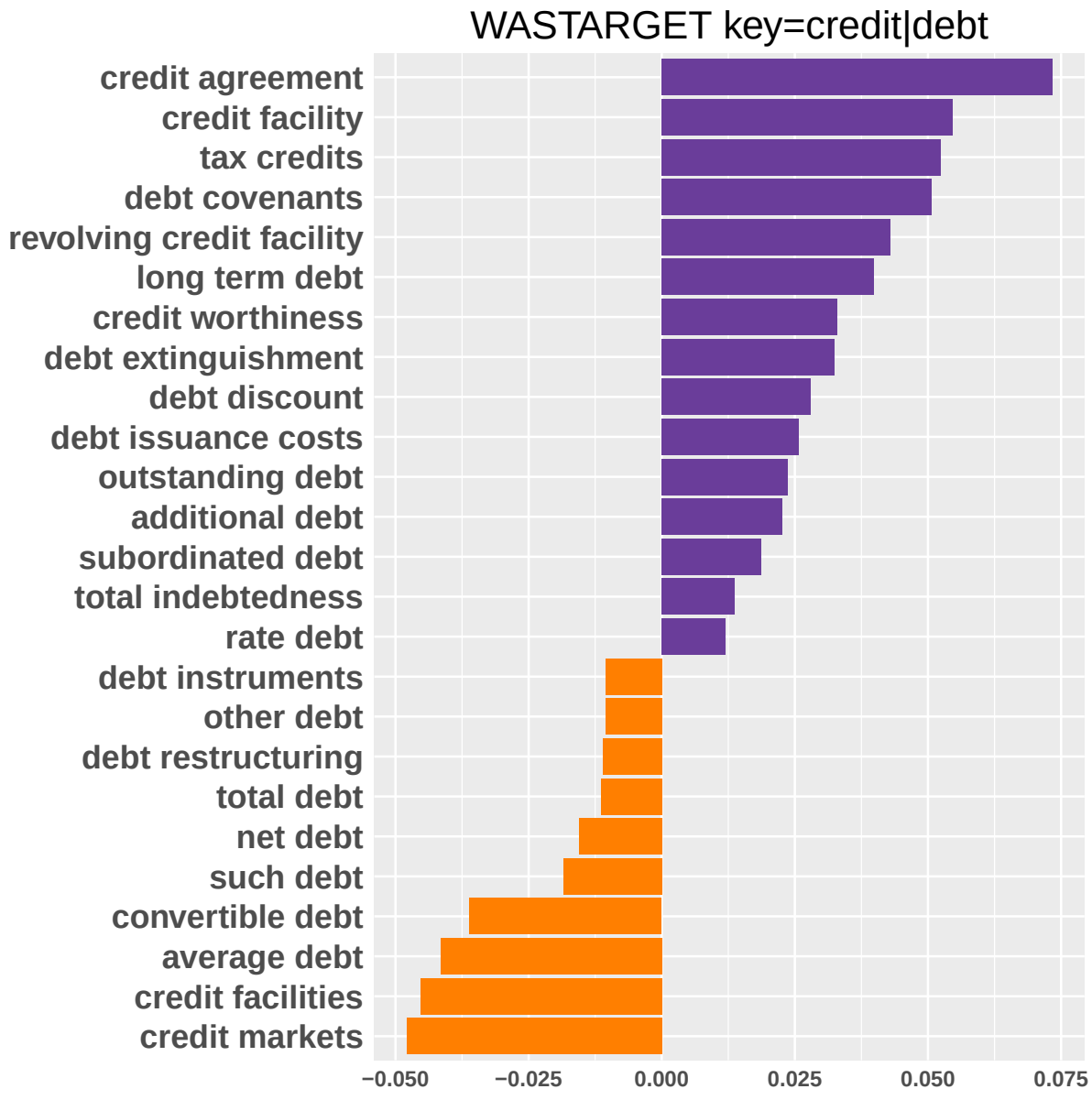

Insights - Impact by phrase

$$\text{log prob}\left(y_{i,t_+} = ...|x_t\right) \quad \propto \quad \beta_0 + \sum_w \beta_w x_{i,t,w}$$

:: Impact

= Define "impact" of phrase (word) w for prediction about firm i on date t as:

$$\beta_w \qquad \times \qquad x_{i,t,w}$$

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weight *times* **frequency**

Abbott Laboratories buys Advanced Medical Optics Inc

ER:Abbott Laboratories TARGET:Advanced Medical Optics Inc DATE:20090112 M:7 SHOW:Aq

Abbott Laboratories buys Advanced Medical Optics Inc

'ER:Abbott Laboratories TARGET:Advanced Medical Optics Inc DATE:20090112 M:7 SHOW:Ta

Abbott Laboratories buys Advanced Medical Optics Inc

https://www.sec.gov/Archives/edgar/data/1168335/000104746909000411/a2190147zsc14d9.htm

- From the 14D "Background and Reasons for the Company Board of Directors' Recommendation"
  - The Company has access to a senior credit facility, ... The amendment to the senior credit facility increased the maximum consolidated total leverage ratio allowed for certain quarterly periods.
  - Parent continually seeks to identify and evaluate strategic opportunities ... During the week of September 29, 2008, Parent noted the declines in the Company's stock price and decided to acquire shares of Company Common Stock in open market purchases.
  - In October 2008, in light of increasing credit market concerns and the impact of the developing global recession on the Company, the Company ... develop and implement a capital raising and debt reduction program

Abbott Laboratories buys Advanced Medical Optics Inc

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Abbott Laboratories buys Advanced Medical Optics Inc

MERGERS & ACQUISITIONS | WHITE COLLAR WATCH

When the C.E.O. Is Involved in an Insider Trading Case

By PETER J. HENNING AUGUST 20, 2012 2:03 PM 1

How many Baltimore Orioles infielders does it take to trade on inside information? The answer apparently is two, after the Hall of Fame first baseman Eddie Murray settled insider trading charges filed by the Securities and Exchange Commission that he profited from information provided by his former teammate, Doug DeCinces.

NYSE, via Bloomberg NewsJames Mazzo, then chief executive Advanced Medical Optics, at the New York Stock Exchange in 2005.

The real test, however, will come for the man accused of tipping Mr. DeCinces about an impending sale of Advanced Medical Optics: James V. Mazzo, the company's former chief executive. Mr. Mazzo denies the S.E.C's allegations, and his lawyer has said he plans to fight the charges.

Abbott Laboratories buys Advanced Medical Optics Inc

comp-pr2012-159.pdf

Plaintiff Securities and Exchange Commission (the "Commission") alleges as follows:

SUMMARY OF THE ACTION

1. This case involves unlawful insider trading by James V. Mazzo ("Mazzo"), David L. Parker ("Parker"), Eddie C. Murray ("Murray"), and others in advance of the January 12, 2009 public announcement that Abbott Laboratories, Inc. ("Abbott") agreed to acquire the outstanding shares of Advanced Medical Optics, Inc. (hereinafter referred to by its former New York Stock Exchange ticker symbol, "EYE") through a tender offer (the "EYE/Abbott Transaction"). Throughout this complaint, Mazzo, Parker, and Murray will be referred to collectively as the "Defendants." The Court has jurisdiction over this action pursuant to Sections 21A and 27 of the Securities Exchange Act of 1934 ("Exchange Act") [15 U.S.C. §§ 78u-1 and 78aa].

2. Mazzo, who at the time was the Chairman and Chief Executive Officer of EYE, tipped material, nonpublic information about the EYE/Abbott Transaction to his friend and neighbor, Douglas V. DeCinces ("DeCinces"), before the public announcement of the EYE/Abbott Transaction. Mazzo had access to material, nonpublic information regarding the impending EYE/Abbott Transaction because he

Ambrose, B. W., AND W. L. Megginson (1992): "The Role of Asset Structure, Ownership Structure, and Takeover Defenses in Determining Acquisition Likelihood," *Journal of Financial and Quantitative Analysis*, 27(4), 575–589.

Betton, S., B. E. Eckbo, AND K. S. Thorburn (2008): "Corporate Takeovers," *Handbook of Corporate Finance: Empirical Corporate Finance*, vol. 2, edited by B. E. Eckbo, Elsevier, Oxford, UK, 291–416.

Chatterjee, S., K. John, AND A. Yan (2012): "Takeovers and Divergence of Investor Opinion," *Review of Financial Studies*, 25(1), 227–277.

Cocco, J. F., AND P. F. Volpin (2013): "Corporate pension plans as takeover deterrents," *Journal of Financial and Quantitative Analysis*, 48(04), 1119–1144.

Comment, R., AND G. W. Schwert (1995): "Poison or placebo? Evidence on the deterrence and wealth effects of modern antitakeover measures," *Journal of Financial Economics*, 39(1), 3–43.

Cremers, K. J. M., V. B. Nair, AND K. John (2009): "Takeovers and the Cross-Section of Returns," *Review of Financial Studies*, 22(4), 1409–1445.

Eckbo, B. E. (2014): "Corporate Takeovers and Economic Efficiency," *Annual Review of Financial Economics*, 6(1), 51–74.

Edmans, A., I. Goldstein, AND W. Jiang (2012): "The real effects of financial markets: The impact of prices on takeovers," *Journal of Finance*, 67(3), 933–971.

Hasbrouck, J. (1985): "The characteristics of takeover targets q and other measures," *Journal of Banking & Finance*, 9(3), 351–362.

Hoberg, G., AND G. Phillips (2010): "Product market synergies and competition in mergers and acquisitions: A text-based analysis," *Review of Financial Studies*, 23(10), 3773–3811.

Macias, A., AND C. Pirinsky (2015): "Employees and the market for corporate control," *Journal of Corporate Finance*, 31, 33–53.

Morck, R., A. Shleifer, AND R. W. Vishny (1988): "Characteristics of Targets of Hostile and Friendly Takeovers," *Corporate Takeovers: Causes and Consequences*, edited by Alan J. Auerbach, University of