Sentiment and Uncertainty indexes to Forecast the Italian Economic Activity[1]

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Modelling with Big Data Machine Learning: Measuring Economic Instability
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[1] The opinions expressed are those of the authors and do not reflect the views of the Bank of Italy, the Eurosystem or the UPB.

Motivation

Forecasters faces constantly new **hard challenges**

- Macroeconomic conditions evolve rapidly (Ng, and Wright, 2013)
- Legacies of the latest two deep recessions and the Covid-19 Pandemic

But...

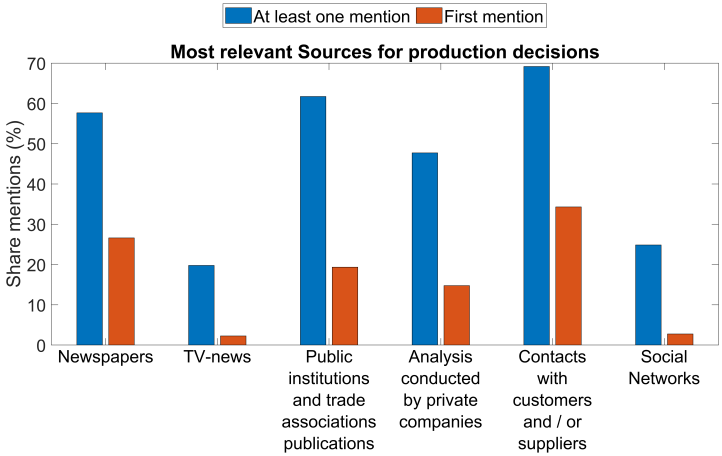
- Big data availability
- Novel sources of *unstructured*, high-dimensional, high-frequency and **timely** information

Our contribution

- Build **Sentiment Indicators (TESI)** and **Uncertainty indicators (EPU)** for Italy from newspaper articles
  - Italian businesses gather information to form their decisions from newspapers
- Use TESI and EPU to track the short-term evolution of the Italian economic activity at **monthly** frequency
- Large benefits in nowcasting Italian GDP at **weekly** frequency

Motivation: Survey on most relevant source of information

Bank of Italy's Survey on Inflation and Growth Expectations



Sample size: 1199 respondents.

Finding: Firms use newspapers as their second/third source of news to inform their decisions

Outline

Literature: Text as Data

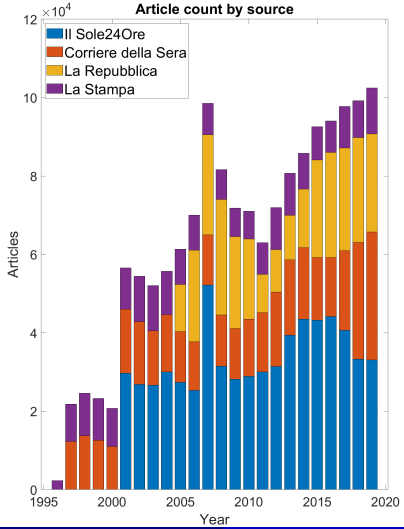
- Growing literature exploring the *media-economy-opinion nexus*
- Shapiro et al. (2018), Gentzkow et al. (2019), Thorsrud (JBES, 2020), Kalamara et al. (BoE WP 2020), Ardia et al. (IJF, 2019), Algaba et al. (JES, 2020), Nguyen and La Cava (RBA WP 2020), Garboden (2019), Rogers and Xu (FRB WP 2020)
  - Economic perceptions affect policy preferences but these perceptions are oftenly driven by factors other than the economy, including media [Soroka et al. (2015)]
  - Newspapers catch the mood
    (and to a certain extent they amplify and propagate pessimism or optimism)
- Documents are not a simple sum of words (*The Library of Babel* by Jorge Luis Borges): extracting the meaning of the sentence

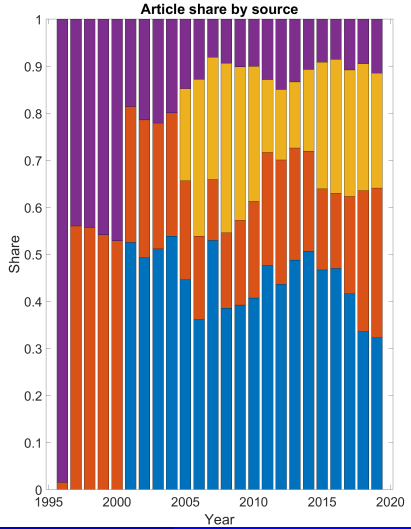
Factiva's repository

We downloaded approximately 2 million newspaper articles in the Italian language related to economic news from September 1996 to December 2019.

The News Corpus

Number of articles by year and source (4) and share of articles for each source in each year





Data treatment - Sentiment & Uncertainty

- Pre-screening or pre-processing (removal of stop-words, non-meaningful punctuation, etc.)
- Building a meaningful **economic dictionary** in Italian
  - Unigrams + n-grams (terms of n words)
  - Polarity (+/-) & weight
  - **Valence Shifters** tailored to newspapers' jargon (negations, lot/little, ...)
    $\Longrightarrow$ better capture actual meaning of sentences
- Unigrams + n-grams = 433 terms; Valence shifters = 190
- Constructing sentiment score as $\Rightarrow SENT_t = \frac{\sum_{i=1}^{No\ words} polarity_{it} \times weight_{it} \times shifter_{it}}{Number\ of\ words\ in\ article}$

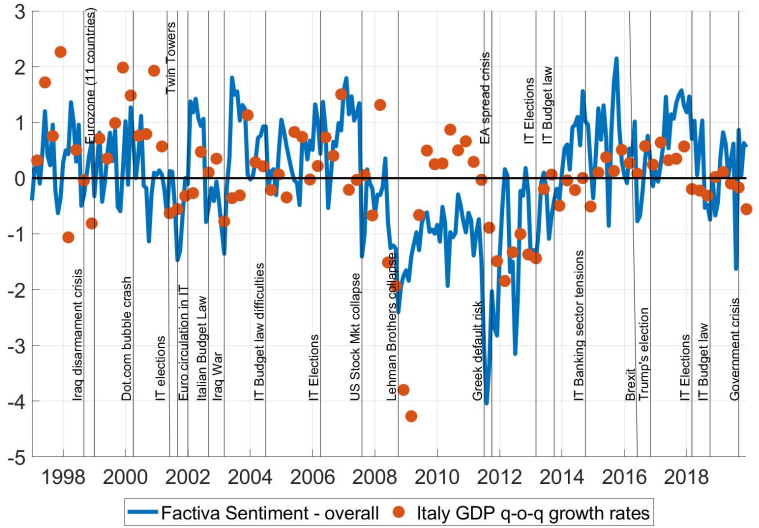
Examples

Gross Domestic Product has fallen $\rightarrow SENT_t = -1.0$

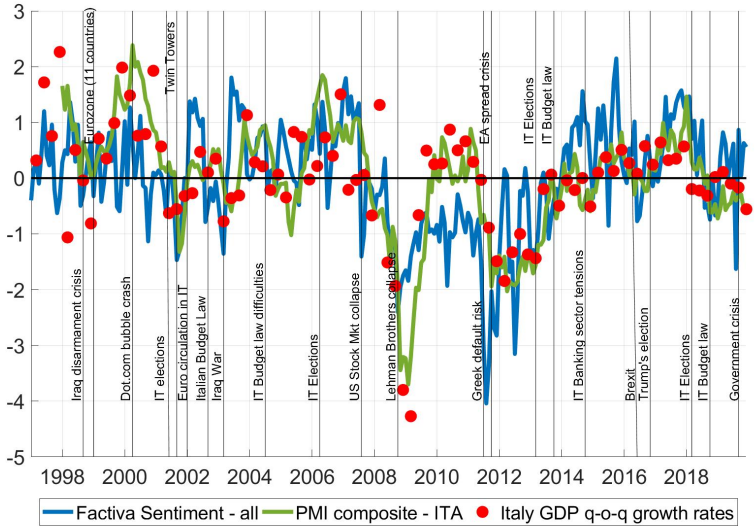
Istat's projections, GDP grew in 2019. Expansion is set to strengthen in 2020 $\rightarrow SENT_t = 0.25$

- Constructing also Economic Policy Uncertainty (EPU) Indicators as in BBD (2016)

Sentiment Index and Economic Activity



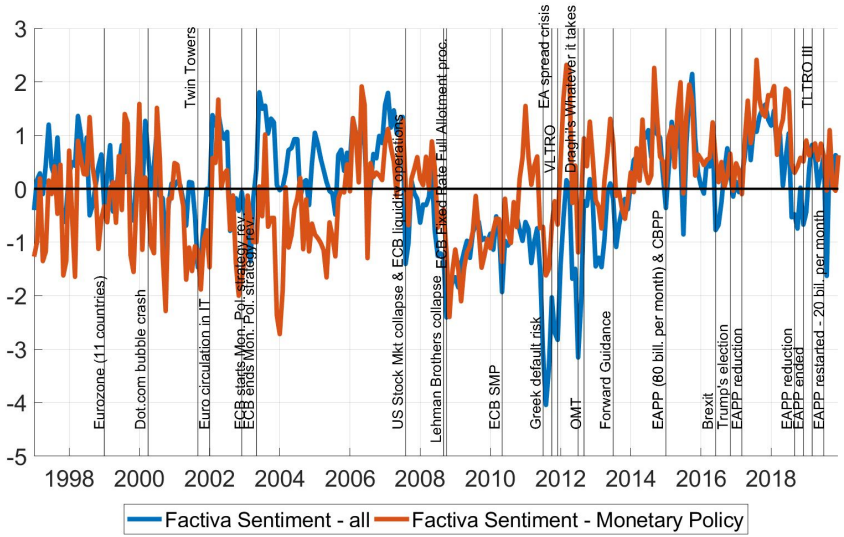
Sentiment Index and Economic Activity with PMI



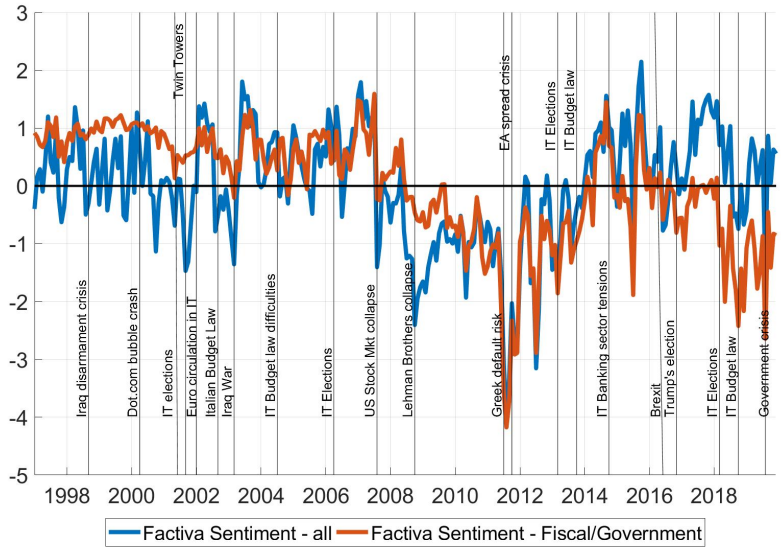
Sentiment Index - Taxonomy

1. **Sentiment by topics** (# 15), grouping $>$ 300 article pre-labeled categories
   - Monetary policy
   - Fiscal Policy/Government
   - Labour Markets
   - Economic conditions
   - Prices
   - Foreign Policy
   - ...
2. **Sentiment by sector** (# 21)
   - Manufacturing
   - Services
   - Retail
   - ...

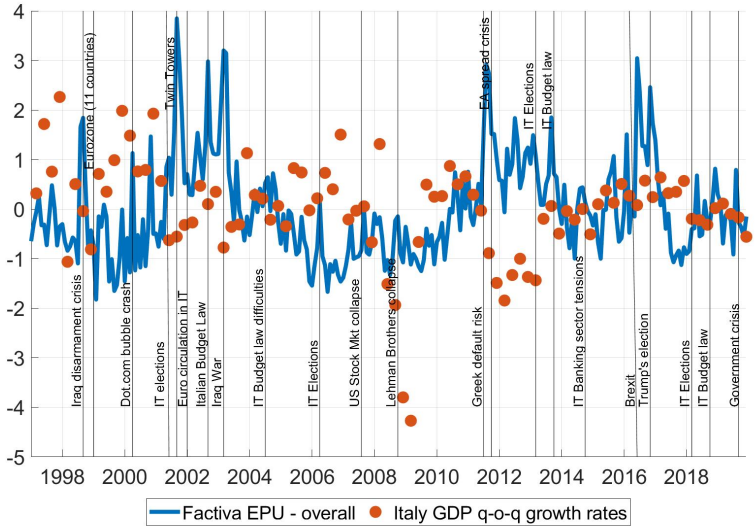
Sentiment index - by topics (Monetary Policy)



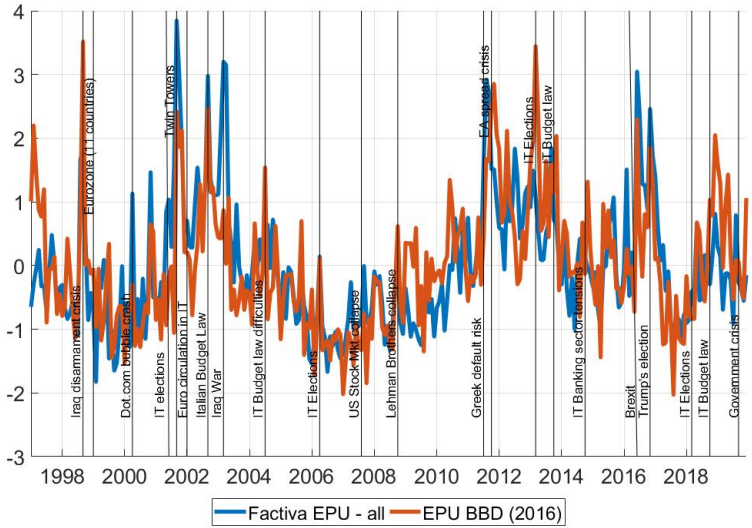
Sentiment index - by topics (Government/Policy)



Economic Policy Uncertainty (EPU)- overall index



Economic Policy Uncertainty - Comparison with Bloom, Baker Davis (2016)



Empirical application #1 - Bayesian Model Averaging (BMA)

Short-term forecasting with **monthly data**

- Test the ability of **text-based indicators** (TESI and EPU) to forecast the GDP and its main components (**demand/supply components**)
- **Model**. Bayesian Model Averaging (BMA) (Bencivelli, Marcellino, and Moretti. EE, 2017)
- Pseudo real-time forecasting exercise with **monthly data**
  - **Baseline model**: soft indicators (from business surveys and PMIs), industrial production index;
  - **Augmented model**: baseline + TESI (total + some components) + EPU
  - **Training sample** 2001m1-2010m12 with a recursive window
  - **Out-of-sample Evaluation period** 2011m1-2019m12
    - All sample 2011m1-2019m12
    - Sovereign debt crisis 2011m1-2014m12
    - Slow recovery 2015m1-2019m12

Bayesian Model Averaging

The Bayesian Model Averaging is a probabilistic variable selection model

- Randomly draw (Monte-Carlo Markov Chain sampling) over all possible models $y = \beta X$
- Find the "best" models by keeping "better" ones and rejecting "worse" ones
- Assign them a posterior probability

The BMA allows to obtain

- Average/median/modal prediction
- **Distribution of forecasts** (from distribution of models)
- **Importance of each variable** (posterior inclusion probabilities)

BMA dataset

N	label	Description	Treatment	GDP		HHC		GFI		VAS	
				Baseline	FCT	Baseline	FCT	Baseline	FCT	Baseline	FCT
1	ITCNFCONR	ITA household confidence index	none	x	x	x	x	x	x	x	x
2	ITCNFBUSQ	ITA business confidence indicator	none	x	x	x	x	x	x	x	x
3	ITTOTPRDR	ITA business svy.: production level	none	x	x			x	x	x	x
4	ITEUSVCIQ	ITA services: confidence sadj	none	x	x			x	x	x	x
5	ITIPMAN.G	ITA industrial prod.- manufacturig	deltaog(1)	x	x	x	x	x	x	x	x
6	EMPMIM..Q	PMI Manufacturing - EA	none	x	x	x	x	x	x	x	x
7	ITPMIM..Q	PMI Manufacturing - IT	none	x	x	x	x	x	x	x	x
8	ITPMIS..Q	PMI Services - IT	none	x	x	x	x	x	x	x	x
9	@:ITMSCIP	Weighted ave. Std. Dev. of the EPS forecast for the t+1 Fiscal Year	deltalog(12)	x	x			x	x	x	x
10	AUTOD	Car registrations in Italy	deltaog(1)			x	x				
11	fct_sent	Factiva Sentiment	zscore MA(3)		x		x		x		x
12	fct_epu	Factiva Economic Policy Uncertainty	zscore MA(3)		x		x		x		x
13	fct_sent_man	Factiva Sentiment - manufacturing	zscore MA(3)		x		x		x		x
14	fct_sent_ser	Factiva Sentiment - Services	zscore MA(3)		x		x		x		x
15	fct_epu_man	Factiva Economic Policy Uncertainty manufacturing	zscore MA(3)		x		x		x		x
16	fct_epu_ser	Factiva Economic Policy Uncertainty Services	zscore MA(3)		x		x		x		x
17	fct_sent_lab	Factiva Sentiment Labor	zscore MA(3)		x		x		x		x
18	fct_sent_ret	Factiva Sentiment Retail	zscore MA(3)		x		x		x		x

Empirical application - BMA Results on point forecasts

Short-term forecasting - Relative RMSFE for nowcasting and forecasting

Table: Relative RMSFE for nowcasting (n) and forecasting (f)

	2011.1 - 2014.12		**2015.1 - 2019.12**		**2011.1 - 2019.12**	
	n	f	n	f	n	f
GDP	**0.93**	**0.91**	1.17	1.16	1.00	1.00
VAS	**0.97**	1.21	1.08	1.08	1.00	1.00
GFI	1.03	**0.94**	1.13	1.08	1.03	1.00
HHC	**0.83**	**0.79**	1.46	1.29	**0.99**	1.00

Empirical application - BMA Results on density forecasts

Short-term forecasting - Average log score based on WLRT (Amisano & Giacomini, 2007)

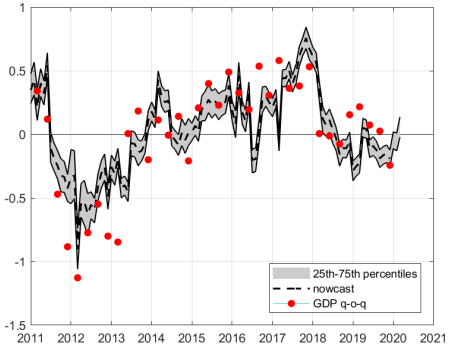
- SI definitely outperforms the benchmark overall, in particular during the sovereign debt crisis. Text-based indicators squeeze the uncertainty around nowcasts

Table: Average Log Score for nowcasting (n) and forecasting (f)

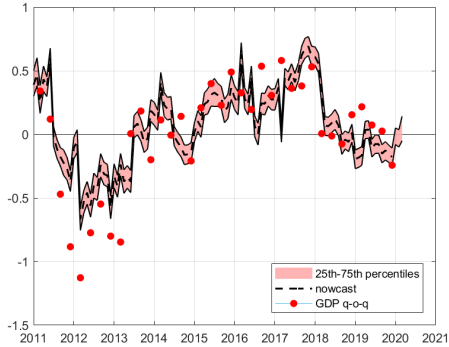
	2011.1 - 2014.12		**2015.1 - 2019.12**		**2011.1 - 2019.12**	
	n	f	n	f	n	f
GDP	**9.1**	8.6	-15.6	-22.4	6.1	**6.6**
VAS	5.3	**6.6**	-7.1	-10.3	3.7	**6.4**
GFI	3.6	**23.7**	6.9	**10.5**	4.6	**24.5**
HHC	**14.6**	12.2	-9.4	-11.8	11.4	**11.8**

Empirical application - Results from BMA

Nowcast of GDP qoq



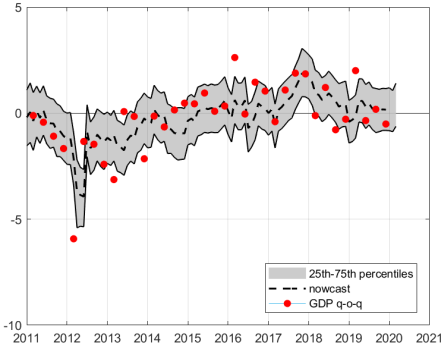
With Text-based indicators (Factiva)



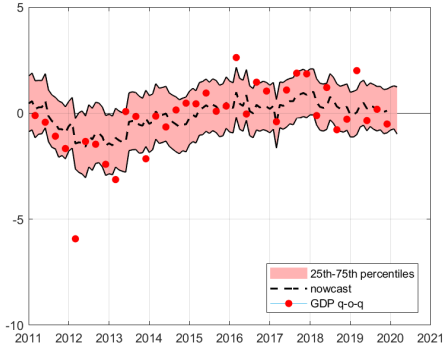
Without Text-based indicators

Empirical application - Results from BMA

Nowcast of GFI qoq



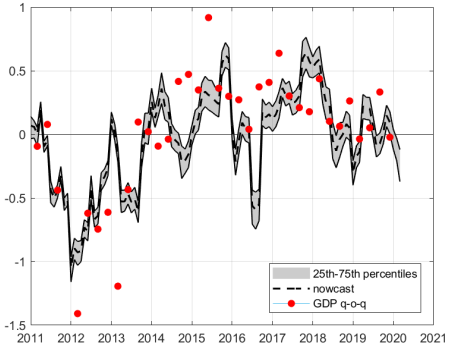
With Text-based indicators (Factiva)



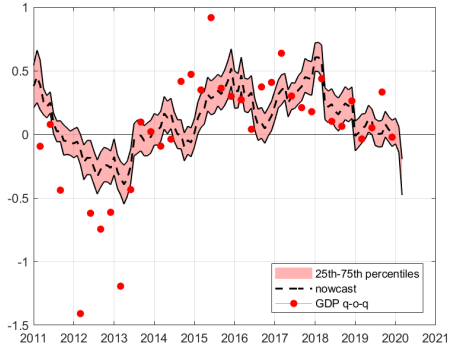
Without Text-based indicators

Empirical application - Results from BMA

Nowcast of HHC qoq



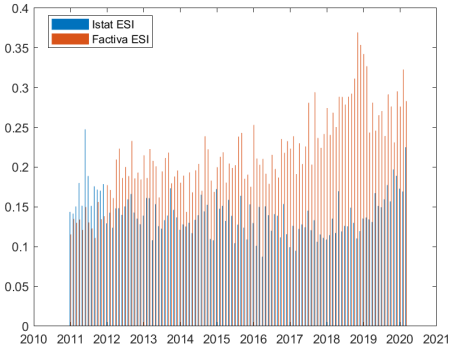
With Text-based indicators (Factiva)

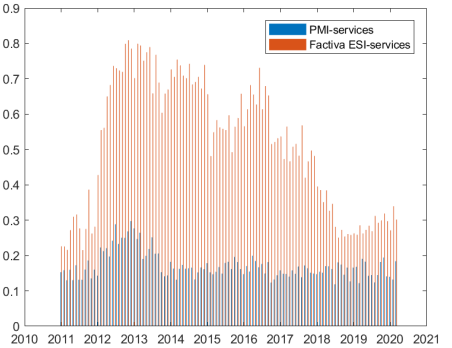


Without Text-based indicators

Empirical application - Results from BMA

Posterior Inclusion Probabilities for GDP qoq Nowcasts

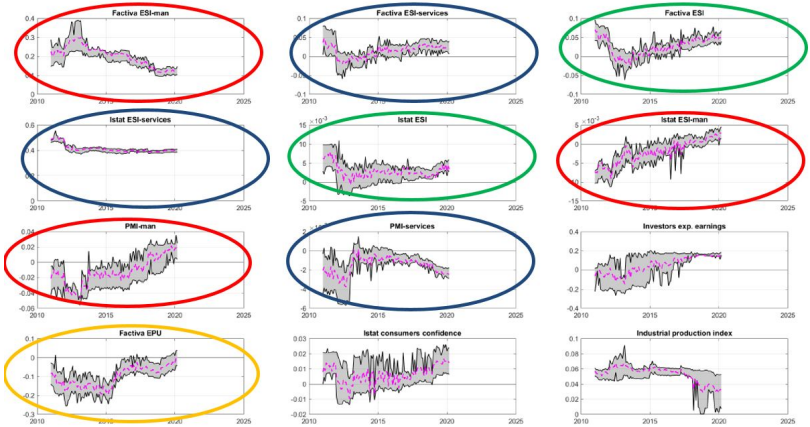




- PIP measure relative importance of each regressor to explain the variance of the target variable. TESI is picked more frequently than PMI or Istat ESI.

Empirical application - Results from BMA

Regression Coefficients and 25th-75th percentiles for GDP qoq Nowcasts



- TESI and EPU included more often but weights less than ISTAT measures.
- Text-based ESI for Manufacturing outperforms. EPU negative contribution as expected.

Empirical application #2 - A **Weekly economic indicator**

Following Stock and Watson (2002) and Lewis, Mertens and Stock (2020), we build a weekly indicator of economic activity

- Explore the role of **information timeliness**

We find that

- Sentiment and EPU help nowcast the GDP (RMSFE reduced by $15 - 17\%$ from baseline)
- Gains seem due to
  - Better tracking than other weekly variables
  - More timely tracking than monthly ones
- CSSED analysis shows stable gains over most of the out-of-sample period

The model

We extract the first Principal Component from two different sets of variables:

1. Group 1 (baseline)
   - Electric Consumption, Expected Earnings std (weekly)
   - PMI indices, ISTAT sentiment (monthly, inferred weekly)
2. Group 2 (factiva)
   - Dabatase 1
   - Sentiment and EPU indicators (weekly)

We use it to nowcast GDP growth YoY in a pseudo real-time exercise

The model

- We regress the 13-periods MA of the first PC against the most recent data on GDP yoy variation available at week t.
  At week t (today) call $T_t < t$ the week at which the latest data is available.

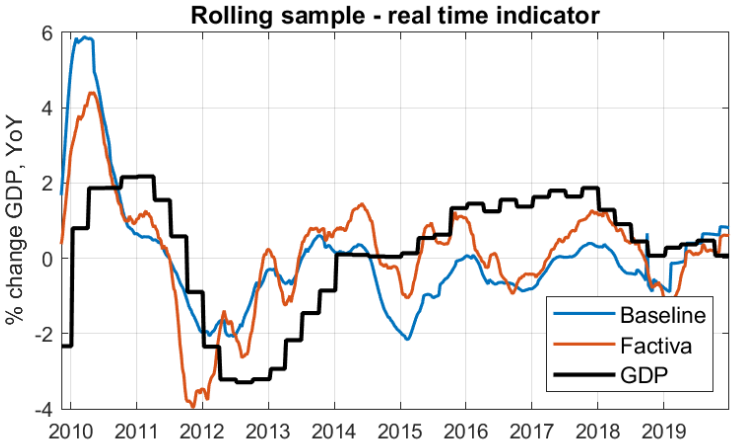
$$\Delta Y_{(yoy),\tau} = \alpha^i_{T_t} + \beta^i_{T_t} X^i_{\mathrm{MA},\tau} + \varepsilon_\tau, \qquad \tau = t_0, t_0 + 1 \ldots, T_t$$

$$X^i_{\mathrm{MA},\tau} = \sum_{s=\tau-12}^{\tau} \mathrm{PC}^i_s$$

- At week t, compute the index for each past period $\tau \leq t$ using estimate coefficient

$$\mathrm{Index}^i_{t,\tau} = \alpha^i_\tau + \beta^i_\tau X^i_{\mathrm{MA},t}$$

Weekly indicator: real-time indicator



Forecasting error

- Compute the nowcasting errors by using the ex-post available data on GDP as

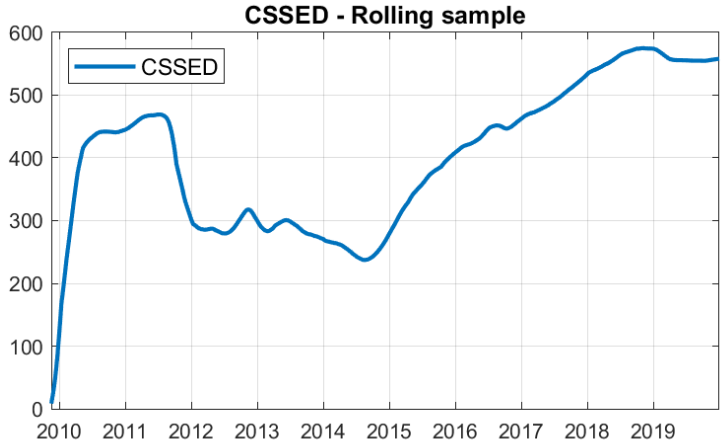
$$E_t^t = \Delta \text{GDP}_{(yoy)t} - \text{Index}_t^t$$

- $\approx$ 13 nowcasts per quarter, 3-4 between each monthly PMI or Istat Sentiment release
- We find large gains on weekly nowcasts when adding Sentiment and EPU indicators

Table: Relative RMSFE

	Expanding	Rolling (335 weeks)
All sample	0.85	0.83
Negative GDP	0.88	0.96
Positive GDP	0.82	0.75

CSSED analysis: error over time



Wrap-up

- We developed an **Italian economic dictionary** with **polarity** and **shifters**
- We used a **large datset** of newspapers articles from Factiva to estimate Sentiment and EPU indices at high frequency
- We evaluated their properties in two short-term forecasting exercises
  1. **Monthly**: point-forecast gains in recessions; large density forecast gains overall
  2. **Weekly**: large point-forecast gains across all the sample
- **Further developments**:
  - Extend exploration of high-frequency properties and gains
  - Generate weight
  - Forecast-maximizing dictionary weighting schemes
  - Compute Past/Present/Future Sentiment: does it make a difference for forecasting?

THANK YOU