Transparency and Deliberation within the FOMC: A computational linguistics approach

Stephen Hansen, Michael McMahon and Andrea Prat

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Specific goal of this Paper

We want to study how transparency affects FOMC deliberation.
$\Rightarrow$ how is *internal deliberation* affected by greater *external communication*?

Motivation

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- ... but primary activity is deliberation.
- Transparency: necessary for accountability but bad for deliberation?

Greenspan's view before the Fed released transcripts

"**A considerable amount of free discussion and probing questioning by the participants of each other and of key FOMC staff members takes place.** In the wide-ranging debate, new ideas are often tested, many of which are rejected ... **The prevailing views of many participants change as evidence and insights emerge.** This process has proven to be a very effective procedure for gaining a consensus ... It could not function effectively if participants had to be concerned that their half-thought-through, but nonetheless potentially valuable, notions would soon be made public. **I fear in such a situation the public record would be a sterile set of bland pronouncements scarcely capturing the necessary debates which are required of monetary policymaking.** A tendency would arise for one-on-one pre-meeting discussions, with public meetings merely announcing already agreed-upon positions or for each participant to enter the meeting with a final position not subject to the views of others."

The outline of our paper ▸ Theory ▸ Empirics ▸ Results

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Theory

Discipline vs Conformity

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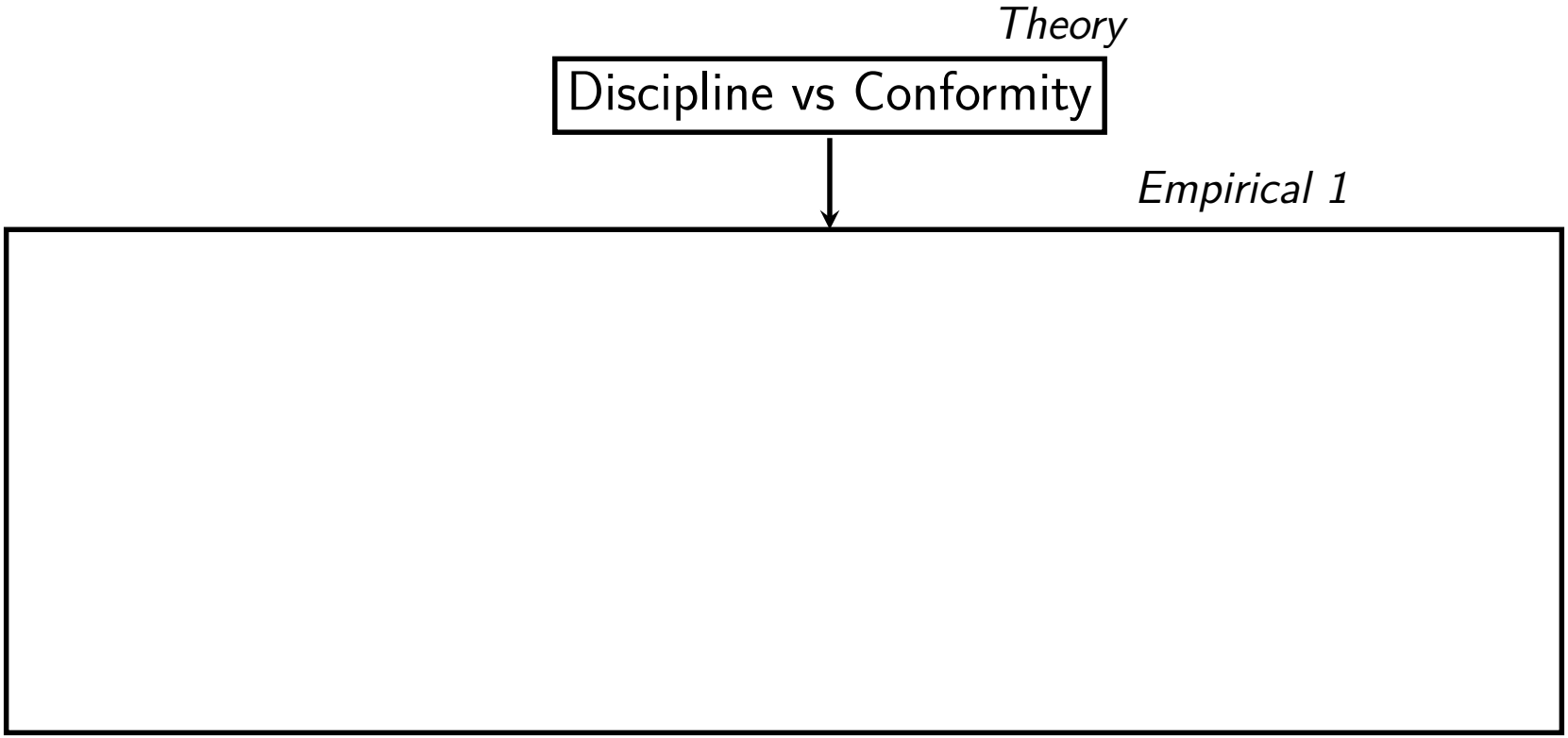

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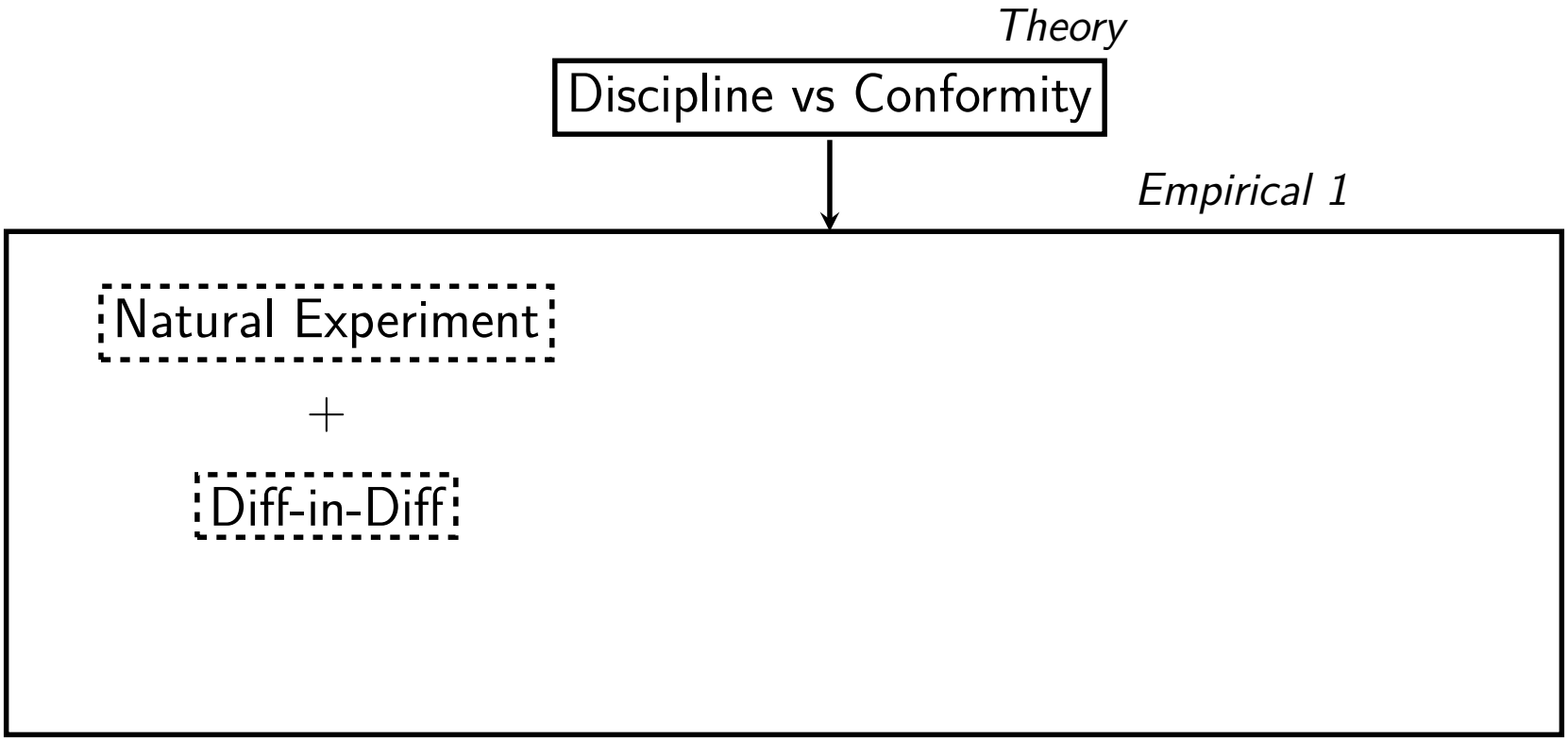

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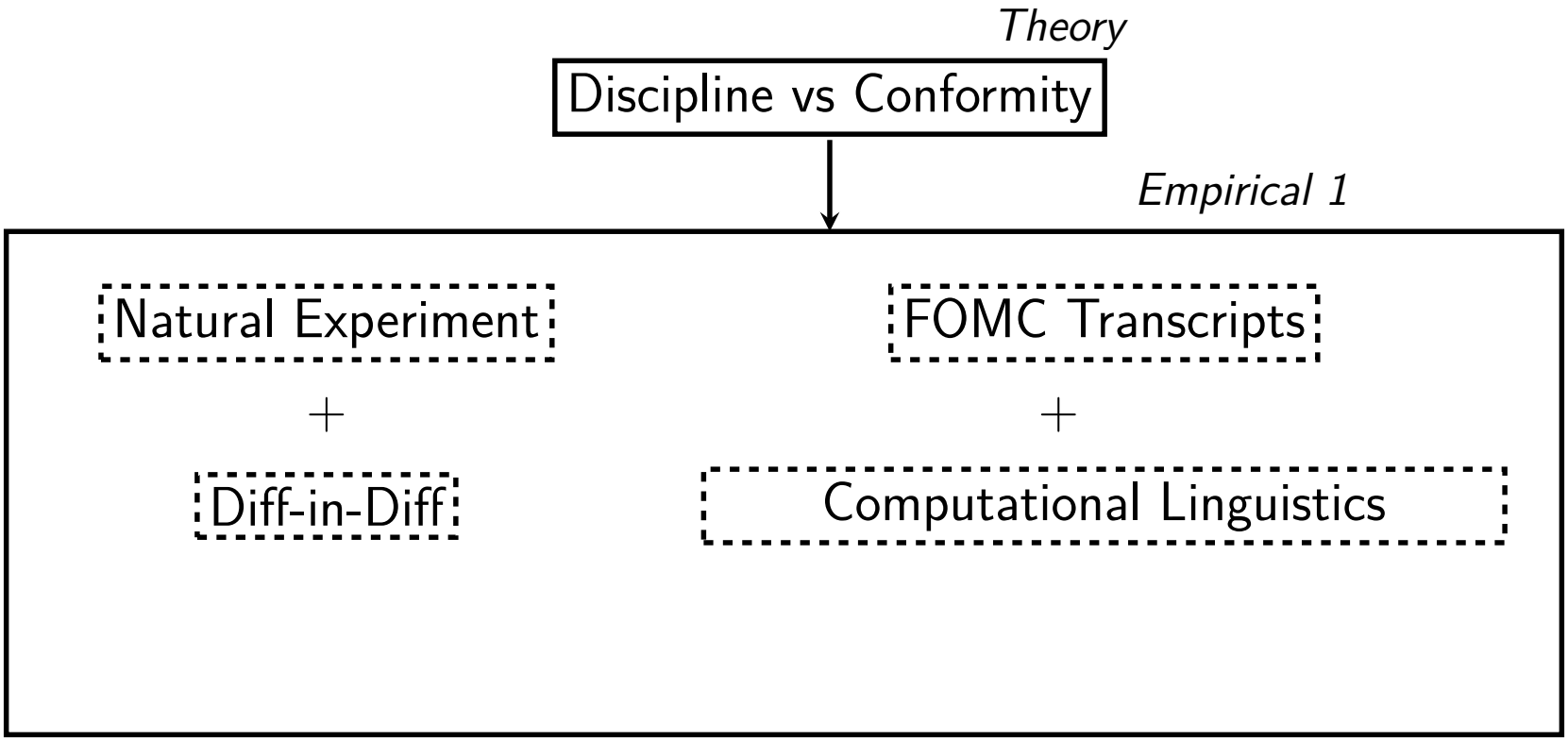

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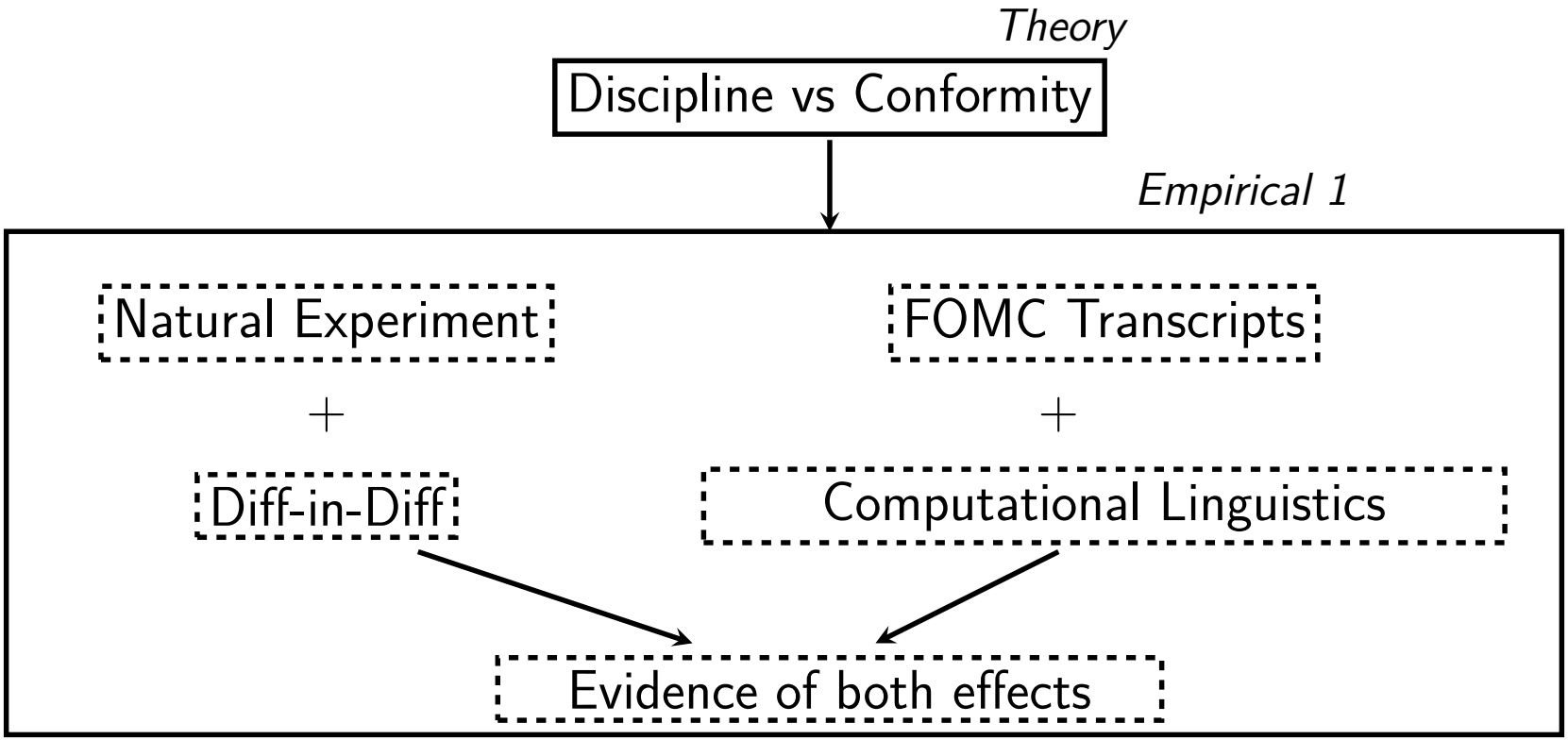

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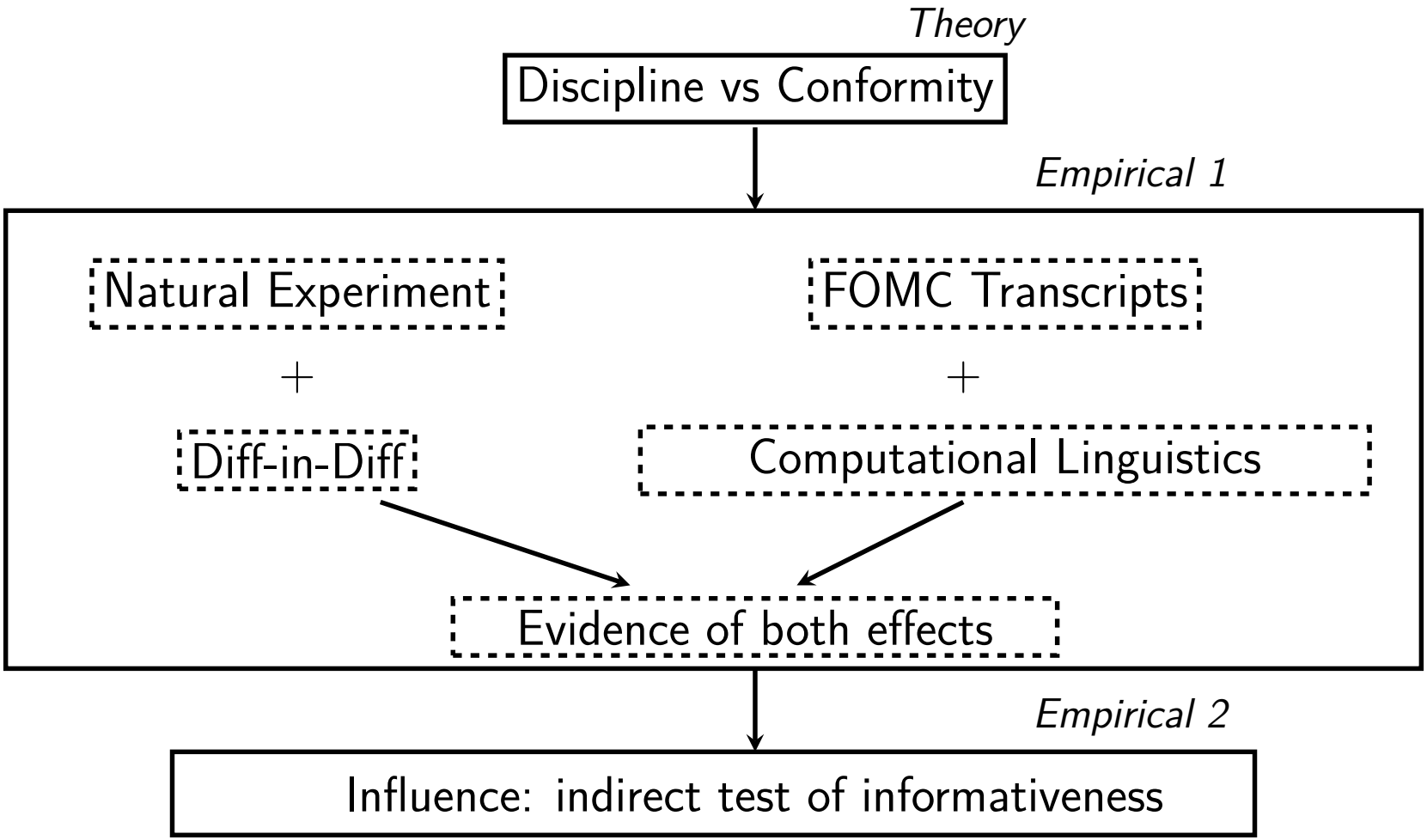

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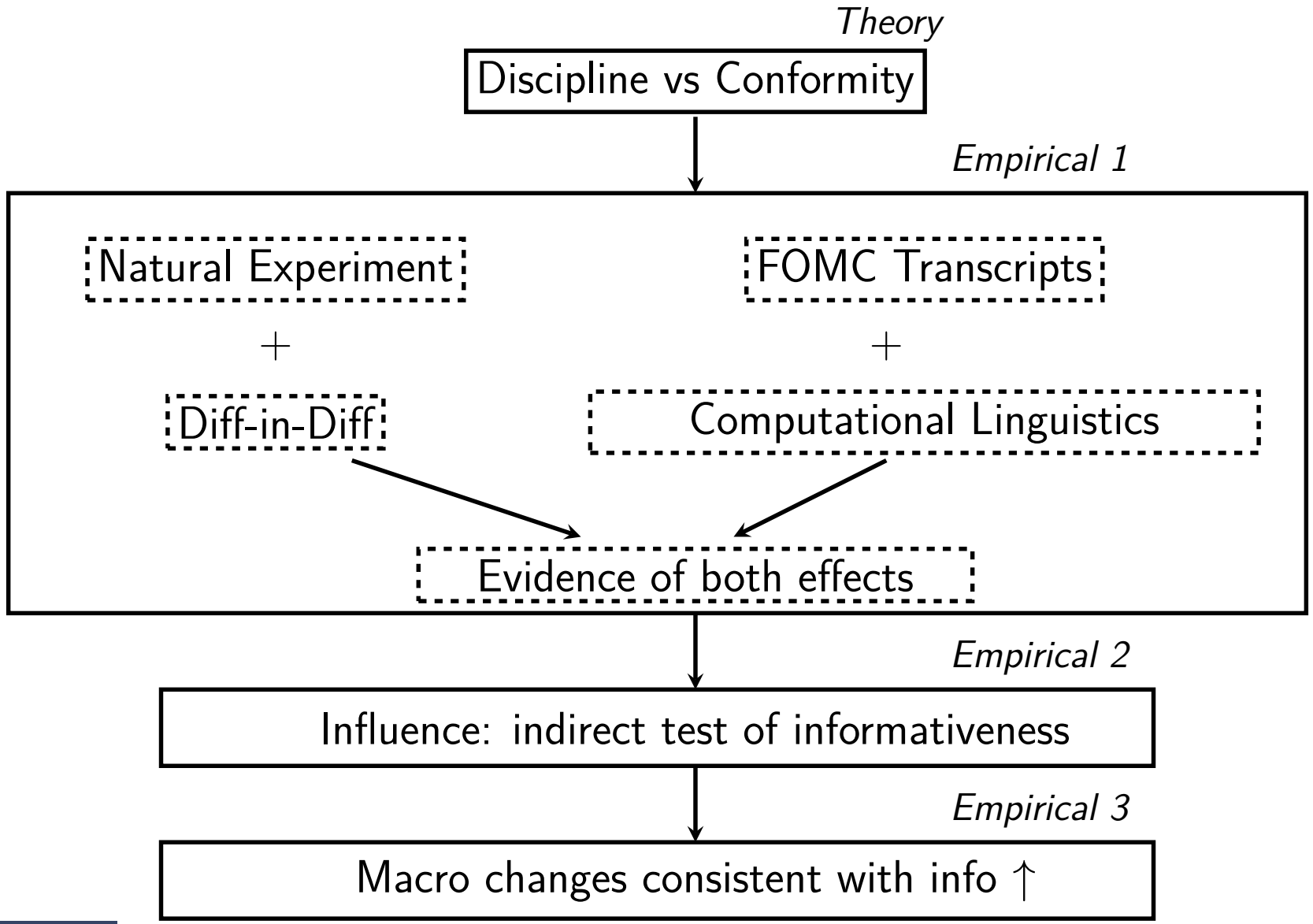

Related Empirical Work

Three main related papers:

- Meade & Stasavage (2008) analyze the effect of transparency on members' incentives to dissent in voice.
- Bailey & Schonhardt-Bailey (2013) analyze FOMC transcripts for three periods of interest (1979-1981, 1991-1993, 1997-1999), focus on arguments and persuasive strategies adopted by policymakers.
- Quinn, Monroe, Colaresi, Crespin, and Radev (2010) use a topic model similar to LDA to study congressional speeches.

Comprehensive Outline

1. FOMC and Data
2. Our empirical strategy
   - The natural experiment
3. Results on counts
4. Results on topic analysis incl topic analysis approach
5. Influence
6. Macro effects
7. Conclusion

APPENDIX: Detailed discussion of the LDA methodology

About the FOMC & Description of our Data

FOMC: Overview

- The FOMC meets 8 times per year to formulate monetary policy.
- The main policy instrument is a target for the Fed Funds rate.
- All meetings last a single day except those that coincide with biannual Monetary Policy Report, which last two days.
- All FOMC members receive briefings in advance:
  1. "Green Book" = staff forecasts
  2. "Blue Book" = staff analysis of monetary policy alternatives
  3. "Beige Book" = Regional Fed analysis of economic conditions
- The FOMC also "meets" via conference calls in between the official face-to-face meetings. These meetings can be about monetary policy (and can even change the Fed Funds target—see 10/98 and 09/01).

FOMC: Personnel

- 7 Governors of the Federal Reserve Board
  - Presidential appointment approved by Senate
  - 14 year terms (with an expiry at the end of January every even-numbered year)
  - 1 is the Chairperson of the Board of Governors who also serves as FOMC chairperson
- 12 Presidents of Regional Federal Reserve Banks
  - Regional Fed presidents are appointed by their own bank's board of nine directors and are approved by the Board of Governors
  - 5 year terms
  - President of the New York Fed as Vice-Chairman of the FOMC

FOMC: Meeting Structure

1. Presentation and discussion of market developments.
2. **Economic Situation Discussion (FOMC 1):**
   - Board staff present the economic situation (including forecast).
   - FOMC members (including those not currently voting) present their views of the economic outlook.
3. **Policy Discussion (FOMC 2):**
   - The Board's director of monetary affairs then presents a variety of monetary policy alternatives (without a recommendation).
   - The Chairman (1st) and the other FOMC discuss their policy preferences.
4. The FOMC votes on the policy decision—FOMC votes are generally unanimous (or close to) but there is more dissent in the discussion.

Transcript Data

- Nearly verbatim records of FOMC meetings available from Fed website with five year lag
- Includes staff statements from appendices
- Use the entire Greenspan era (8/87-1/06): 149 meetings:
  - 46,502 statements
  - Almost 6m words
- Lots of other text data available from Fed
- We have also collected biographical information on FOMC members

Our empirical strategy

Baseline Regressions

Diff

$$y_t = \alpha + \beta D(Trans) + \lambda X_t + \varepsilon_t$$

Diff-in-Diff

$$y_{it} = \alpha_i + \delta_t + \beta D(Trans) + \eta FedExp + \phi\,(D(Trans) \times FedExp) + \epsilon_{it}$$

- Where:
  - $D(Trans)$ is a transparency dummy (1 after November 1993)
  - FedExp measures experience in the Fed System
  - X_t is a vector of macro controls for the diff regressions
- Main sample is 8 years around our natural experiment
- Driscoll-Kraay standard errors
- Placebo test and triple-diff analysis in the paper

Our Natural Experiment

- A natural experiment we exploit to assess the effect of transparency:
  - Prior to Nov 1993: Discussion took place under the assumption that individual statements would not be on the public record
  - After Nov 1993: Each policy maker knew that every spoken word would be public within five years.

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- FOMC meetings were recorded and transcribed from at least the mid-1970's in order to assist with the preparation of the minutes.
- Committee members were unaware that transcripts were stored prior to late 1993
- October 1993: Alan Greenspan acknowledged the transcripts' existence to the Senate Banking Committee.
- The Fed then quickly agreed:
  - To begin publishing them with a five-year lag.
  - To publish the back data

Natural Experiment - FOMC members reaction (Oct 1993)

President Keehn: "Until 10 minutes ago I had no awareness that we did have these detailed transcripts."

President Boehne: "...to the very best of my recollection I don't believe that Chairman Burns or his successors ever indicated to the Committee as a group that these written transcripts were being kept. What Chairman Burns did indicate at the time when the Memorandum was discontinued was that the meeting was being recorded and the recording was done for the purpose of preparing what we now call the minutes but that it would be recorded over at subsequent meetings. So there was never any indication that there would be a permanent, written record of a transcript nature. .... So I think **most people in the subsequent years proceeded on that notion that there was not a written transcript in existence.** And I suspect that many people on this conference call may have acquired this knowledge at about the same time that Si Keehn did."

Measuring career concerns with Fed Experience

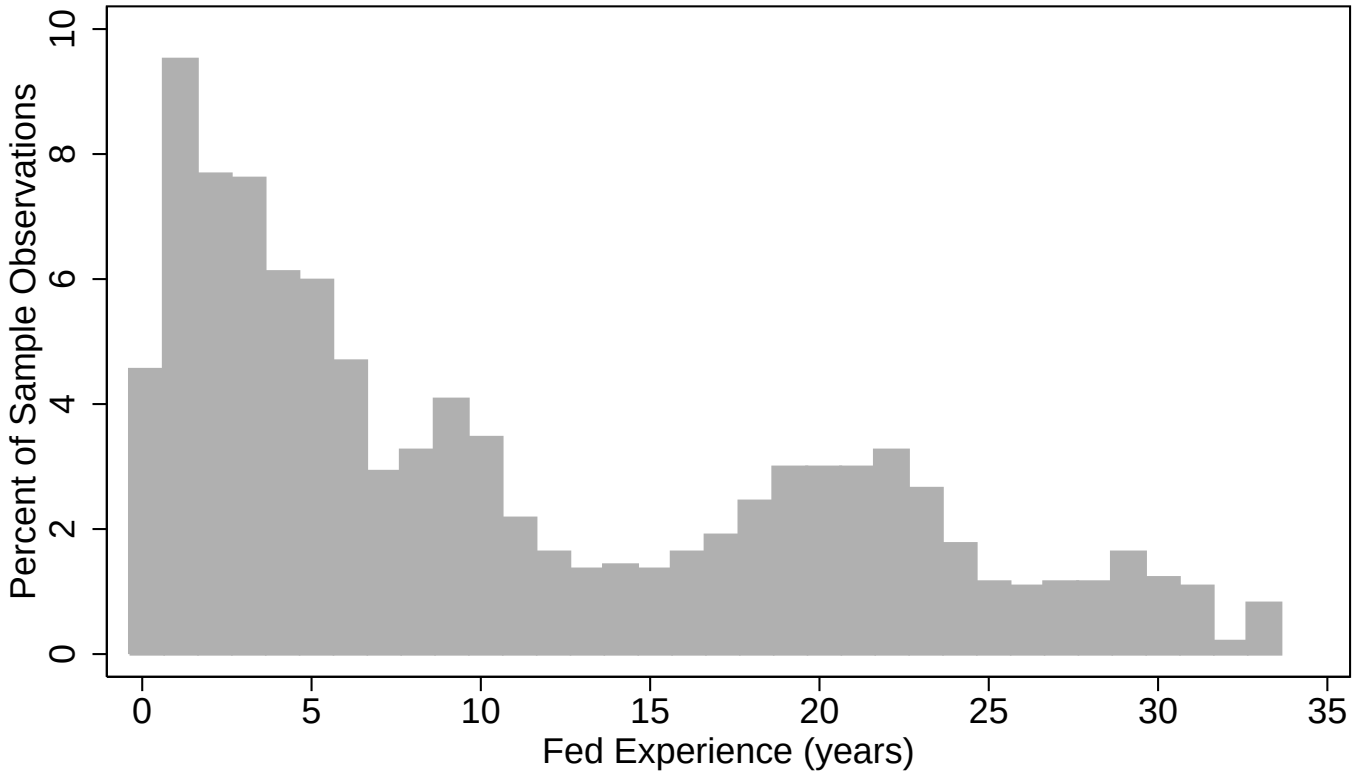
Holmstrom (1999, proposition 1)

The strength of career concerns increases in $\sigma^2_{\theta,i}$ - the variance in the principal's belief about member i's type θ.

- Our measure of the extent of career concerns is *FedExp*
- Captures:
  - the number of years that a person has spent working in the Fed system (prior to FOMC)
  - years on the FOMC

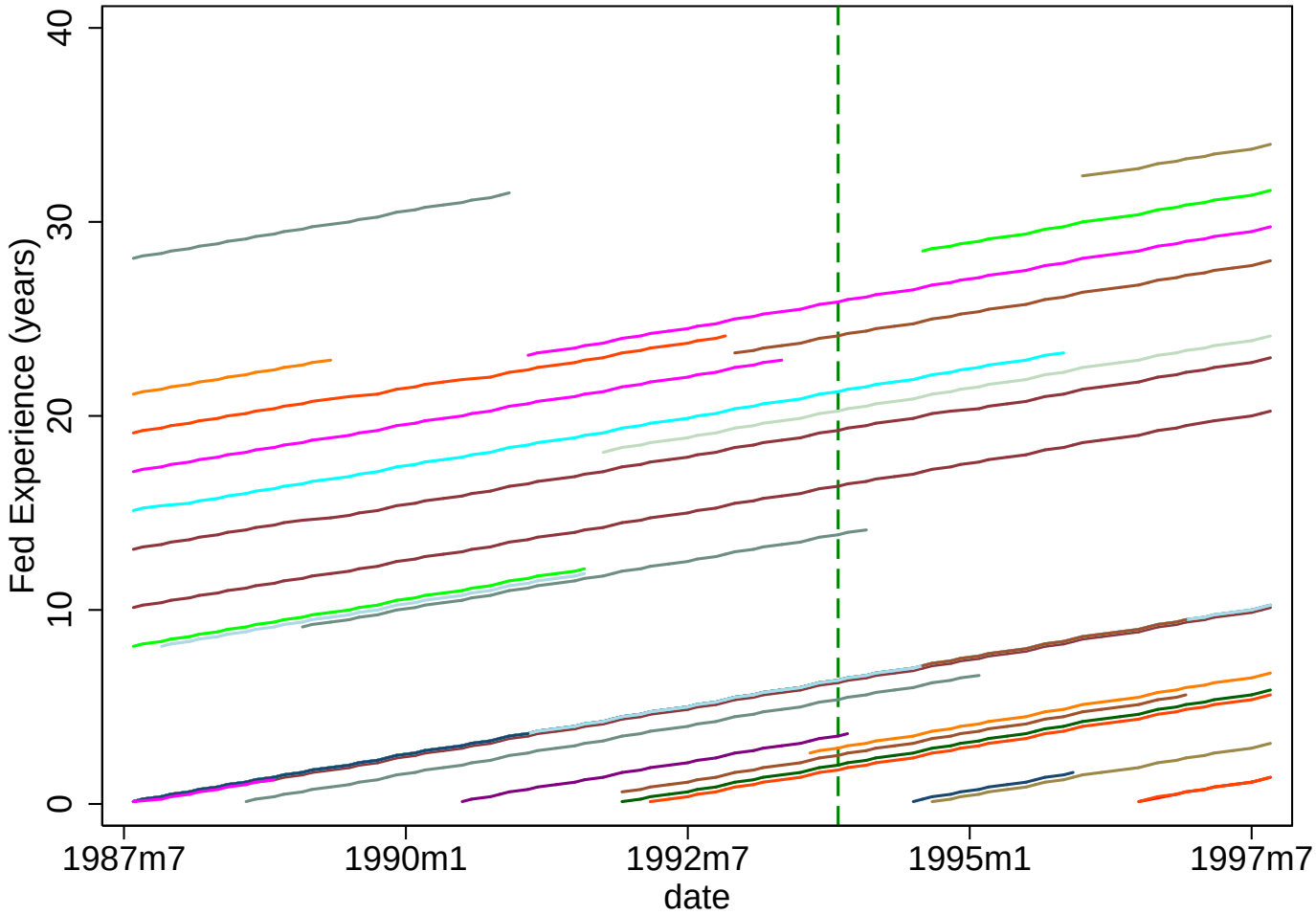
Measuring career concerns with Fed Experience

Histogram of $FedExp_{i,t}$



Measuring career concerns with Fed Experience

Time-series of $FedExp_{i,t}$



Computational Linguistics / Natural Language Processing

- Advanced (and advancing) algorithms for the analysis of text
- Identifying particular words or phrases is trivial
- We measure attention using the Latent Dirichlet Allocation
  - an unsupervised machine learning algorithm for NLP.
  - The article that introduced it (Blei, Ng, and Jordan 2003) has over 7,000 citations, but only just attracting interest in economics.
  - LDA (and its extensions) estimates what fraction of each document in a collection is devoted to each of several "topics."
  - Great promise for economics more broadly.

Dependent Variables

1. Counts of discussion
   - How much someone speaks - words
   - How many statements they make
   - How many questions they ask
2. Measures of what people talk about (LDA)
   - Measure of prepared nature of statements
   - Breadth of their discussion
   - How different their discussion is compared with the Chair
3. Measures of influence
4. Macro regressions

Using simple counts of the transcripts

Language measures - Meeting level

Main Regressors	(1) Total Words	(2) Statements	(3) Questions	(4) Sentences	(5) Words/Statement
D(Trans)	1,005**	-20.1***	-5.62**	67.7***	42.4***
	[0.038]	[0.007]	[0.044]	[0.009]	[0.001]
Serving FOMC members	375	-0.22	-0.25	21.9*	1.32
	[0.101]	[0.944]	[0.849]	[0.061]	[0.824]
D(NBER recession)	487	-13.9	-5.35	5.89	29.8
	[0.394]	[0.173]	[0.271]	[0.846]	[0.172]
D(2 Day)	720*	20.3**	8.87***	52.4**	-31.7***
	[0.079]	[0.047]	[0.008]	[0.022]	[0.006]
Uncertainty(t-1)	1.01	-0.052*	-0.0086	0.026	0.083**
	[0.659]	[0.095]	[0.438]	[0.825]	[0.035]
Constant	230	97.0	29.2	-4.22	68.5
	[0.955]	[0.102]	[0.243]	[0.984]	[0.540]
R-squared	0.314	0.166	0.167	0.344	0.348
Lag Dep. Var?	Yes	Yes	Yes	Yes	Yes
Meeting Section	FOMC1	FOMC1	FOMC1	FOMC1	FOMC1
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	79	79	79	79	79

Language measures - Meeting level

Main Regressors	(1) Total Words	(2) Statements	(3) Questions	(4) Sentences	(5) Words/Statement
D(Trans)	283	-51.6***	-16.4***	-12.5	51.8***
	[0.672]	[0.001]	[0.000]	[0.715]	[0.000]
Serving FOMC members	-184	-1.15	-1.35	-8.75	-4.19
	[0.543]	[0.785]	[0.262]	[0.545]	[0.345]
D(NBER recession)	-401	-5.29	-5.04	-28.9	-1.67
	[0.703]	[0.829]	[0.539]	[0.628]	[0.785]
D(2 Day)	1,632**	8.33	5.77	75.0**	12.7
	[0.013]	[0.495]	[0.165]	[0.023]	[0.121]
Uncertainty(t-1)	-0.27	-0.035	-0.020*	-0.014	0.013
	[0.914]	[0.429]	[0.079]	[0.909]	[0.613]
Constant	9,574*	130	51.5**	498*	125
	[0.093]	[0.114]	[0.027]	[0.072]	[0.114]
R-squared	0.085	0.179	0.177	0.071	0.468
Lag Dep. Var?	Yes	Yes	Yes	Yes	Yes
Meeting Section	FOMC2	FOMC2	FOMC2	FOMC2	FOMC2
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	79	79	79	79	79

Language measures - Member level

Main Regressors	(1) Total Words	(2) Statements	(3) Questions	(4) Total Words	(5) Statements	(6) Questions
D(Trans)	-1,481	-17.8*	-1.78	241***	3.15	1.62*
	[0.384]	[0.094]	[0.676]	[0.009]	[0.198]	[0.093]
Fed Experience	250	2.61	0.23	464**	-6.55	-3.68**
	[0.331]	[0.106]	[0.721]	[0.016]	[0.137]	[0.050]
D(Trans) x Fed Experience	-0.54	0.033	0.0052	-2.44	0.13***	0.047***
	[0.761]	[0.226]	[0.663]	[0.359]	[0.007]	[0.004]
Constant	-876	-11.8	-0.11	-5,363**	79.9	44.0**
	[0.559]	[0.206]	[0.976]	[0.019]	[0.126]	[0.048]
Number of groups	38	38	38	38	38	38
Member FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Within Meeting	FOMC1	FOMC1	FOMC1	FOMC2	FOMC2	FOMC2
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	1449	1449	1449	1432	1432	1432
% Rookie effect	-	-	-	-	-36.9	-67.5

Analysis of what people talk about

The Latent Dirichlet Allocation (LDA) model

- LDA is an unsupervised learning approach - we don't set probabilities
  - JSTOR example
  - query expansion idea with topic allocations

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4. Model also generates θ_d **document distributions**

Example statement: Yellen, March 2006, #51

Raw Data → Remove Stop Words → Stemming → Multi-word tokens = Bag of Words

We have noticed a change in the relationship between the core CPI and the chained core CPI, which suggested to us that maybe something is going on relating to substitution bias at the upper level of the index. You focused on the nonmarket component of the PCE, and I wondered if something unusual might be happening with the core CPI relative to other measures.

Example statement: Yellen, March 2006, #51

Raw Data → Remove Stop Words → Stemming → Multi-word tokens = Bag of Words

noticed change relationship between core CPI
chained core CPI suggested maybe something going
relating substitution bias upper level index focused
nonmarket component PCE wondered something
unusual happening core CPI relative measures

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Raw Data → Remove Stop Words → Stemming → Multi-word tokens = Bag of Words

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Federal Funds Rate → fed fund rate → ffr
monetary policy → monetari polici → monpol

Example statement: Yellen, March 2006, #51

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notic chang relationship between core CPI
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relat substitut bia upper level index focus
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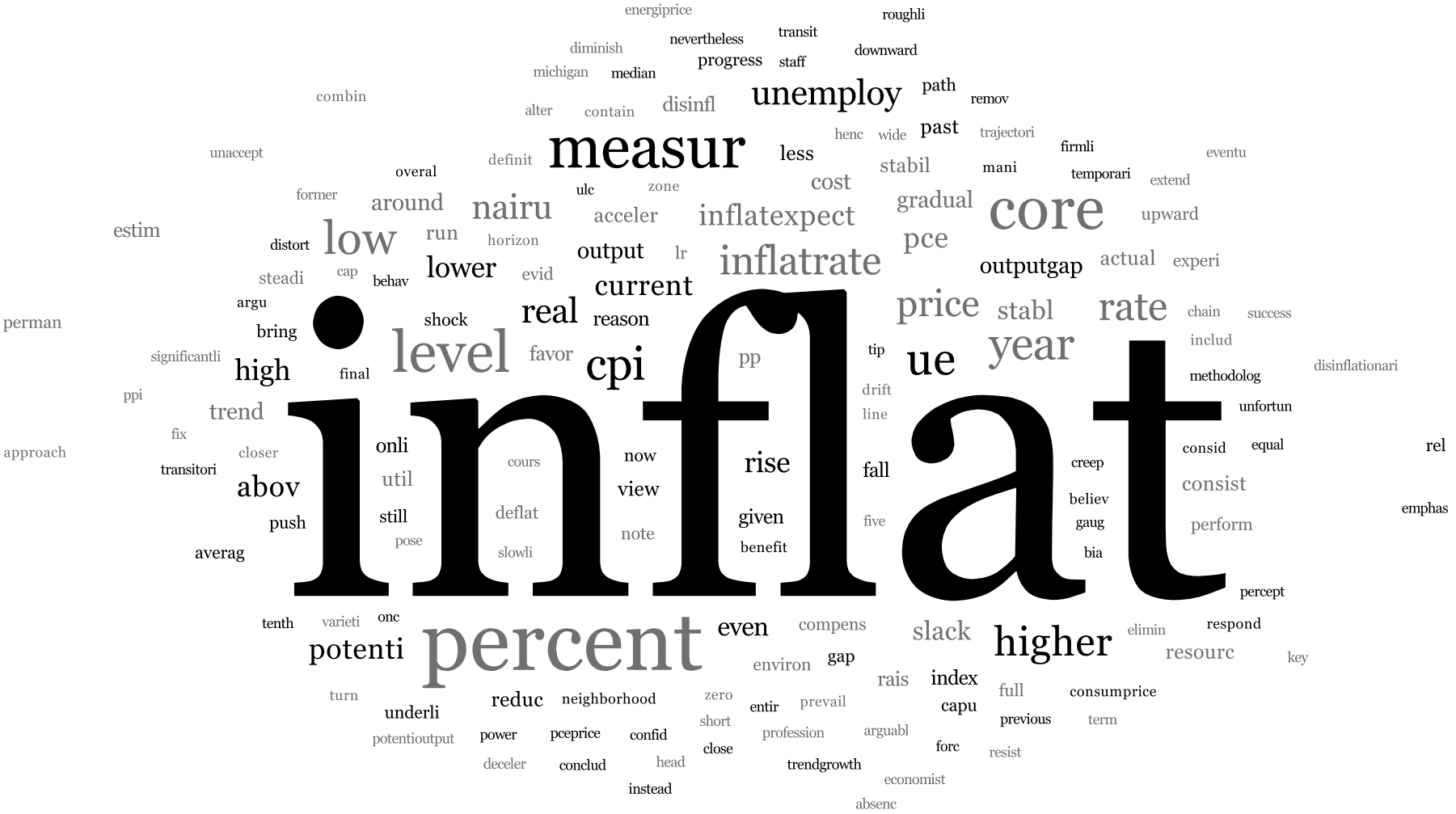
Example statement: Yellen, March 2006, #51

Allocation

			17			39					39				1				25		25			
41			25		25			25							36			36					38
43				25				20				25		39					16				23
		25				25						25				32					38		
16						4						25		25	16							25	

Topic 25 - Inflation



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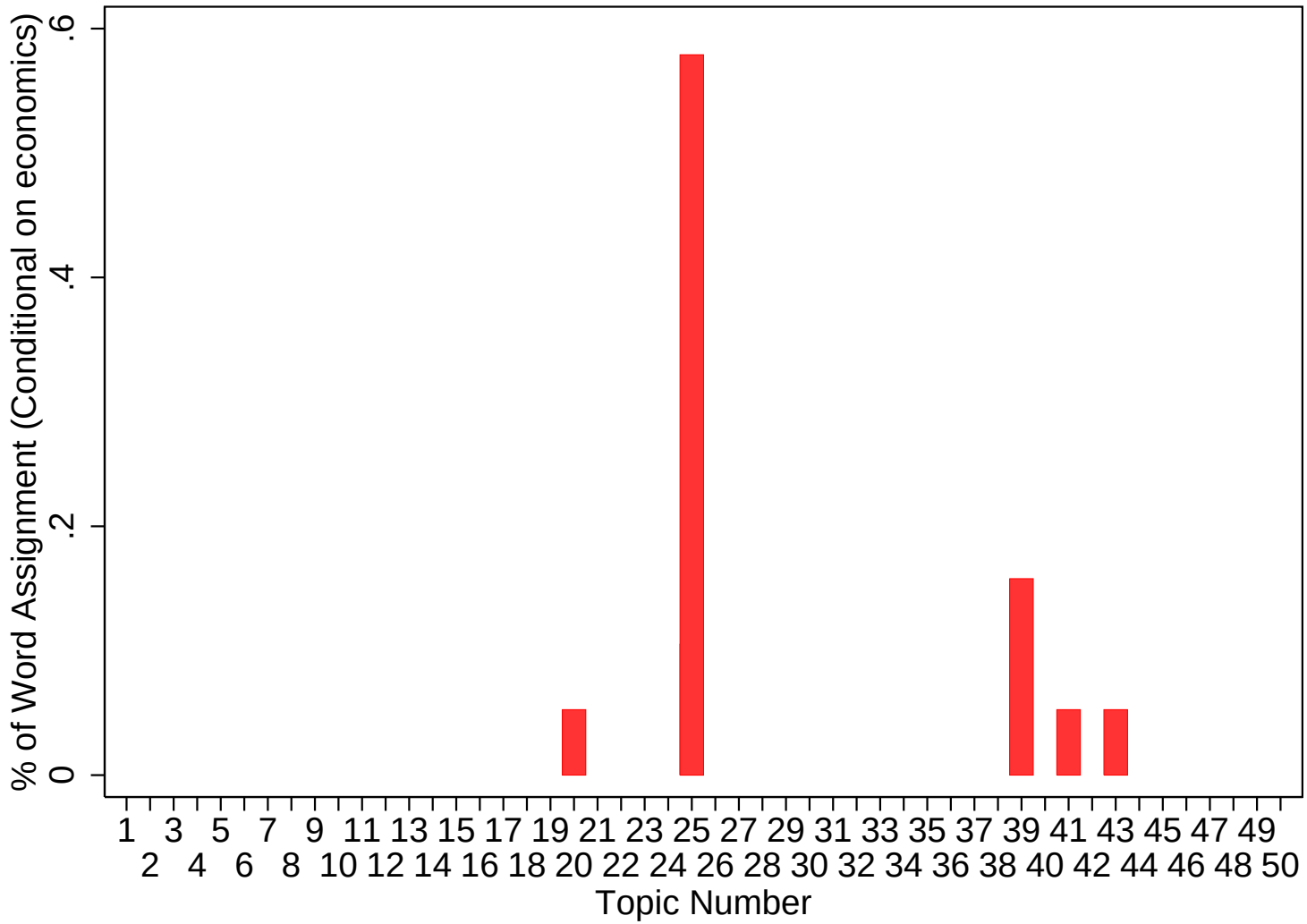
Conditional Topic Distribution - $\mathbb{E}[\theta_d \mid W_d, \beta_K]$

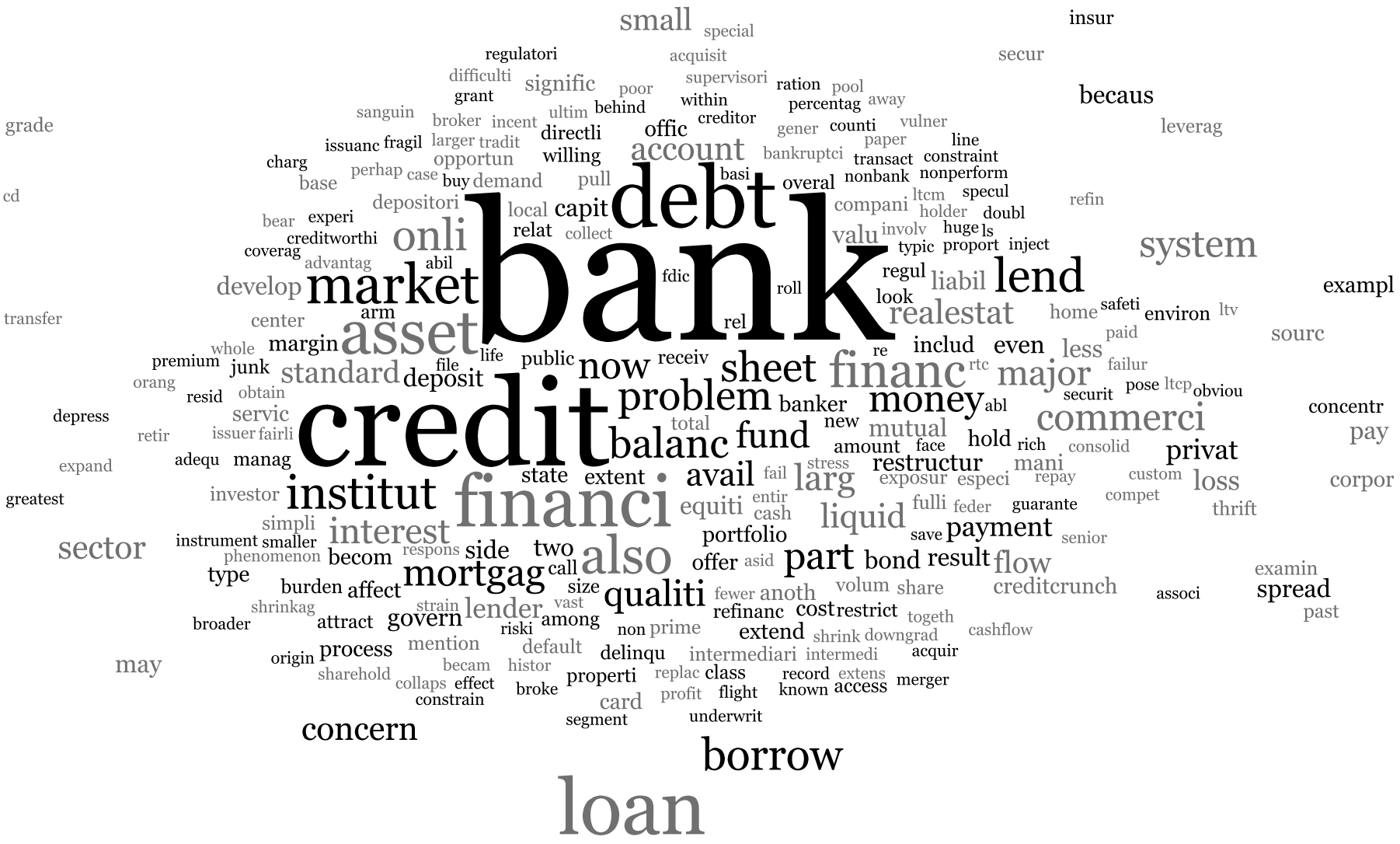


Topic 2 - Monetary Policy Objective

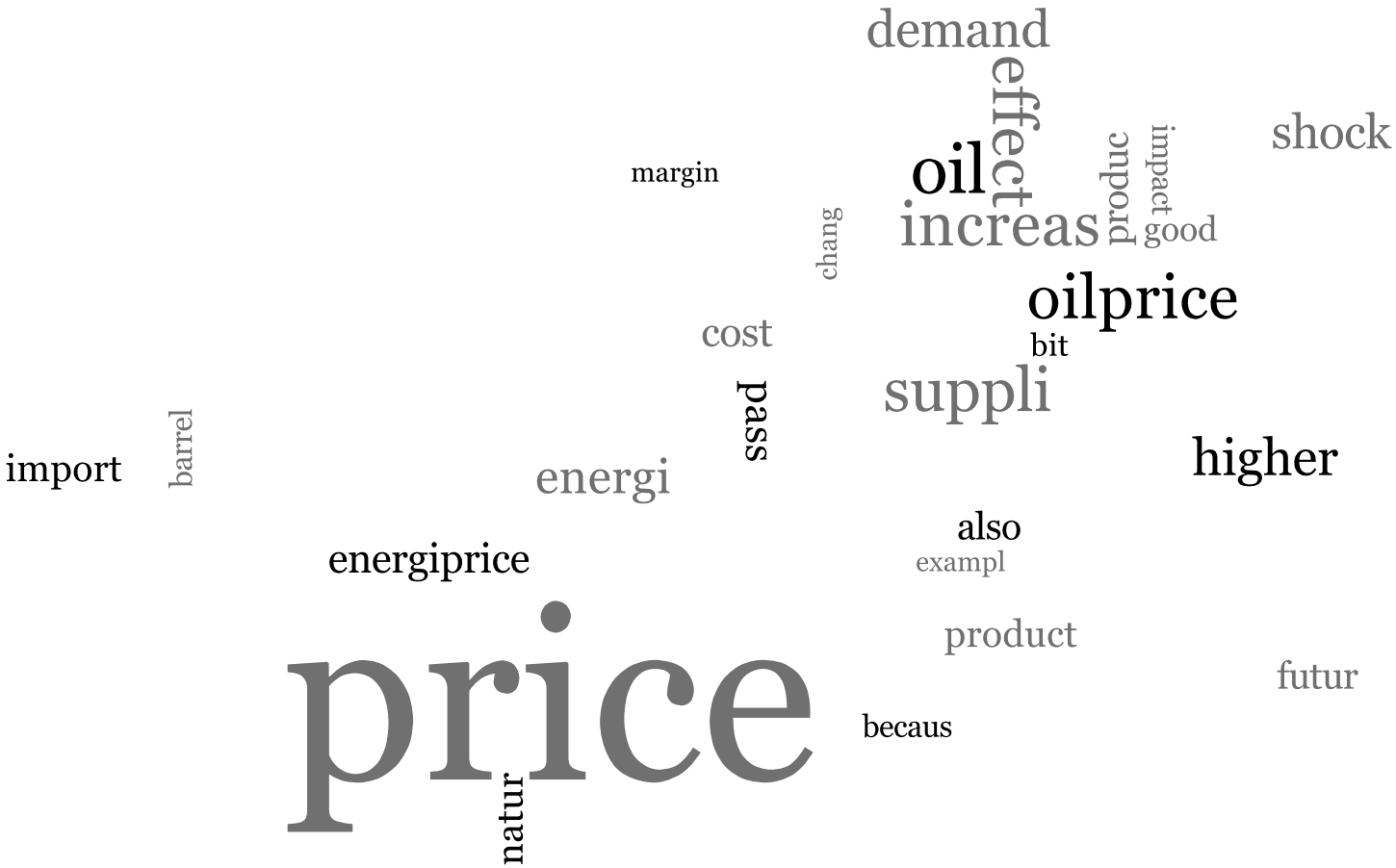
Topic 29 - Productivity

Topic 23 - Consumption and Investment demand

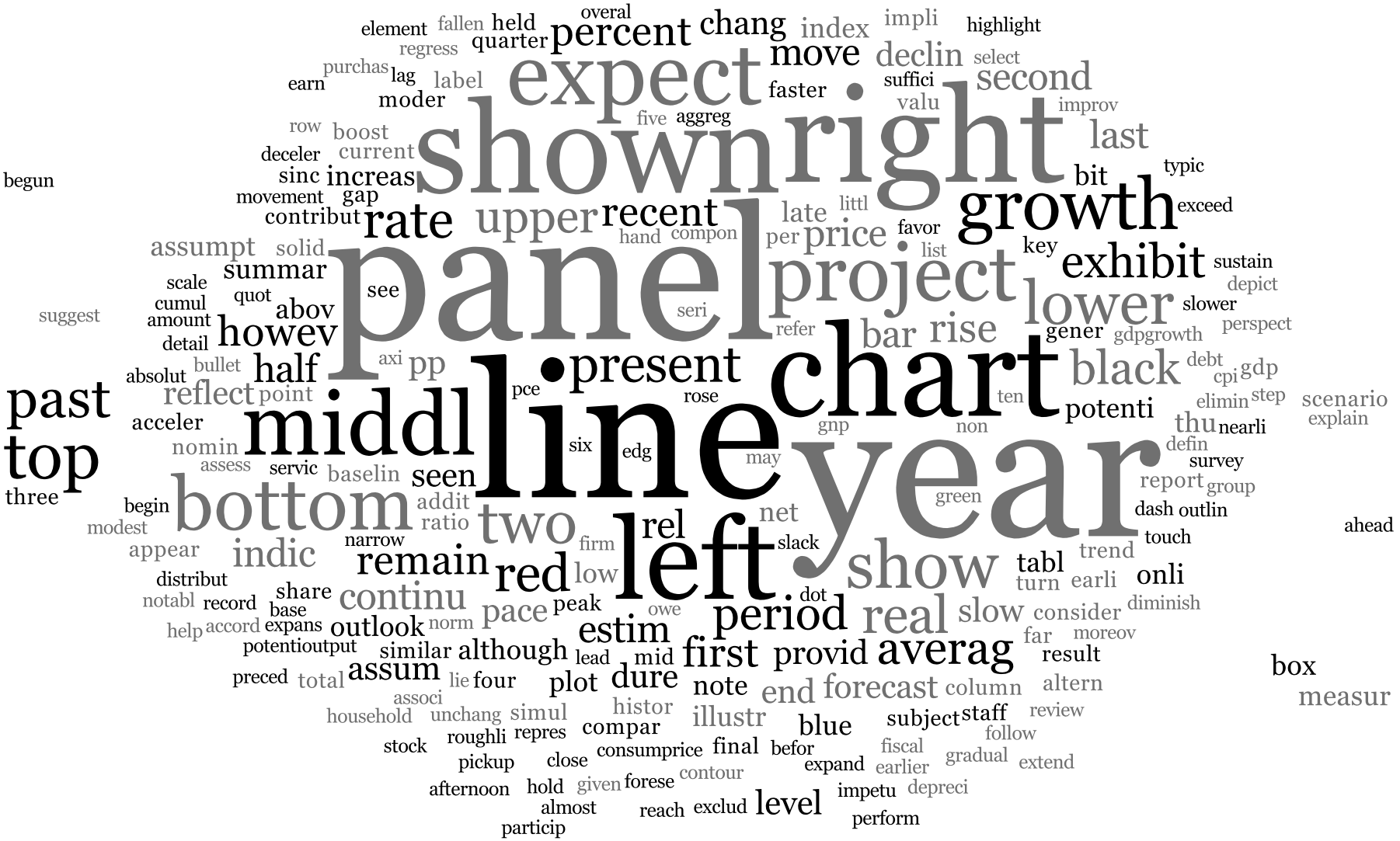
Topic 38 - Banking



Topic 1 - Oil and Commodities



Topic 22 - Referring to figures (staff materials)



Topic 7 - Data topic

Topic 0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case
fair
attitud
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hard
find
feel
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perhap
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lot
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comment
good
modest
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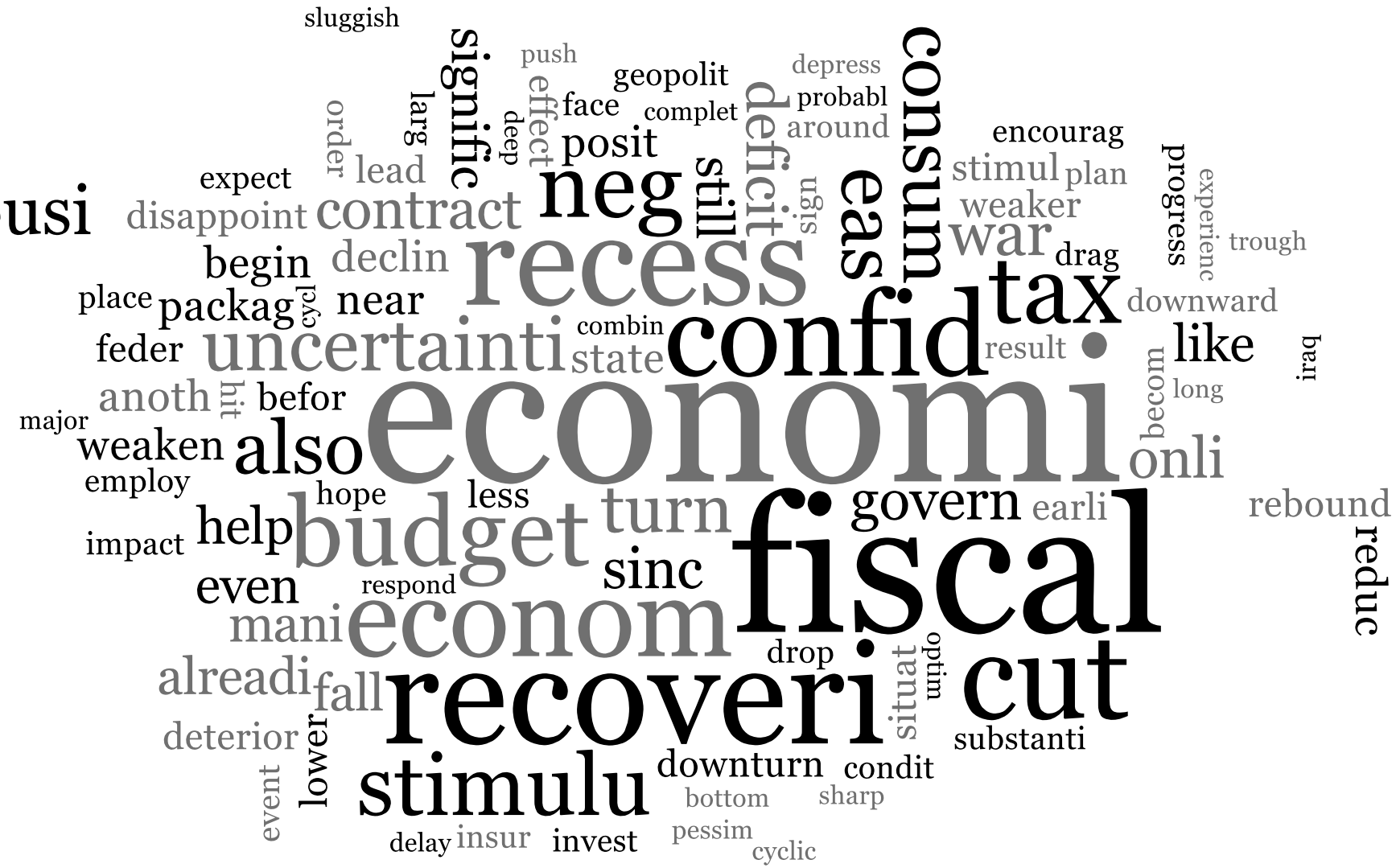
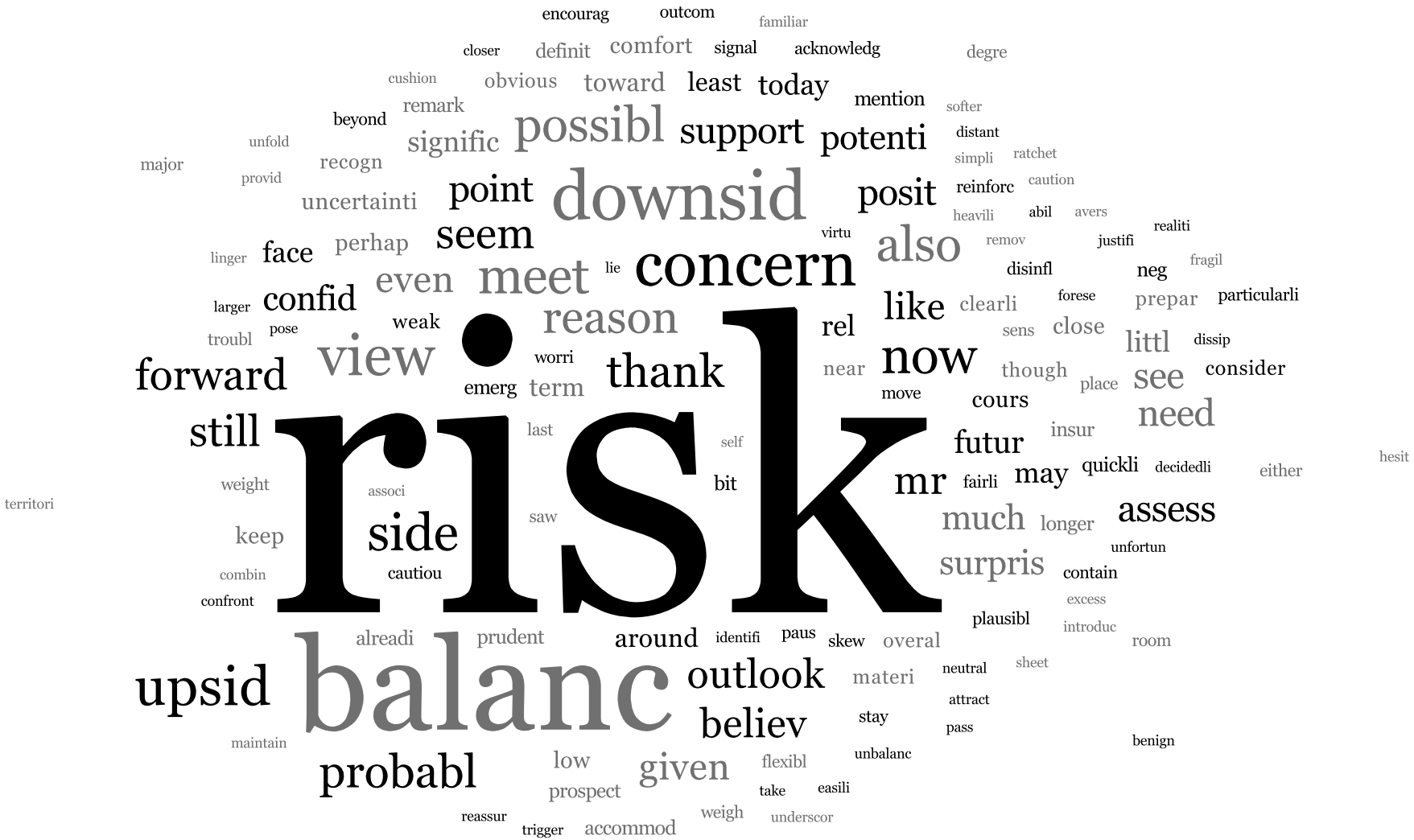
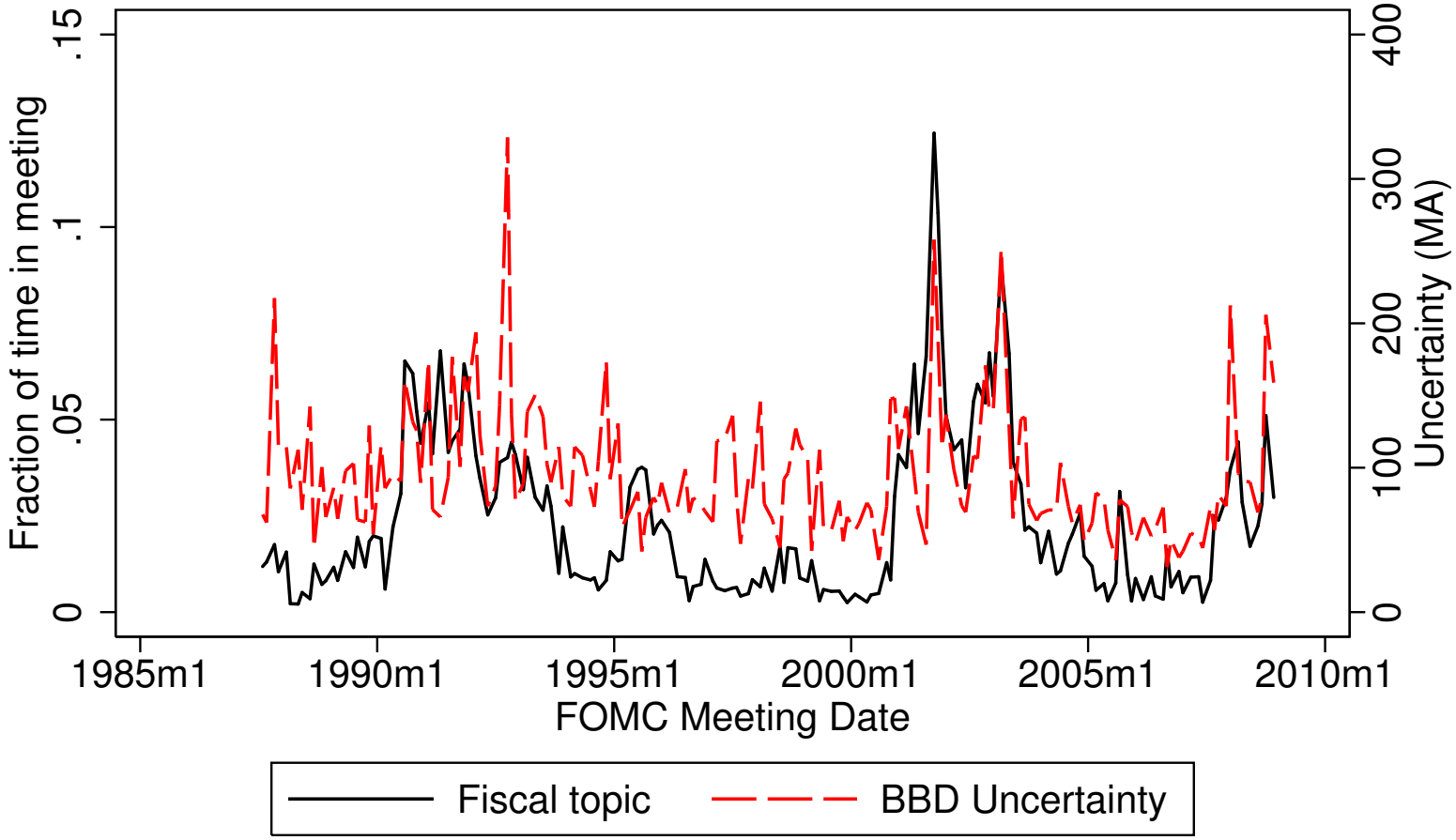
Topic 45 - Fiscal



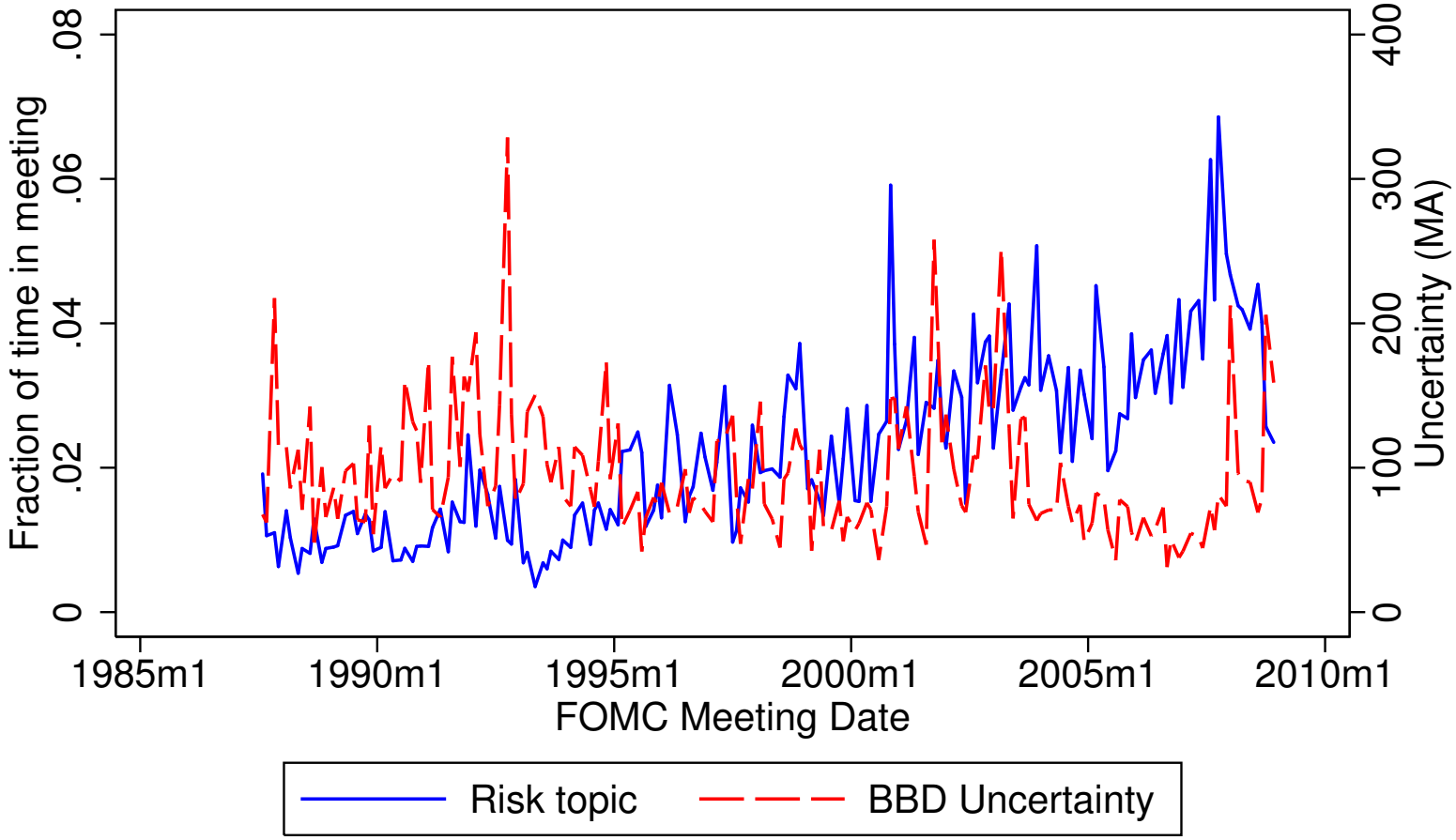
Topic 40 - Risk



BBD Uncertainty and Discussion of "Fiscal Topic"



BBD Uncertainty and Discussion of "Risks Topic"



Topic vectors and measures from them

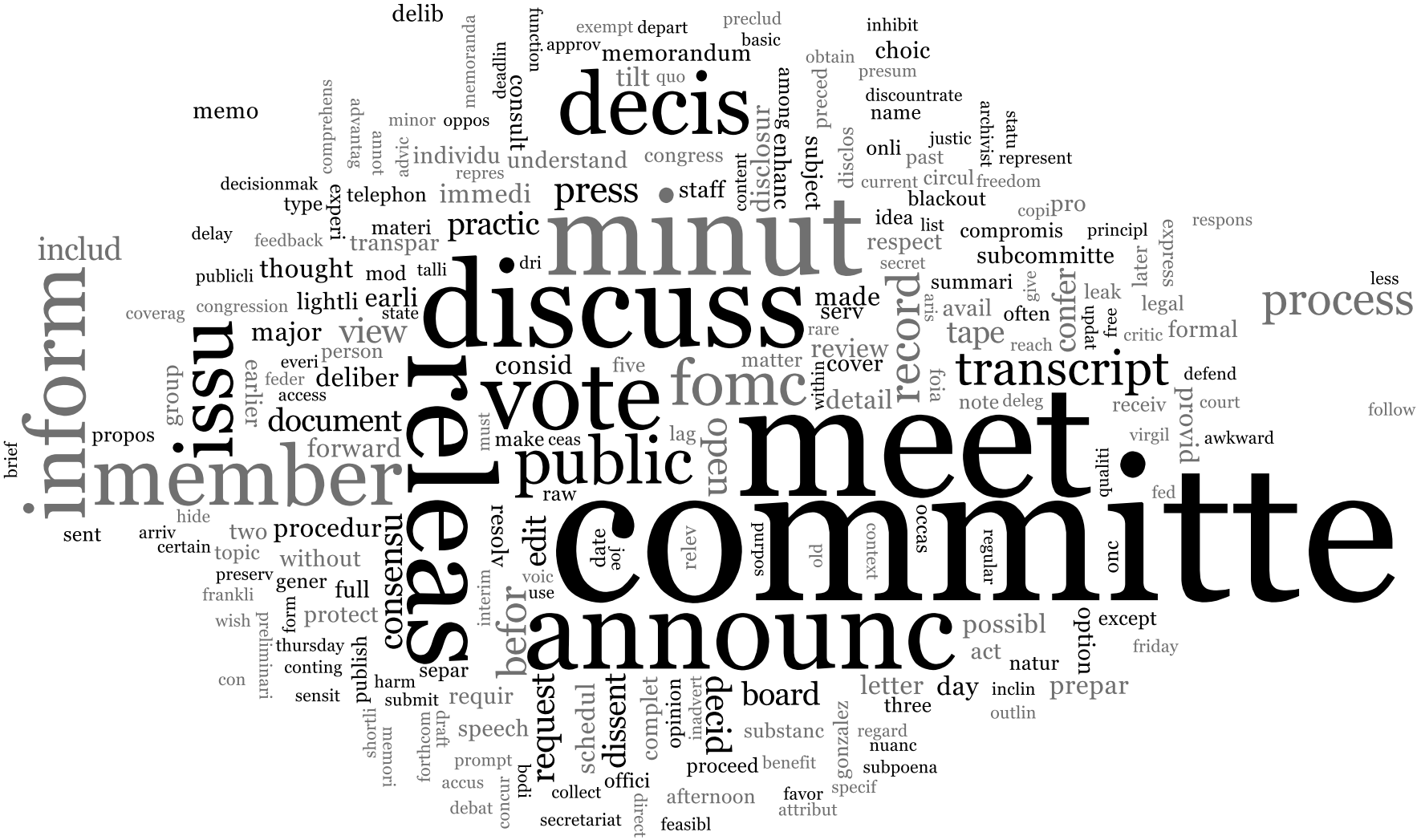
So we have a $Kx1$ vector of allocated attention for each member in each meeting section:

1. Measure of prepared nature of statements
   - Whether the topics discussed are more specifically about economics (subjectively defined)
2. Breadth of their discussion
   - Herfindahl concentration index
3. How different their discussion is compared with the Chair
   - Dot product between member i and Chair (C) vectors:

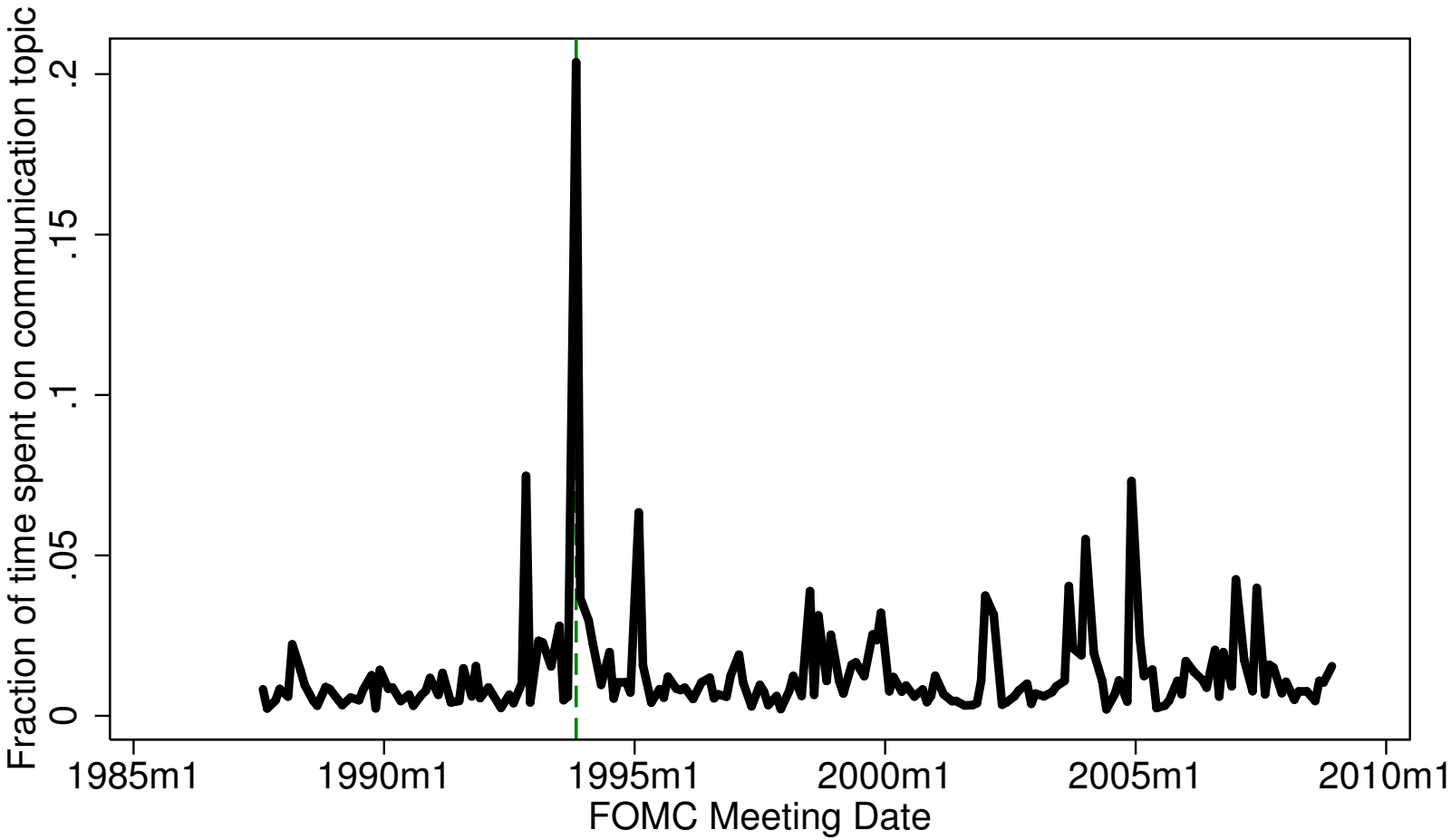
$$SG_{i,t.s} = \boldsymbol{\chi}_{i,t,s} \cdot \boldsymbol{\chi}_{G,t,s} \tag{1}$$

where $\boldsymbol{\chi}_{G,t,s}$ is the index of Greenspan's allocation of attention.

Topic 6 - CB communication



Topic 16 Discussion: Surprised by transparency revelation?



Topics discussed I - Member level

Main Regressors	(1) Economics	(2) Economics	(3) Herfindahl	(4) Herfindahl
D(Trans)	1.43***	-0.041	-0.21***	-0.10
	[0.003]	[0.908]	[0.002]	[0.323]
Fed Experience	-0.22***	0.0081	0.035***	0.017
	[0.003]	[0.878]	[0.001]	[0.267]
D(Trans) x Fed Experience	0.00021	-0.0014**	0.00071**	-0.00037***
	[0.622]	[0.015]	[0.035]	[0.000]
Constant	1.86***	0.56*	-0.12*	-0.030
	[0.000]	[0.073]	[0.050]	[0.737]
Number of groups	38	38	38	38
Member FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Within Meeting	FOMC1	FOMC2	FOMC1	FOMC2
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	1449	1431	1449	1431
% Rookie effect	-	4.7	-13.0	10.4

Topics discussed II - Member level

Main Regressors	(1) Data Topic (7)	(2) Data Topic (7)	(3) Figures Topic (22)	(4) Figures Topic (22)
D(Trans)	-0.12	0.020	0.0090	-0.035
	[0.239]	[0.729]	[0.743]	[0.267]
Fed Experience	0.019	-0.0038	-0.0011	0.0048
	[0.205]	[0.675]	[0.797]	[0.310]
D(Trans) x Fed Experience	-0.00065***	-0.000098	-0.000088**	0.00011*
	[0.002]	[0.103]	[0.035]	[0.078]
Constant	-0.089	0.041	0.017	-0.015
	[0.325]	[0.431]	[0.488]	[0.594]
Number of groups	38	38	38	38
Member FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Within Meeting	FOMC1	FOMC2	FOMC1	FOMC2
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	1449	1431	1449	1431
% Rookie effect	43.9	-	11.7	-14.2

Distance - Member level

Main Regressors	(1) SG(it)	(2) SG(it)
D(Trans)	0.00085	-0.054*
	[0.987]	[0.089]
Fed Experience	-0.0020	0.0090*
	[0.805]	[0.067]
D(Trans) x Fed Experience	-0.00015	-0.00023***
	[0.452]	[0.000]
Constant	0.056	-0.0084
	[0.223]	[0.767]
Number of groups	38	38
Member FE	Yes	Yes
Time FE	Yes	Yes
Within Meeting	FOMC1	FOMC2
Sample	87:08-97:09	87:08-97:09
Obs	1449	1431
% Rookie effect	-	9.9

The overall effect of transparency on information content

Influence

What is influence?

When what member i talks about affects what member j talks about, we call this influence. We use a standard measure as in Palacios-Huerta and Volij (2004).

- v_{it} is member i's influence on Chairman Greenspan.
- v_{it}^{G} is member i's influence on Chairman Greenspan.
- d_{it} uses i's FOMC1 + FOMC2 statement in meeting t to predict other members' FOMC2 statements in meeting $t+1$.
- d_{it}^{G} is inter-meeting influence on Greespan.

Meyer - A Term at the Fed (2004)

"The Chairman's disproportionate influence on FOMC decisions, his efforts to build consensus around his policy recommendations before FOMC meetings, and the strong tendency for Committee members to support the majority view - all these were secrets of the temple that I learned at my first FOMC meeting."

*"**So was the FOMC meeting merely a ritual dance?** No. I came to see policy decisions as often evolving over at least a couple of meetings. The seeds were sown at one meeting and harvested at the next. **So I always listened to the discussion intently, because it could change my mind, even if it could not change my vote at that meeting.** Similarly, while in my remarks to my colleagues it sounded as if I were addressing today concerns and today policy decisions, in reality I was often positioning myself, and my peers, for the next meeting."*

Influence - Member level

Main Regressors	(1) w_{it}	(2) a_{it}	(3) w_{it}^G	(4) a_{it}^G
D(Trans)	0.093**	-0.040	0.0039	-0.018***
	[0.041]	[0.273]	[0.507]	[0.000]
Fed Experience	-0.0093**	-0.0041	-0.00036	0.00031
	[0.045]	[0.284]	[0.551]	[0.547]
D(Trans) x Fed Experience	-0.000023	-0.00010***	-7.2e-06*	-0.000027***
	[0.593]	[0.000]	[0.062]	[0.000]
Constant	0.11***	0.16***	0.0053	0.018***
	[0.000]	[0.000]	[0.133]	[0.000]
Number of groups	38	35	38	35
Member FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Within Meeting	Intra	Inter	Intra	Inter
Sample	87:08-97:09	87:08-97:09	87:08-97:09	87:08-97:09
Obs	1427	1377	1427	1377
% Rookie effect	-	3.6	4.5	15.7

Supportive evidence in more macro analysis?

Gradualism before and after transparency

Main Regressors	(1) FFR_t	(2) FFR_t	(3) FFR_t
Expected inflation	-0.15	0.26***	-0.053
	[0.496]	[0.000]	[0.726]
Expected output gap	0.067	0.069**	0.024
	[0.193]	[0.019]	[0.542]
Expected output growth	0.078**	0.085***	0.100***
	[0.044]	[0.001]	[0.000]
FFR(-1)	1.02***	0.90***	1.03***
	[0.000]	[0.000]	[0.000]
D(Transparent) x Expected Inflation			0.32*
			[0.056]
D(Transparent) x Expected output gap			0.062
			[0.205]
D(Transparent) x Expected real GDP growth			-0.024
			[0.377]
D(Transparent) x FFR(-1)			-0.16*
			[0.090]
Constant	0.32	-0.29*	-0.20
	[0.563]	[0.090]	[0.238]
R-squared	0.986	0.992	0.991
Frequency	Quarterly	Quarterly	Quarterly
Sample	1987:1-1993:4	1994:1-2006:4	1987:1-2006:4
Obs	28	52	80
Method	Prais-Winsten	Prais-Winsten	Prais-Winsten

Effect on market surprises

Main Regressors	(1) |Surprise (GSS)|	(2) |Surprise (K)|
D(Trans)	7.83***	5.36*
	[0.002]	[0.053]
D(NBER recession)	-2.43	-2.08
	[0.351]	[0.505]
D(2 Day)	0.70	0.76
	[0.601]	[0.777]
Uncertainty(t-1)	0.0050	0.0052
	[0.401]	[0.455]
Expected output growth	-0.027	0.42
	[0.971]	[0.616]
Expected inflation	4.00***	3.23*
	[0.006]	[0.058]
Expected output gap	-0.74	-0.83
	[0.139]	[0.256]
Constant	-11.8**	-9.04
	[0.034]	[0.158]
R-squared	0.156	0.063
Lag Dep. Var?	Yes	Yes
Sample	89:11-97:09	89:11-97:09
Obs	71	66

Correlation between market surprises and Greenspan topics

Main Regressors	(1) Surprise (GSS)	(2) Surprise (GSS)
Demand topic	0.11	0.13*
	[0.104]	[0.066]
Productivity topic	-0.12**	-0.14**
	[0.019]	[0.042]
D(NBER Recession)	-0.023	0.0065
	[0.331]	[0.770]
BBD uncertainty	-0.000071	-0.000063
	[0.336]	[0.363]
Expected output growth		0.0089*
		[0.073]
Expected inflation		-0.0057
		[0.416]
Expected output gap		-0.0023
		[0.391]
Constant	0.0036	-0.0096
	[0.766]	[0.755]
R-squared	0.054	0.110
Sample	87:08-06:01	87:08-06:01
Obs	139	139

FOMC influence over Greenspan's key policy topics

Main Regressors	(1) w_{it}^{G*}	(2) a_{it}^{G*}
D(Trans)	-0.045	-0.17***
	[0.154]	[0.000]
Fed Experience	0.0050	0.015***
	[0.132]	[0.000]
D(Trans) x Fed Experience	-0.00011*	-0.00017**
	[0.065]	[0.014]
Constant	-0.025	-0.054**
	[0.198]	[0.027]
Number of groups	38	35
Member FE	Yes	Yes
Time FE	Yes	Yes
Within Meeting	Intra	Inter
Sample	87:08-97:09	89:08-97:09
Obs	1427	1377
% Rookie effect	46.8	76.3

Summary table of effects of transparency

Discipline	**Conformity**
↑ economics topic coverage in FOMC1	↓ statements in FOMC2
↑ references to data topics in FOMC1	↓ questions in FOMC2
	↓ distance from Greenspan in FOMC2
	↓ economics topic coverage in FOMC2
↑ economics topic percentage in FOMC2	

which could lead rookies to exhibit more or less:

Influence

Intra-meeting −

Intra-meeting on Chair ↑

Inter-meeting ↑

Inter-meeting on Chair ↑

+

Macro evidence supports more information in FOMC meetings

Future work

- More analysis of influence
- Ball (2012) and institutional capture
- Testing rational inattention models
- Use in VAR analysis

Topic Modelling

- Algorithmic tools to carry out broadly-defined information retrieval
  - Used for organising, searching, and exploiting large sets of data
- Our case: understand what FOMC members were talking about
- Topic modelling contains 3 steps
  1. Identify hidden topical structures in a corpus of documents
  2. Annotate the documents according these topics
  3. Use the annotated documents for whatever we want to do

Topic Modelling

Two important concepts

We maintain two basic definitions in our language model:

Statement A statement (or document) is a collection of (not necessarily) words and has a distribution over topics which is denoted θ_d. Importantly - a statement can, and typically will, exhibit multiple topics.

Topic A topic is a distribution over vocabulary (which are unqiue words or tokens). The number of topics K is fixed and each topic has its own distribution of vocabulary which is given by β_k - an N dimensional vector indexing all unique words and giving a probability to that word appearing in that topic.

The underlying language generation model

Consider the following model of how the words making up statement d are generated:

1. A member making statement d chooses the distribution of topics that they wish to cover (θ_d) and a statement length N_d is generated randomly from a Poisson distribution.
2. for each word $n \in 1, 2, ..., N_d$, the member draws from θ_d which topic that word will come from. This is the word-topic assignment of word n in statement d denoted $z_{d,n} = k$.
3. given the topic assignment, they select the word $w_{d,n}$ by drawing randomly from the β_k term distribution.
4. The N_d words form the complete statement d.

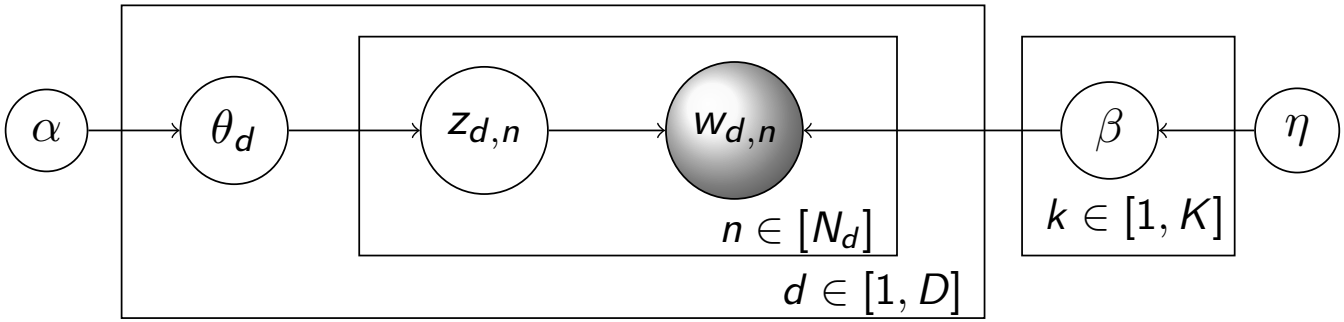
Data Cleaning

LDA is a *bag-of-words model*: word order is unimportant.

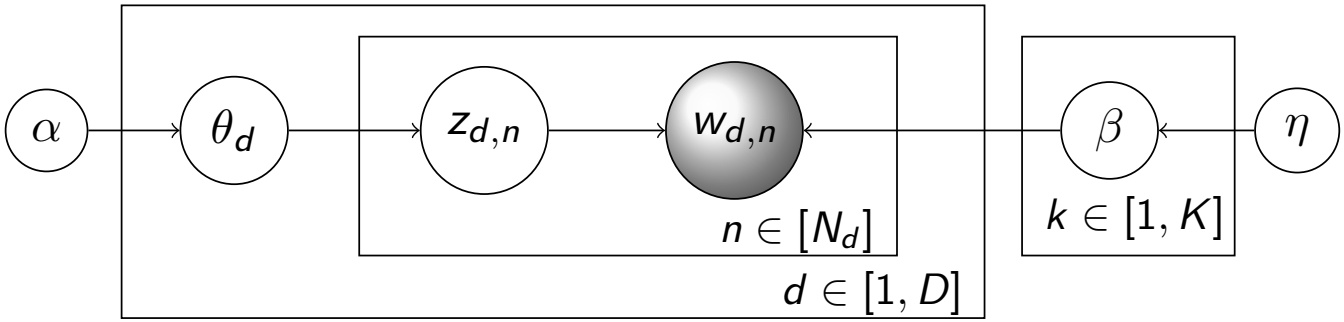
1. Form *multi-word-expressions* ("fed" + "funds" + "rate" becomes "ffr")
2. Remove all punctuation and capitalization
3. Remove *stop-words*: common words that are computationally costly but uninformative
4. Stem the remaining words: transform various semantic forms into common root; e.g. "price" and "prices" become "price"
5. Remove words that appear in less than five statements
6. Drop empty statements

Results: 7,292 unique tokens; 2,950,844 total tokens; 49,954 statements

LDA Model



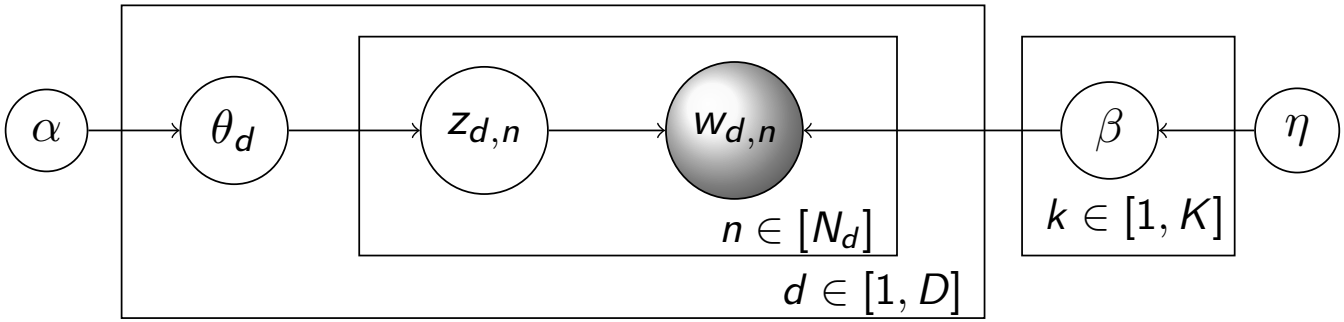
LDA Model



The overall joint probability of a statement is:

$$\left(\prod_{k=1}^{K} p(\beta_k|\eta)\right)\left(\prod_{d=1}^{D} p(\theta_d|\alpha)\left(\prod_{n=1}^{N_d} p(z_d|\theta_d)p(w_{d,n}|z_{d,n},\beta_k)\right)\right) \quad (2)$$

LDA Model



The overall joint probability of a statement is:

$$\left(\prod_{k=1}^{K} p(\beta_k|\eta)\right)\left(\prod_{d=1}^{D} p(\theta_d|\alpha)\left(\prod_{n=1}^{N_d} p(z_d|\theta_d)p(w_{d,n}|z_{d,n},\beta_k)\right)\right) \quad (2)$$

- This is an approximate posterior inference problem
  - we use collapsed Gibbs-Sampling

The Collapsed Gibbs-Sampling Algorithm I

Griffiths and Steyvers (2002) show that the conditional distribution of a word being assigned to a topic, given all other word-topic assignments and the data (vector of words) is given by:

$$Pr(z_i = k|z_{-i}, \vec{w}) \propto \frac{n^k_{v,-i} + \eta}{\sum_{v=1}^{V} n^k_{v,-i} + \eta} \left(n^d_{k,-i} + \alpha \right) \tag{3}$$

where $\vec{w}$ is the collection of all words, $n^d_{k,-i}$ is the count of words in document d allocated to topic k (K of these) excluding the current token $i = (d, n)$ and $n^k_{v,-i}$ is, again excluding token i, the count of times unique token v is allocated to topic k (V of these).

The Collapsed Gibbs-Sampling Algorithm II

1. Start with a series of words in statements ($w_{d,n}$) and K topics
2. Initialise the process with any allocation of topics to words to generate a first iteration of $z_{d,n}$ for each word in each document.
3. Using this allocation of words to topics, we can calculate the necessary word counts n_v^k and n_k^d.
4. Then, iterating through each word in each document (each i):
   - 4.1 Drop the word i from the sample (reducing all the relevant counts) - this gives us the $-i$ sample;
   - 4.2 Sample a new topic allocation for word i using (3);
   - 4.3 Update all relevant word counts;
   - 4.4 Move on to the next word $i+1$
5. Sample from Markov chain with "burn in" and "thinning interval"

$$\widehat{\beta}_k^v = \frac{n_v^k + \eta}{\sum_{v=1}^{V}\left(n_v^k + \eta\right)} \qquad \widehat{\theta}_d^k = \frac{n_k^d + \alpha}{\sum_{k=1}^{K}\left(n_k^d + \alpha\right)}$$

LDA model

Topic Distributions (β_K)

How does the LDA model generate topics which make sense?

1. Key idea is co-occurrence (don't even need to think about prior)
2. Word probabilities ($p(w_{d,n}|z_{d,n}, \beta_k)$ term), for each given topic, are maximised by splitting the words among the topics.
3. Mixture vs mixed membership model
   - Don't force all words in a given document to be part of the same topic.
   - Increases the ability of the model to put co-occuring words together.
   - Example of an article about statistics in football - Gaussian and Goal

Measuring Influence

- We build an *influence matrix* I_t in the following steps:
  1. Let $a_{ij,t}$ be the correlation between $x_{it}^{\text{ECON}} - \overline{x}_t^{\text{ECON}}$ and $x_{jt}^{\text{POL}} - \overline{x}_t^{\text{POL}}$.
  2. Compute a matrix A_t whose (i,j) element is $\mathbb{1}\left[a_{ij,t} > 0\right] a_{ij,t}$.
  3. Compute a normalized matrix B_t where $B_{ij,t} = \frac{a_{ij,t}}{\sum_j a_{ij,t}}$.
  4. Introduce "escape probability" (Brin and Page 1998). $I_t = dU + (1-d)B_t$ where $U_{ij} = \frac{1}{\#i}$ and $d = 0.1$.
- I_t is Markov $\Longrightarrow$ a unit eigenvalue exists, with associated eigenvector v_t.
- Member i's influence v_{it} is defined to be the ith element of v_t.

Effects of transparency on experts with career concerns

- Effects via member career concerns channel (5-year release lag):
  - Members wish to signal their expertise in monetary policy
  - It could be to broader Fed community, markets, politicians, etc..
- "Discipline": Holmström (1999)
- "Conform": Scharfstein and Stein (1990)
  - Prat (2005): If unsure of correct action, better to go with the crowd
  - Levy (2007): If know type, can generate contrarian behaviour
- Transparency increases precision of signals relating to members' committee performance
  - Should amplify the effects of career concerns
  - Transparency can have positive and/or negative effects

▸ Outline

Empirical challenges

I. Empirical specification

- Identification problem is that other things also change over time
  - Single-Diff approach is potentially problematic
- Transparency effects greater for members with more career concerns
- We use a Diff-in-Diff strategy + Natural experiment on transparency
- Identify those with greater career concerns using their Fed experience
  - Holmström: career concerns ↓ as noise about monetary expertise ↓

II. Measurement of discussion

- Use NLP techniques on FOMC transcripts

▸ Outline

Specific evidence for career concerns

Discipline	**Conformity**
↑ economics topic coverage in FOMC1	↓ statements in FOMC2
↑ references to data topics in FOMC1	↓ questions in FOMC2
	↓ distance from Greenspan in FOMC2
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▸ Outline