Networked Inflation Expectations: a closer look at Professional Forecasters

Macro Club

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Roadmap

Introduction

ECB SPF

The Model

Conclusion

Motivation

- Central Banks care about people's *expectations*
  - → Households, Firms, Professional Forecasters
- Professional Forecasters are *experts*
  - → "Superior" information and better processing skills
  - → Reflect the *private sector* expectations
- Central Banks *directly receive* Professional Forecasters *opinions* on future economic outcomes
  - → European Central Bank: Survey of Professional Forecasters (SPF)

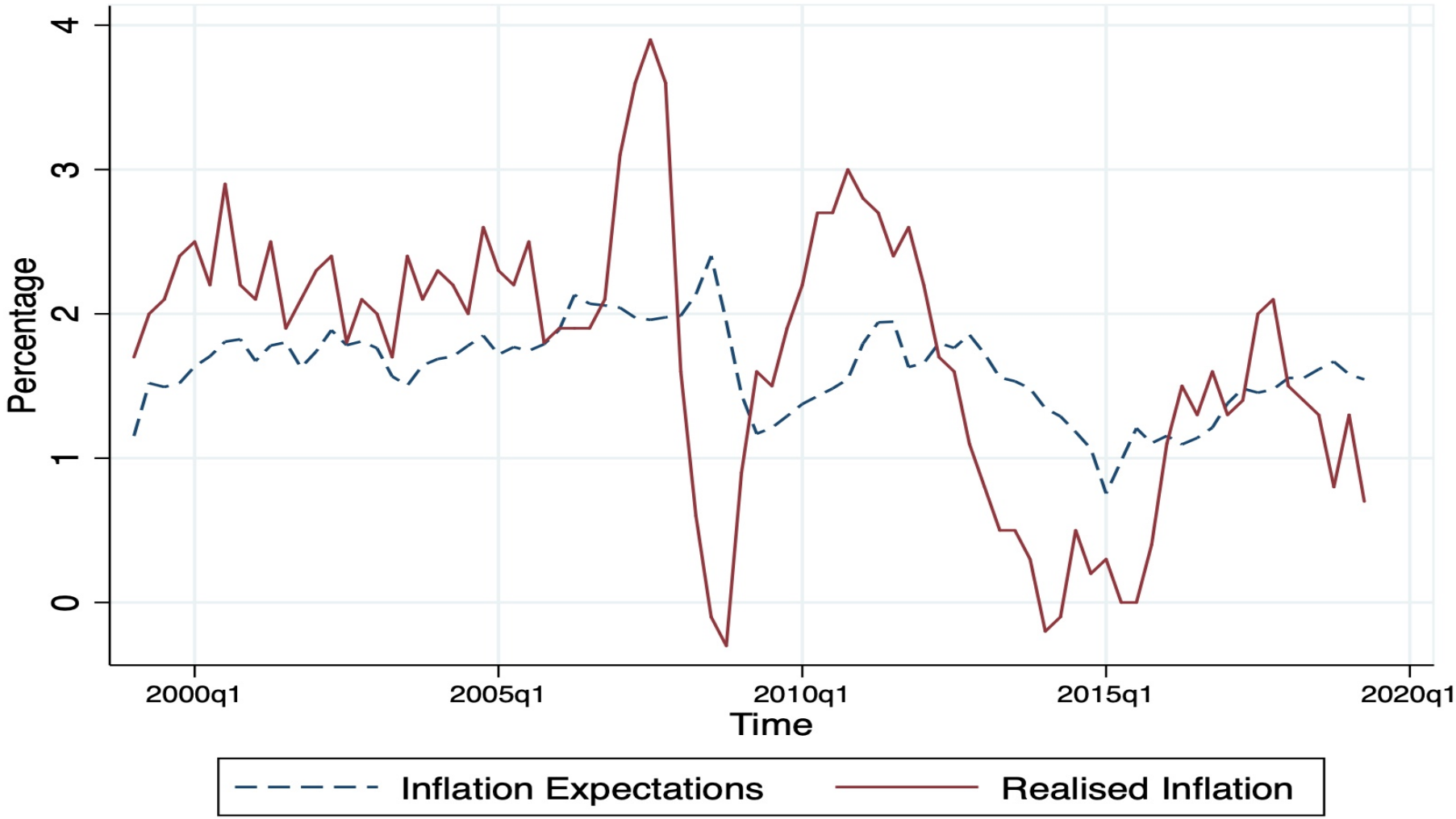
SPF $\longrightarrow$ Central Bank's belief $\longrightarrow$ Policy $\longrightarrow$ Economic Outcomes

Motivation

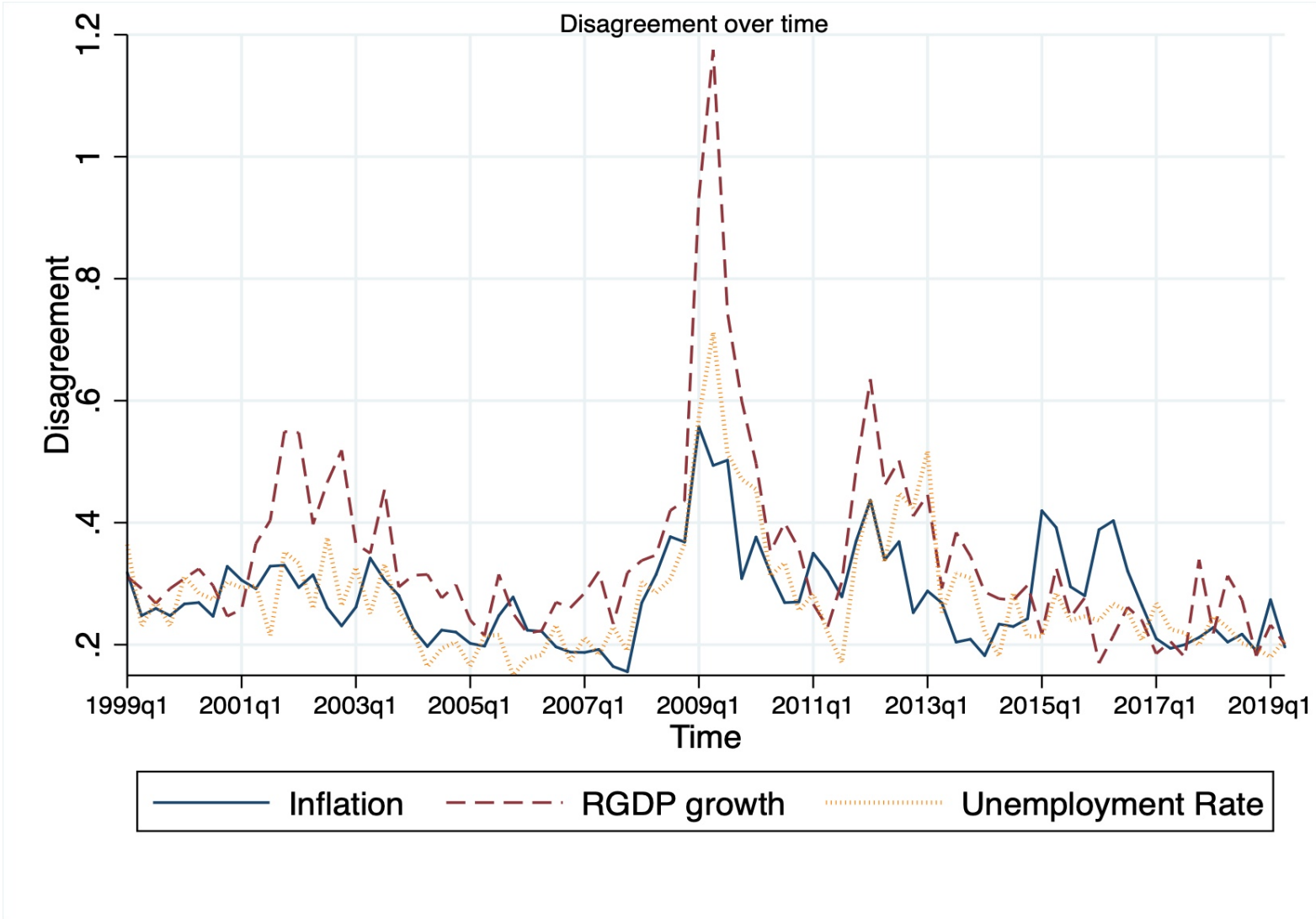
- The average of forecasts influences Central Banks policy decisions

  But...
- Professional Forecasters come from a close pool of industry professionals
  - → They know each other and often the interest of their job is similar
  - → Subjective to environmental characteristics: social circles, geographical location
- There is disagreement: implies that agents do not have the same information set

SPF Mean Inflation Forecast



SPF Disagreement



Measure of Disagreement: $\sigma^x_{t,h} = \sqrt{\frac{1}{n_t}\sum_{i=1}^{n_t}(\mathbb{E}(x_{it,t+h}) - \mathbb{E}(x_{t,t+h}))^2}$

Research Question

→ How do Professional Forecasters account for others Forecasters?

- Does this matter for their predictions?
- For the Central Bank's Expectation?

We argue that they do so through an informational channel = network:

- Professional Forecasters' have private information and interact with each other
- Difference and overlapping of information drive their behavior
- In turn, affects a Central Bank's belief about inflation process - who is *unaware* about this mechanism

This Paper

- Empirical part - European Central Bank Survey of Professional Forecasters
  - → Why forecasts are heterogeneous?
  - → What is the underlying network?
- Theoretical part
  - → Dynamic model of expert advice with
  - i) endogenous public information
  - ii) network sharing of information

Literature

- Networks: Social Learning, Information Sharing
  - → Golub and Jackson, 2010, DeMarzo, Vayanos, and Zwiebel, 2003,Dasaratha, Golub, and Hak, 2020,Golub and Sadler, 2017
- Disagreement and Professional Forecaster Expectations
  - → Mankiw, Reis, and Wolfers, 2003, Patton and Timmermann, 2010, Coibion and Gorodnichenko, 2012, Andrade and Le Bihan, 2013, Andrade, Crump, et al., 2014

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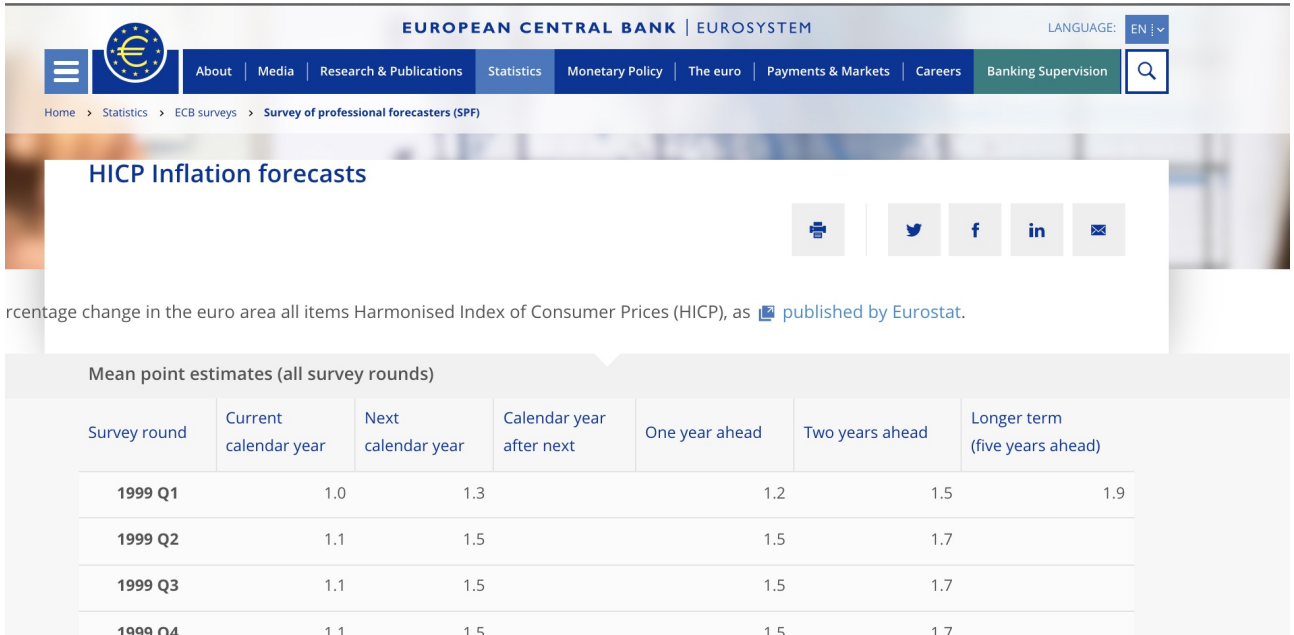
ECB Survey of Professional Forecasters

- Time 1999Q1 - 2019Q1
- Forecasters mostly include forecasting firms, research firms, investment banks, universities.
- Rolling forecast horizon with one-year-ahead or two-year-ahead forecasts.
- Forecast is one-year-ahead ahead of the last realised observation
- ECB uses aggregate results

ECB Survey of Professional Forecaster



Survey round	Current calendar year	Next calendar year	Calendar year after next	One year ahead	Two years ahead	Longer term (five years ahead)
1999 Q1	1.0	1.3		1.2	1.5	1.9
1999 Q2	1.1	1.5		1.5	1.7	
1999 Q3	1.1	1.5		1.5	1.7	
1999 Q4	1.1	1.5		1.5	1.7	

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Theoretical Framework

Dynamic model of expert advice and Endogenous Public Information

- Unknown inflation state: $\bar{\pi} \sim N(\mu, \sigma^2)$
- Common prior info: $\bar{\pi} \sim N(y_0, \sigma_0^2)$
- A Central Bank (CB)
- $i = 1, ..., N$ Professional Forecasters (PF)
- $j = 1, .., N + 1$ agents trying to learn π_0 over time $t \geq 0$:

$$\min u_{jt} = -E\left[(\pi_{jt} - \bar{\pi})^2 | \mathcal{I}_{jt}\right] \tag{1}$$

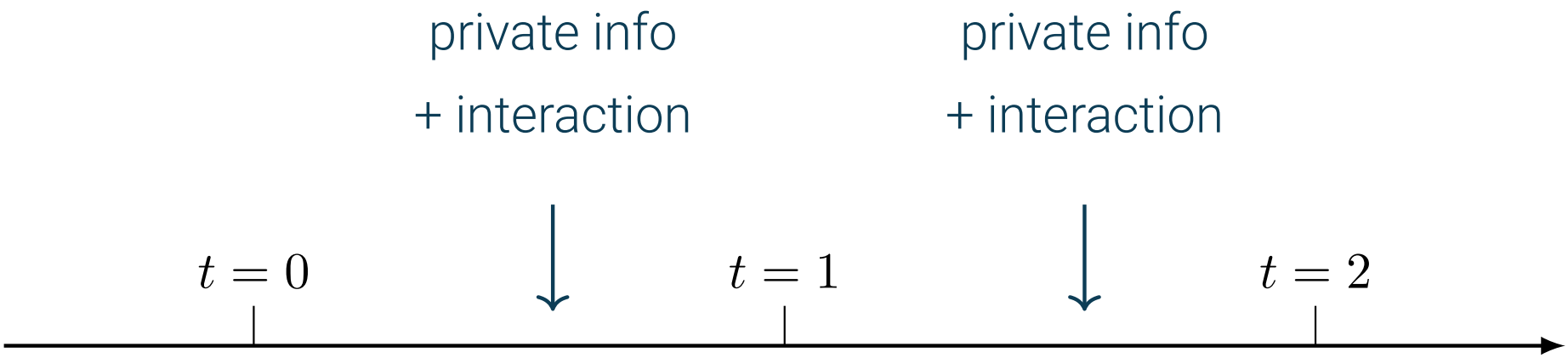
$$\pi_{jt} = E\left[\bar{\pi} | \mathcal{I}_{jt}\right] \tag{2}$$

- Forecasters' Network $\mathbf{G}$: private information sharing

Theoretical Framework

- PFs use private information to make inflation forecasts
- CB relies on PFs' advices to infer about current inflation
- At each time t,
  - $\rightarrow$ PFs have private info and interact in the network $\mathbf{G}$
  - $\rightarrow$ Each PF reports to the CB his forecast about inflation
  - $\rightarrow$ The CB *aggregate forecasts* and publishes a public report on the state of inflation
  - $\rightarrow$ At $t+1$, PFs use *past report* and *new private info* to update his inflation forecast
  - $\rightarrow$ ...

Timeline



- Initial public info

- PFs forecast
- CB aggregates forecasts
- CB publishes inflation report

- PFs forecast
- CB receives forecasts
- CB publishes inflation report

Professional Forecasters

Each PF i's information set $\mathcal{I}_{it}$ consists of

- private information: $s_{it} = \bar{\pi} + e_{it}$, $e_{it} \sim N(0, \sigma_e^2)$
- social information: $z_{it} = \bar{\pi} + e_{zit}$, $e_{zit} \sim N(0, \sigma_{ei}^2)$
- public signal: $y_{t-1} \sim N(\psi_t \cdot \bar{\pi}, \sigma_y^2) \longrightarrow$ endogenous
  - $\rightarrow$ ψ_t can be different than 1
  - $\rightarrow$ Perceived to summarize all relevant private information (past inflation estimates) $\rightarrow$ "memoryless"

Time-t forecast is then

$$\pi_{it} = E\left[\bar{\pi} | s_{it}, z_{it}, y_{t-1}\right] \tag{3}$$

Professional Forecasters

- The network $\mathbf{G}$
  - → $g_{ij} = \{0, 1\} \forall i \in N$: if $g_{ij} = 1$ PFs i and j are connected
  - → i's neighborhood: $N_i = \{j \neq i : g_{ij} = 1\}$
  - → i's degree: $d_i = \sum_{j \neq i, j \in N} g_{ij}$
- *Truthful* sharing of current private signals → social information

$$z_{it} = \frac{1}{d_i} \sum_{j \in N_i} s_{jt} \tag{4}$$

- Why the network?
  - → It captures behavior among PFs that may drive their estimate and is not known to the CB

Professional Forecasters

- By Bayes' rule, i's inflation estimate at t is

$$\pi_{it} = \frac{\kappa_e}{\kappa_{t-1} + \kappa_e(1+d_i)} \sum_{k:j \in N_i \cup i} s_k + \frac{\kappa_{t-1}}{\kappa_{t-1} + \kappa_e(1+d_i)} y_{t-1} \qquad (5)$$

- $\bar{\pi} | \mathcal{I}_{it} \sim N\left(\pi_{it}, \left[\kappa_{t-1} + \kappa_e(1+d_i)\right]^{-1}\right)$

Central Bank

- At each t, CB's information set $\mathcal{I}_{ct}$
  - $\rightarrow$ PFs' forecasts: $\boldsymbol{\pi}_t \equiv \{\pi_{it}\}_{i \in N}$
    - $\star$ It does not know the network
- CB aggregates $\boldsymbol{\pi}_t$ to infer about inflation:

$$E\left[\bar{\pi} | \boldsymbol{\pi}_t\right] \equiv \pi_{ct} \equiv \frac{1}{N} \sum_{i \in N} \pi_{it} \tag{6}$$

- "Naive CB": publishes the inflation report ▸ Bayesian

$$y_t | \bar{\pi} \sim N\left(\pi_{c_t}, \sigma_y^2\right) \tag{7}$$

where σ_y^2 is exogenous

Timeline: in between periods

- past report y_{t-1} (public info)
- PFs forecast: $\{\pi_{it}\}_{i\in N}$;
- CB aggregates forecasts: π_{ct};
- CB publishes y_t

Theoretical Framework

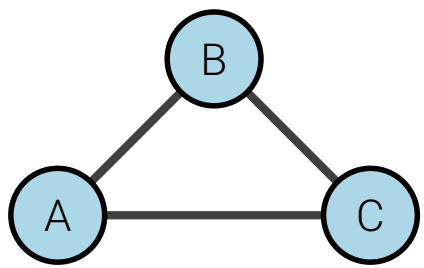
Implications

- Professional Forecasters have *more information* and certain information can have *more weight* on various forecasts
- Disregarding the network, the Central Bank is not aggregating independent advices
  - → Aggregate forecast may reflect more certain information which it *should not* from the CB's perspective
- In turn, Professional Forecasters are also affected since they use the CB as a source of information as well

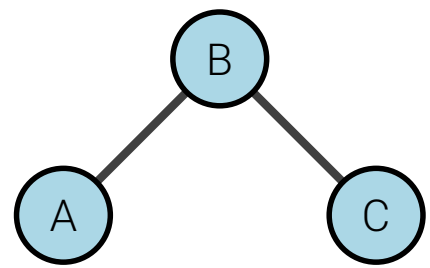
Simulation

Simple example: 3 Forecasters connected in two different ways

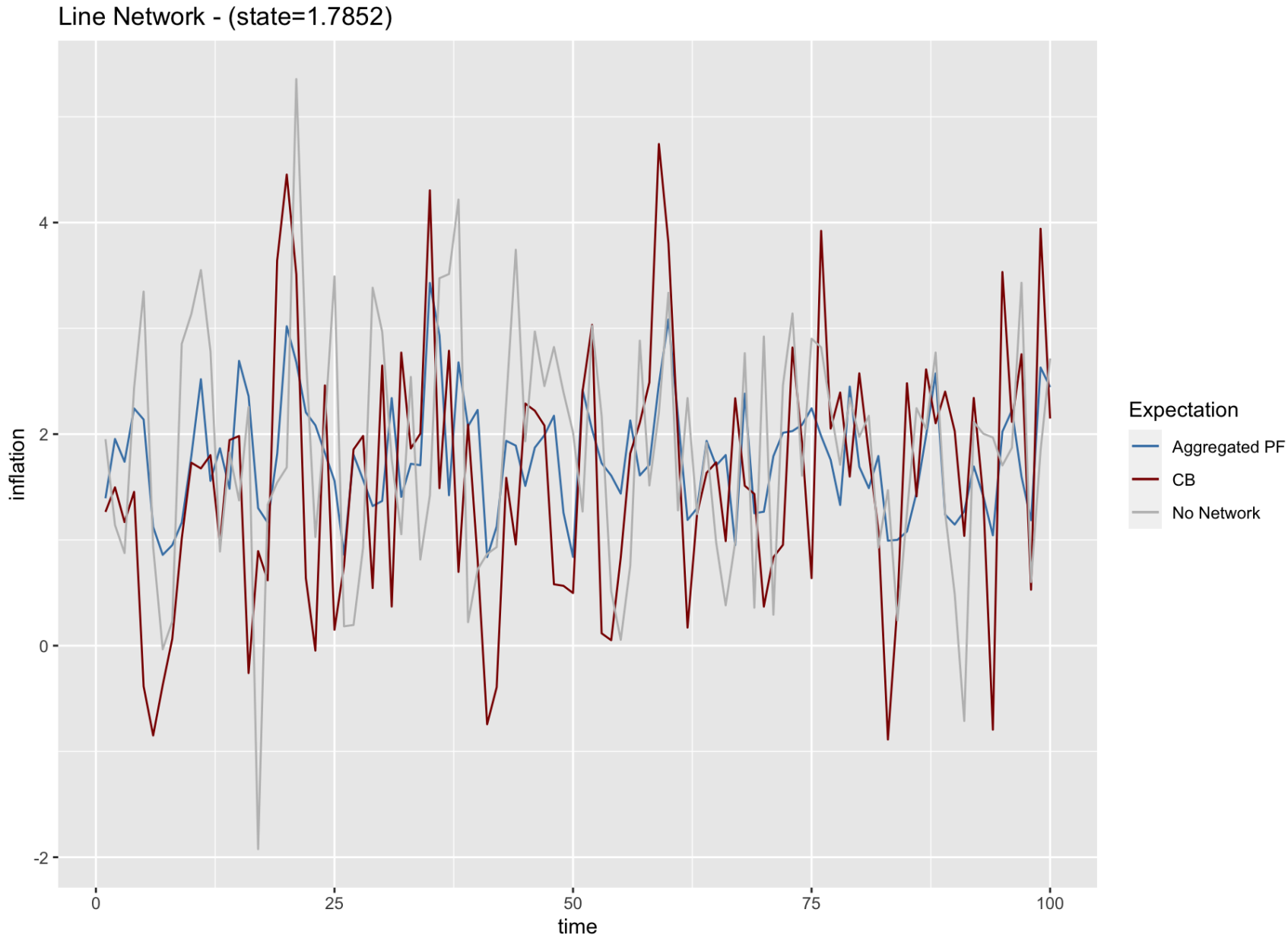
Complete



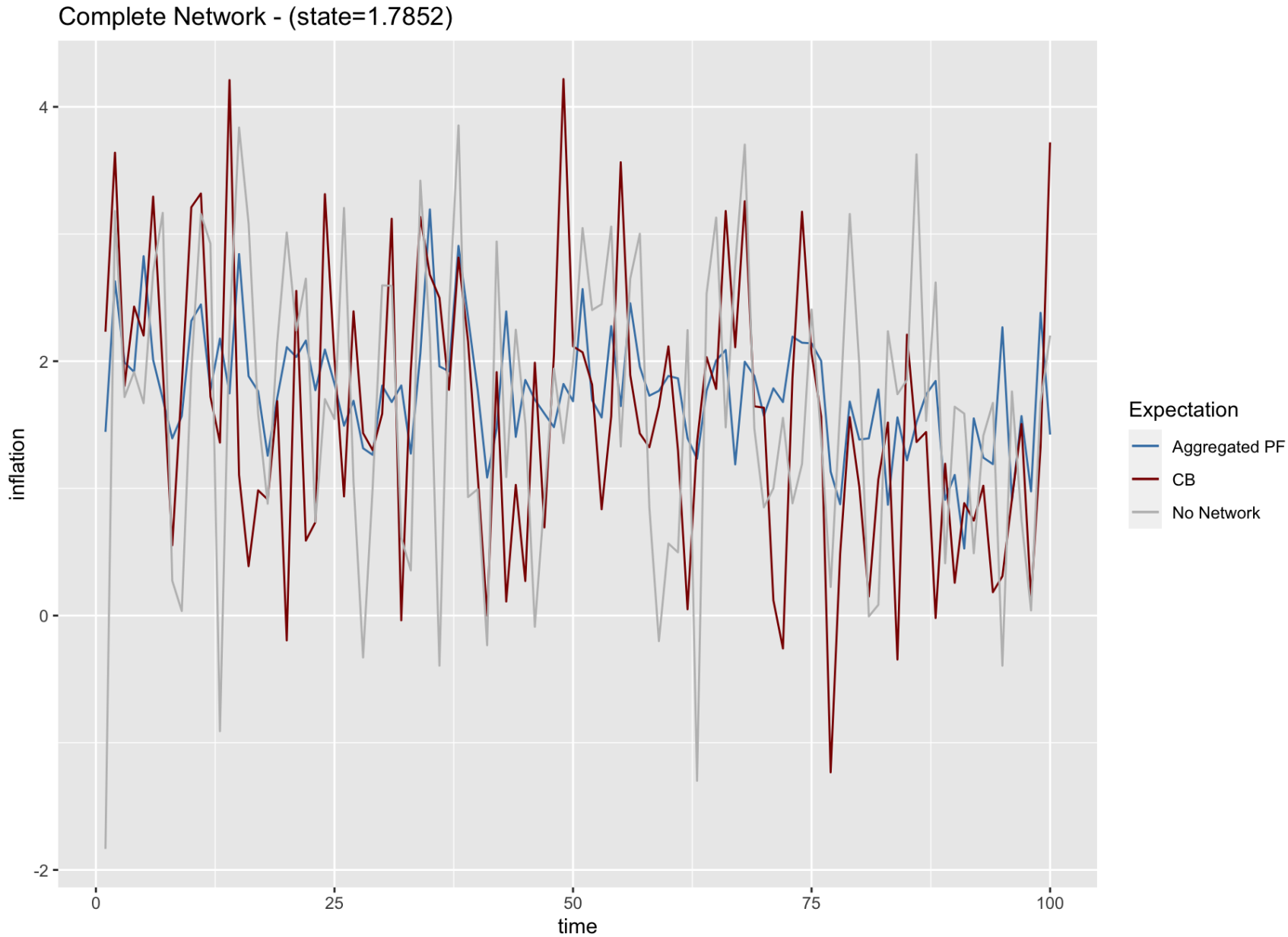
Line



Simulation


Line Network - (state=1.7852)
inflation
4
2
0
-2
0
25
50
75
100
time
Expectation
Aggregated PF
CB
No Network

Simulation


Complete Network - (state=1.7852)
inflation
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⇒ What role does the network structure play in determining Forecasters and Central Bank's beliefs?

- Heterogeneity *and* sharing of information drive Professional Forecasters' advices
- The Central Bank is *unaware* of this network effect, but this has implication for CB's beliefs
- Thus it is important to *empirically identify* what is the network among Professional Forecasters

Open Questions

- Are Professional Forecasters' strategic?
  - → Do they want to "beat" each others forecast?
  - → Not clear: no reward, ECB only concerned about aggregate forecast
- Do they learn from each others forecast? Or information?
- The average forecast may not be the consensus ("wisdom of the crowd")
- How can the ECB ensures that Professional Forecasters are submitting their best forecast?

Thank you!

References I

Andrade, Philippe, Richard Crump, et al. (2014). *Fundamental disagreement*. Working papers. Banque de France. URL: https://EconPapers.repec.org/RePEc:bfr:banfra:524.

Andrade, Philippe and Hervé Le Bihan (2013). "Inattentive professional forecasters". *Journal of Monetary Economics* 60.8, pp. 967–982. URL: https://EconPapers.repec.org/RePEc:eee:moneco:v:60:y:2013:i:8:p:967-982.

Coibion, Olivier and Yuriy Gorodnichenko (2012). "What can survey forecasts tell us about information rigidities?" *Journal of Political Economy* 120.1, pp. 116–159.

Dasaratha, Krishna, Benjamin Golub, and Nir Hak (2020). "Learning from neighbors about a changing state". *Available at SSRN 3097505*.

References II

DeMarzo, Peter M, Dimitri Vayanos, and Jeffrey Zwiebel (2003). "Persuasion bias, social influence, and unidimensional opinions". *The Quarterly journal of economics* 118.3, pp. 909–968.

Golub, Benjamin and Matthew O Jackson (2010). "Naive learning in social networks and the wisdom of crowds". *American Economic Journal: Microeconomics* 2.1, pp. 112–49.

Golub, Benjamin and Evan Sadler (2017). "Learning in social networks". *Available at SSRN 2919146*.

Mankiw, N Gregory, Ricardo Reis, and Justin Wolfers (2003). "Disagreement about inflation expectations". *NBER macroeconomics annual* 18, pp. 209–248.

References III

Patton, Andrew and Allan Timmermann (2010). “Why do forecasters disagree? Lessons from the term structure of cross-sectional dispersion”. *Journal of Monetary Economics* 57.7, pp. 803–820. URL: https://EconPapers.repec.org/RePEc:eee:moneco:v:57:y:2010:i:7:p:803-820.

Appendix

Central Bank and Network Knowledge

Back

- For the CB to be a rational Bayesian agent, it *must* know the network structure: recall (5)

$$\pi_{ct} \equiv \frac{1}{N}\sum_{i\in N}\pi_{it} = \frac{1}{N}\sum_{i}(\psi_i \cdot s_{it}) + \psi_y \cdot y_{t-1}$$

where

$$\psi_i\left(G, \mathbf{s}_t\right) \equiv \psi_i = \frac{\kappa_e}{\kappa_0 + \kappa_e(1+d_i)} + \sum_j \frac{g_{ij}\cdot\kappa_e}{\kappa_0 + \kappa_e(1+d_j)} \tag{8}$$

$$\psi_y\left(G, \mathbf{s}_t\right) \equiv \psi_y = \frac{\kappa_0}{N}\cdot\sum_i\left[\frac{1}{\kappa_0 + \kappa_e(1+d_i)}\right] \tag{9}$$

$$\pi_{ct}|\bar{\pi} \sim N\left(\left[\sum_i \psi_i + \psi_y\right]\cdot\pi_0, \left[\sum_i \psi_i^2\right]\cdot\sigma_e^2 + \psi_y^2\cdot\sigma_0^2\right) \tag{10}$$

CB Naive

- "Naive CB": it does not try to make inference on the aggregate forecast π_{ct}
- Another possibility is to say CB has an additional source of information:

$$
\begin{aligned}
c_t &= \pi_0 + e_{ct} \qquad\qquad N(0, \sigma_c^2) \\
y_t | \pi_0 &\sim N\left(\frac{\pi_{c_t} + \pi_0}{2}, \sigma_c^2\right)
\end{aligned}
\tag{11}
$$

Utility with Network Effects

$$u_i = -E\left[r(\theta_i - \theta)^2 + (1-r)\cdot\left(\theta_i - \frac{1}{d_i}\sum_{j\in N_i}\theta_j\right)^2 |I_i\right]$$
$$\longrightarrow \theta_i = r\cdot E(\theta|I_i) + (1-r)\cdot\frac{1}{d_i}E\left[\sum_{j\in N_i}\theta_j\Big|I_i\right] \tag{12}$$

Assume

$$E\left[\sum_{j\in N_i}\theta_j\Big|I_i\right] = \sum_{j\in N_i}s_j \tag{13}$$