Information Flows and Disagreement

Cristian Badarinza

Marco Buchmann

INTRODUCTION

- Companion ECB Working Paper 1088/2008: *Inflation Perception and Expectations in the Euro Area: The Role of News*

- Why are we interested in disagreement/heterogeneous beliefs ?

  - **Geanakoplos (2009)** and **He and Xiong (2010)**: cash-constrained optimists use their asset holdings as collateral to raise debt financing from less optimistic creditors
  - **Sims (2008)**: dispersion of beliefs about monetary policy causes high leverage levels
  - **Lorenzoni (2010)**: disagreement induces a trade-off in terms of aggregate vs. cross-sectional efficiency, such that in order to stabilize aggregate variables, the policy maker induces agents to ignore private signals which would have made them better off

- The unanswered question: why do people disagree?

- Our contribution:

  - quantification methods for information flows and disagreement about inflation
  - empirical question: more information induces agreement
  - models of expectation formation: time-varying updating frequency

DATA AND METHODOLOGY

Disagreement

Europe

Panel data: Seven countries with monthly observations for the period 1990-2010. Survey data is taken from the *European Commission's Business and Consumer Survey*.

Question 5: *How do you think that consumer prices have developed over the past 12 months? They have...*

p^1	*risen a lot*
p^2	*risen moderately*
p^3	*risen slightly*
p^4	*stayed about the same*
p^5	*fallen*
n/a	*don't know*

Question 6: *By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will...*

e^1	*increase more rapidly*
e^2	*increase at the same rate*
e^3	*increase at a slower rate*
e^4	*stay about the same*
e^5	*fall*
n/a	*don't know*

USA

Michigan Survey of Consumers: cross-sectional monthly observations for the period 1978-2009

Question PX1Q1: *During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?*

e^1 *Go up*
e^2 *Same*
e^3 *Go down*
n/a *don't know*

Question PX1: *By about what percent do you expect prices to go (up/down) on the average, during the next 12 months? (PX1Q2 recoded)*

e^* *point forecast*
n/a point forecast $> 95\%$
       or *don't know*

QUANTITATIVE DISAGREEMENT

cross-sectional standard deviation and inter-quartile range of e^*

CATEGORICAL DISAGREEMENT

Cumulative frequencies:

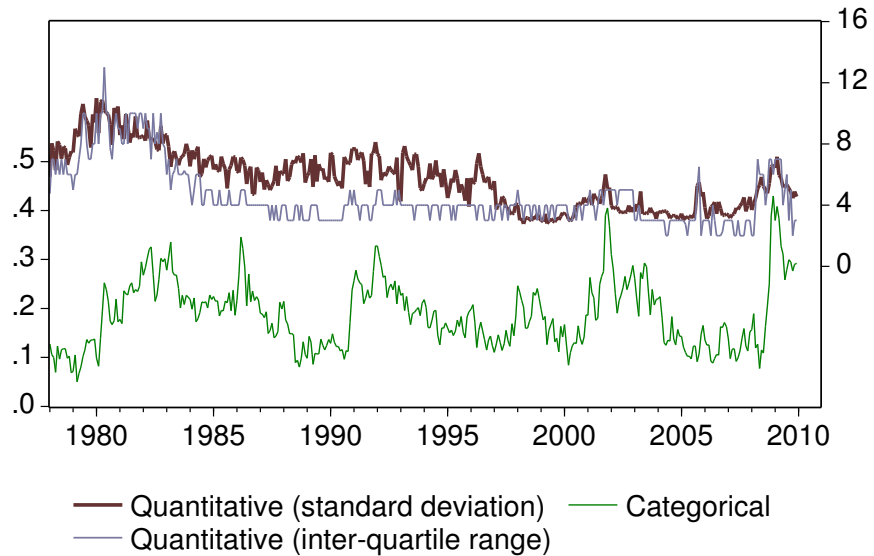$$F_t^{e,i} = \sum_{j=1}^{i} e_t^j$$

Disagreement measure:

$$\sigma_t^e = \sum_{i=1}^{2} F_t^{e,i} \left(1 - F_t^{e,i}\right)$$

Reference: Lacy (2006)

Example:

e_t^1	e_t^2	e_t^3	$F_t^{e,1}$	$F_t^{e,2}$	σ_t^e
0.0	0.0	1.0	0.0	0.0	**0.00**
1.0	0.0	0.0	1.0	1.0	**0.00**
0.0	0.5	0.5	0.0	0.5	**0.25**
0.1	0.3	0.6	0.1	0.4	**0.33**
0.5	0.0	0.5	0.5	0.5	**0.50**

Figure 1
Quantification of disagreement

Information flows

RECEIVER SIDE

Michigan Survey of Consumers **Questions NEWS1** and **NEWS2:** *During the last few months, have you heard of any favorable or unfavorable changes in business conditions? What did you hear?*

$\cdots$

n^{31}	**Lower/stable prices, less inflation**
n^{32}	**Higher prices, inflation is good**
n^{37}	**Other references to prices/credit**
n^{71}	**Prices falling, deflation**
n^{72}	**Prices high, inflation**
n^{77}	**Other price/credit references**

$\cdots$

n/a *don't know*

RECEIVER SIDE

Google Insights for Search [©] with search phrase: **inflation**

SENDER SIDE

Professional public news provider **Factiva** by Dow Jones/Reuters

$$\text{News intensity} = \frac{\text{number of keyword search results}}{\text{number of control search results}}$$

- Search phrase: **inflation**

- Control phrase: **none**

- Category across which we search: **Economic News**

Summary

$$\text{USA} \begin{cases} \text{Survey news} \\ \text{Public news} \\ \quad \text{Google} \end{cases} \qquad \text{Europe} \begin{cases} \text{Public news} \\ \quad \text{Google} \end{cases}$$

Figure 2
Sender vs. receiver perspective on information flows

— Public news   — Survey-based news   — Google searches
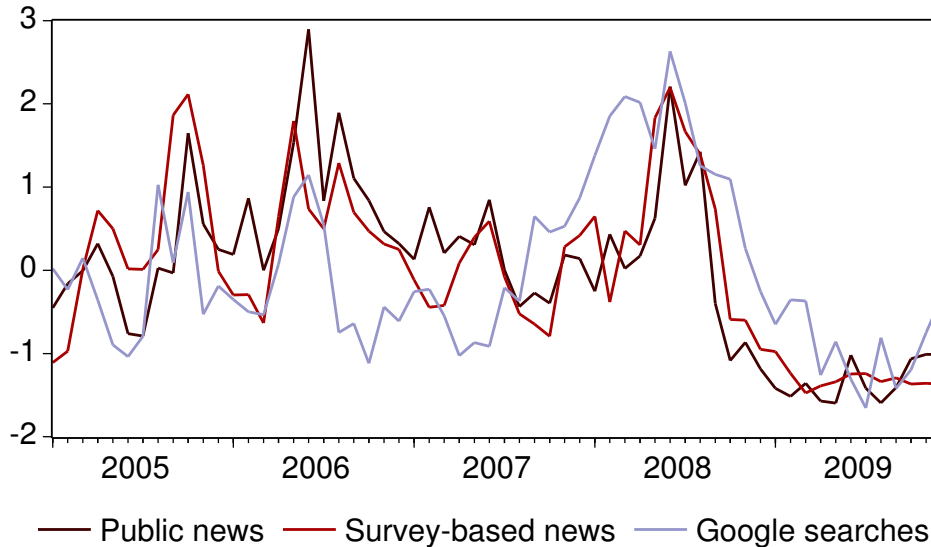
Note: The Google series is the year-on-year change computed from raw search frequencies. All variables have been normalized by subtracting their mean and dividing by respective standard deviations.

Figure 3
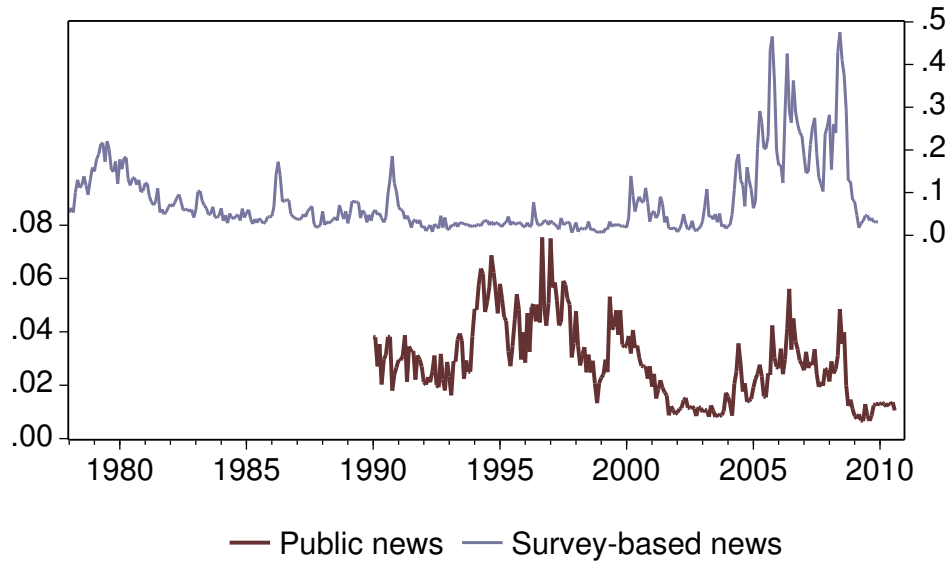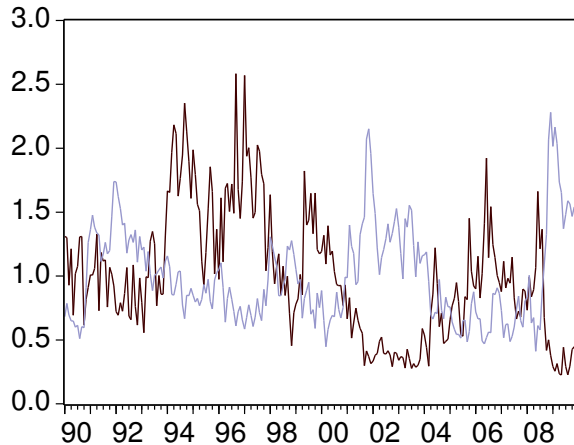### Comparison between the measures of inflation-related news

Public news   Survey-based news

Figure 4

Co-movement between news intensity and categorical disagreement
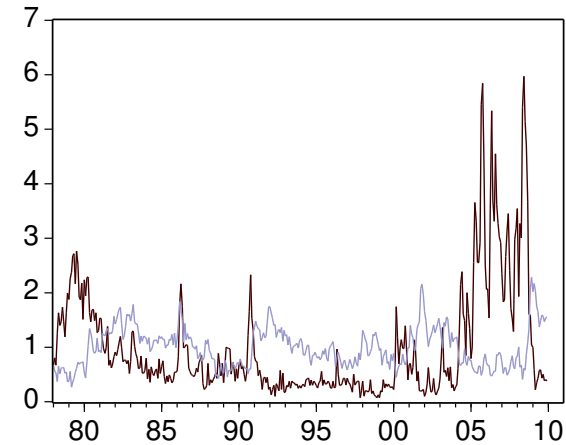

Note: The series are divided by their sample means.

Figure 5
Co-movement between news intensity and categorical disagreement

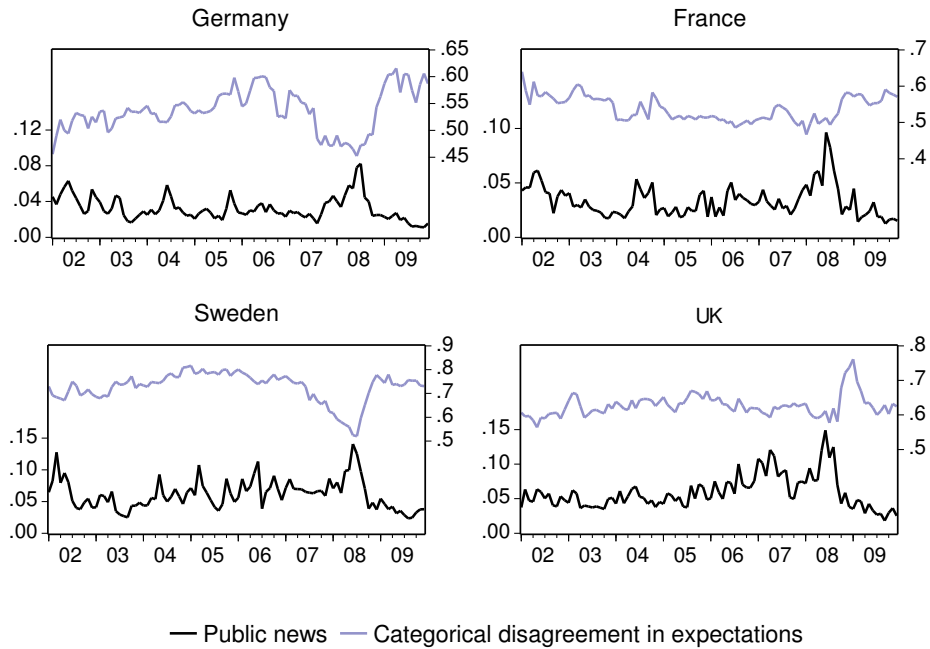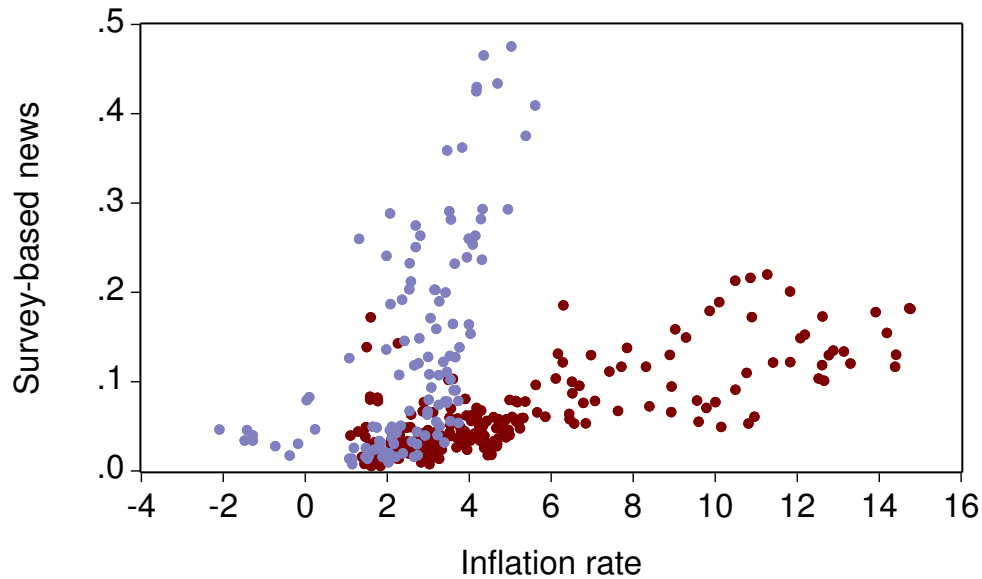— Public news — Categorical disagreement in expectations

Figure 6
Co-movement between news intensity and inflation

Note: The brown dots correspond to the sample period 1978 to 1999 and the blue dots to the sample period 2000 to 2009.

REGRESSION RESULTS

Table 1
Disagreement and **survey** news

	Quantitative		Categorical		Quantitative		Categorical	
	1978-2009		1978-2009		2000-2009		2000-2009	
Lagged	0.800	(0.00)	0.871	(0.00)	0.792	(0.00)	0.835	(0.00)
Survey news	-0.032	(0.04)	-0.046	(0.03)	0.028	(0.77)	-0.127	(0.01)
Inflation	0.209	(0.00)	-0.045	(0.53)	-0.152	(0.29)	-0.061	(0.33)
Inflation^2	-0.045	(0.45)	0.052	(0.46)	0.208	(0.29)	0.087	(0.27)
(ΔInflation)^2	0.040	(0.00)	0.130	(0.00)	0.201	(0.00)	0.180	(0.00)
obs.	383		383		120		120	
R^2	0.62		0.83		0.63		0.86	

Note: We report coefficient estimates that have been normalized by multiplying OLS coefficients with the standard deviation of the regressor and dividing by the standard deviation of the dependent variable. P-values derived from heteroskedasticity and autocorrelation robust standard errors (Newey-West) are reported in parentheses.

Table 2
Quantitative disagreement and **public** news

	Sample: 1990-2009						Sample: 2000-2009					
Lagged						0.846	(0.00)				0.774	(0.00)
Public news			0.168	(0.07)	0.010	(0.72)			-0.257	(0.07)	-0.092	(0.09)
Inflation	-0.322	(0.04)	-0.436	(0.01)	-0.003	(0.93)	-1.033	(0.00)	-0.958	(0.01)	-0.106	(0.29)
Inflation^2	0.690	(0.00)	0.766	(0.00)	0.095	(0.07)	0.937	(0.00)	1.044	(0.00)	0.220	(0.11)
(ΔInflation)^2	0.053	(0.39)	0.071	(0.23)	0.059	(0.02)	0.292	(0.00)	0.306	(0.23)	0.156	(0.00)
obs.	240		240		240		120		120		120	
DW	0.29		0.31		2.31		0.58		0.69		2.26	
R^2	0.19		0.25		0.78		0.37		0.41		0.76	

Table 3
Categorical disagreement and **public** news

	Sample: 1990-2009						Sample: 2000-2009					
Lagged					0.866	(0.00)					0.838	(0.00)
Public news			-0.397	(0.00)	-0.043	(0.10)			-0.532	(0.00)	-0.082	(0.05)
Inflation	-0.807	(0.00)	-0.539	(0.01)	-0.048	(0.43)	-0.573	(0.01)	-0.419	(0.05)	-0.027	(0.67)
Inflation^2	0.389	(0.10)	0.210	(0.32)	0.045	(0.51)	-0.101	(0.67)	0.121	(0.51)	0.021	(0.76)
(ΔInflation)^2	0.137	(0.02)	0.093	(0.13)	0.133	(0.00)	0.143	(0.03)	0.171	(0.00)	0.168	(0.00)
obs.	240		240		240		120		120		120	
DW	0.26		0.41		1.86		0.32		0.70		1.82	
R^2	0.27		0.41		0.83		0.48		0.63		0.86	

Table 4
Categorical disagreement and **public** news

Disagreement in expectations

	News		Inflation		Inflation^2		$(\Delta\text{Inflation})^2$	
Germany	-0.878	(0.00)	-0.003	(0.24)	-0.064	(0.18)	-0.870	(0.26)
Spain	0.527	(0.03)	0.001	(0.37)	-0.028	(0.31)	5.118	(0.02)
France	0.177	(0.27)	-0.005	(0.07)	0.002	(0.49)	3.378	(0.02)
Italy	-0.168	(0.23)	0.016	(0.08)	-0.025	(0.36)	3.928	(0.05)
Netherlands	-1.318	(0.00)	-0.019	(0.01)	0.100	(0.05)	-1.221	(0.24)
Sweden	-0.612	(0.00)	-0.015	(0.03)	-0.023	(0.37)	-0.406	(0.37)
UK	-0.679	(0.00)	0.029	(0.00)	-0.095	(0.08)	6.938	(0.02)
Panel	-0.456	(0.00)	-0.003	(0.03)	0.007	(0.30)	0.862	(0.04)

Table 5
Categorical disagreement and **public** news

Disagreement in perceptions

	News		Inflation		Inflation^2		(ΔInflation)^2	
Germany	-3.486	(0.00)	-0.001	(0.34)	-0.024	(0.36)	-0.456	(0.36)
Spain	1.132	(0.00)	-0.017	(0.00)	0.142	(0.00)	1.770	(0.05)
France	-0.726	(0.03)	-0.003	(0.07)	-0.137	(0.00)	1.836	(0.04)
Italy	-0.900	(0.00)	-0.010	(0.08)	-0.087	(0.02)	0.631	(0.33)
Netherlands	0.143	(0.39)	-0.015	(0.01)	-0.036	(0.23)	-2.208	(0.06)
Sweden	-0.422	(0.02)	-0.019	(0.03)	0.252	(0.00)	0.686	(0.33)
UK	-1.783	(0.00)	0.070	(0.00)	-0.380	(0.00)	1.290	(0.33)
Panel	-0.806	(0.00)	-0.008	(0.00)	0.010	(0.28)	0.842	(0.07)

Table 6
Categorical disagreement and **public** news

Disagreement in expectations

	Lag		News		Inflation		Inflation^2		(Δ Inflation)^2	
Germany	0.824	(0.00)	-0.004	(0.47)	-0.050	(0.36)	-0.024	(0.43)	0.028	(0.29)
Spain	0.604	(0.00)	0.125	(0.12)	0.090	(0.32)	-0.107	(0.30)	0.049	(0.29)
France	0.798	(0.00)	0.012	(0.43)	-0.157	(0.12)	0.127	(0.19)	-0.028	(0.32)
Italy	0.773	(0.00)	-0.067	(0.17)	0.101	(0.31)	0.006	(0.49)	0.028	(0.33)
Netherlands	0.868	(0.00)	-0.101	(0.03)	0.054	(0.38)	-0.068	(0.33)	0.018	(0.35)
Sweden	0.990	(0.00)	-0.009	(0.42)	-0.180	(0.12)	0.253	(0.06)	0.047	(0.12)
UK	0.658	(0.00)	-0.216	(0.01)	-0.150	(0.31)	0.400	(0.08)	0.171	(0.02)
Panel	0.854	(0.00)	-0.032	(0.01)	-0.030	(0.16)	0.045	(0.08)	0.012	(0.14)

Table 7
Categorical disagreement and **public** news

Disagreement in perceptions

	Lag		News		Inflation		Inflation^2		$(\Delta$ Inflation$)^2$	
Germany	0.914	(0.00)	-0.045	(0.16)	-0.015	(0.44)	-0.008	(0.47)	-0.040	(0.12)
Spain	0.742	(0.00)	0.101	(0.01)	-0.343	(0.02)	0.087	(0.20)	0.002	(0.48)
France	0.919	(0.00)	-0.030	(0.27)	-0.093	(0.15)	0.089	(0.21)	0.045	(0.12)
Italy	0.934	(0.00)	-0.047	(0.13)	0.044	(0.34)	-0.030	(0.39)	0.087	(0.01)
Netherlands	0.894	(0.00)	-0.028	(0.13)	0.135	(0.05)	-0.244	(0.00)	-0.017	(0.22)
Sweden	0.838	(0.00)	0.021	(0.36)	-0.119	(0.28)	0.200	(0.18)	0.079	(0.07)
UK	0.878	(0.00)	-0.182	(0.00)	0.140	(0.20)	0.011	(0.47)	0.043	(0.14)
Panel	0.941	(0.00)	-0.027	(0.01)	-0.001	(0.48)	-0.004	(0.44)	0.010	(0.12)

MODELS OF INFORMATION DIFFUSION

Assume the law of motion for aggregate variables:

$$X_t = AX_{t-1} + B\epsilon_t, \text{ where } X_t \equiv \begin{bmatrix} x_t \\ x_{t-1} \\ \vdots \\ x_{t-11} \end{bmatrix} \text{ and } x_t \equiv \begin{bmatrix} \pi_t \\ r_t \\ y_t \end{bmatrix}$$

with π_t being the inflation rate, r_t the Federal Funds rate and y_t the economy-wide output gap. Four model variants concerning individual expectations formation:

1. **Rational expectations**

   Average aggregate expectation $\quad E_t X_{t+12} = A^{12} X_t$

   Cross-sectional disagreement $\quad V_t X_{t+12} = 0.$

2. **Sticky information**: a fraction δ_t updates information

$$E_t^{SI} X_{t+12} = \delta_t E_t X_{t+12}$$
$$+ (1 - \delta_t)\delta_{t-1} E_{t-1} X_{t+12}$$
$$+ (1 - \delta_t)(1 - \delta_{t-1})\delta_{t-2} E_{t-2} X_{t+12}$$
$$\cdots$$

$$= [\delta_t \quad (1 - \delta_t)\delta_{t-1} \quad (1 - \delta_t)(1 - \delta_{t-1})\delta_{t-2} \cdots] \begin{bmatrix} A^{12} X_t \\ A^{13} X_{t-1} \\ A^{14} X_{t-2} \\ \vdots \end{bmatrix}$$

$$V_t^{SI} X_{t+12} = Variance \begin{bmatrix} A^{12} X_t \\ A^{13} X_{t-1} \\ A^{14} X_{t-2} \\ \vdots \end{bmatrix} \begin{matrix} \leftarrow \delta_t \\ \leftarrow (1 - \delta_t)\delta_{t-1} \\ \leftarrow (1 - \delta_t)(1 - \delta_{t-1})\delta_{t-2} \\ \vdots \end{matrix}$$

3. **Sticky expectations**

$$E_t^{SE} X_{t+12} = \delta_t A^{12} X_{t+12} + (1 - \delta_t) E_{t-1}^{SE} X_{t+11}$$

4. **Epidemiological diffusion**

$$E_t^{EPI} X_{t+12} = \delta_t E_t^{prof} X_{t+12} + (1 - \delta_t) E_{t-1}^{EPI} X_{t+11}$$

Time-varying δ: we let the share of updating agents be given by the survey-based measure of inflation-related information flows
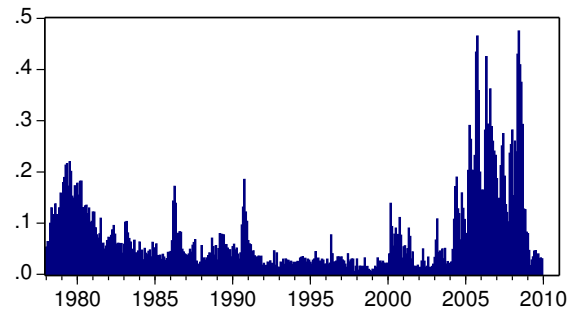
-

Figure 7
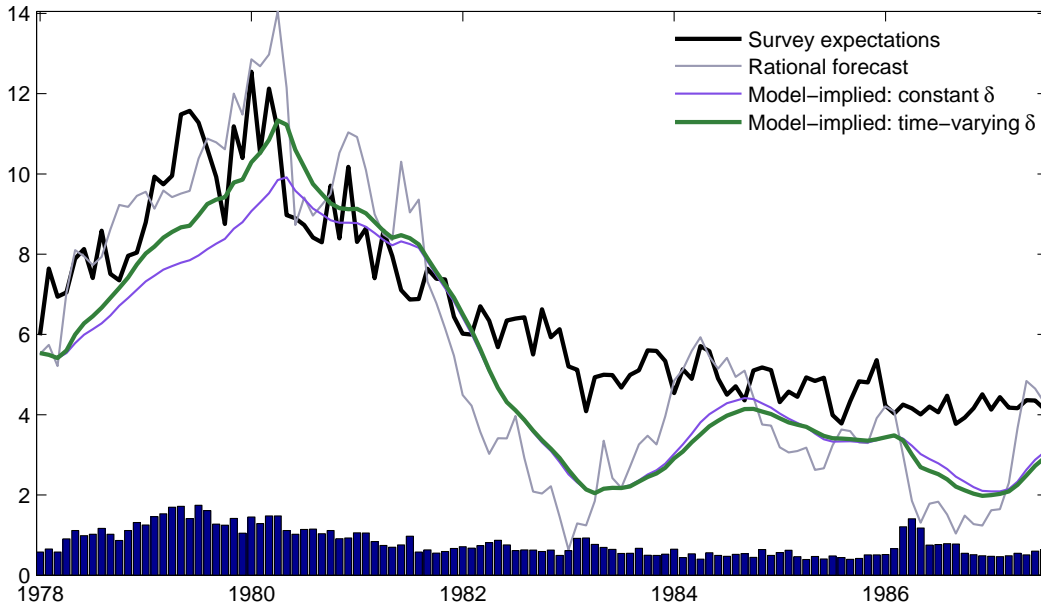Sticky information model: inflation expectations

Figure 8
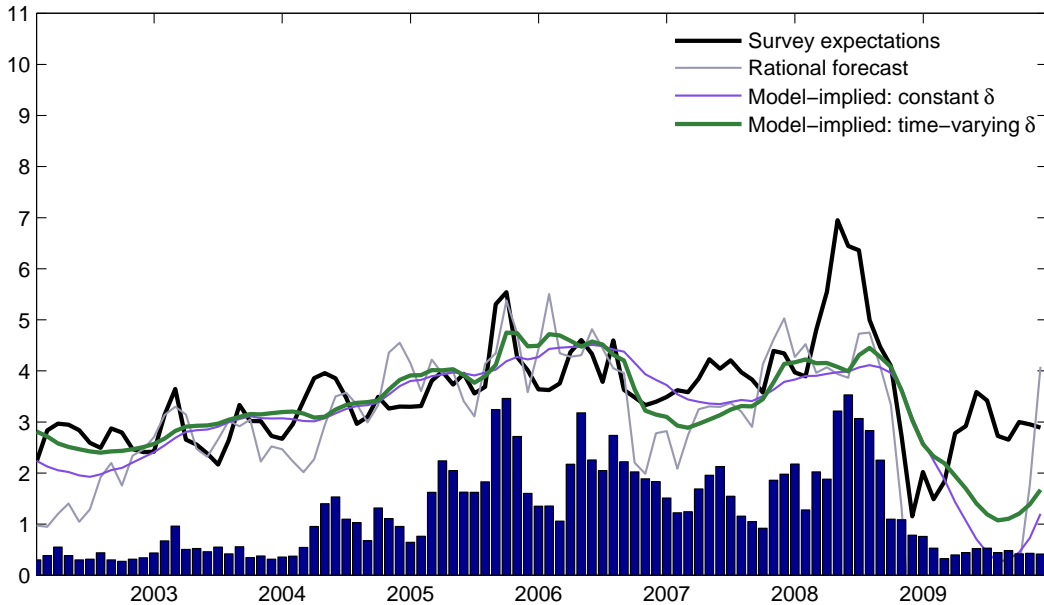Sticky information model: inflation expectations
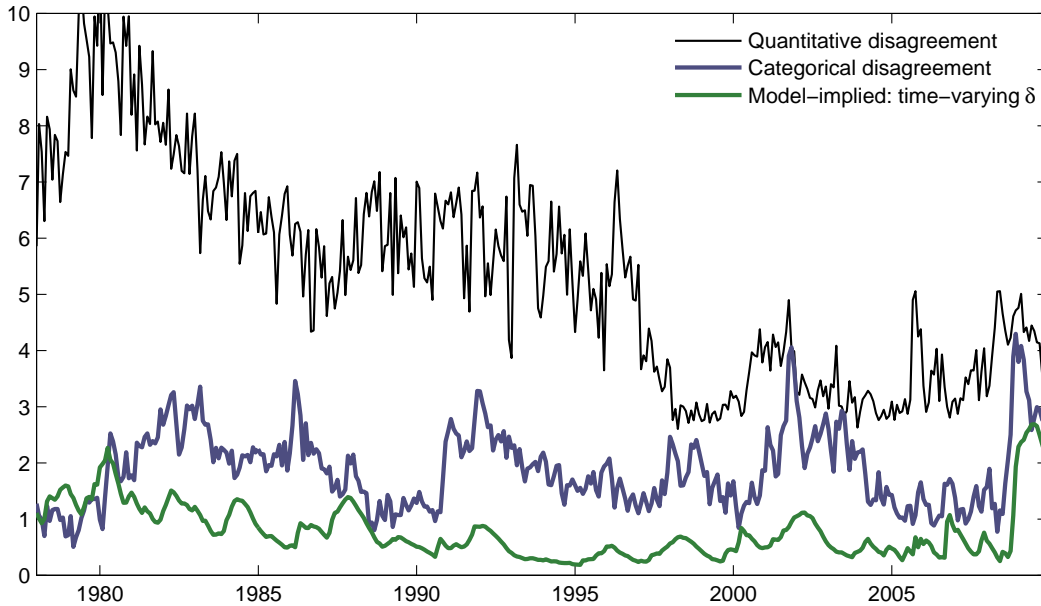
Figure 9
Sticky information model: disagreement
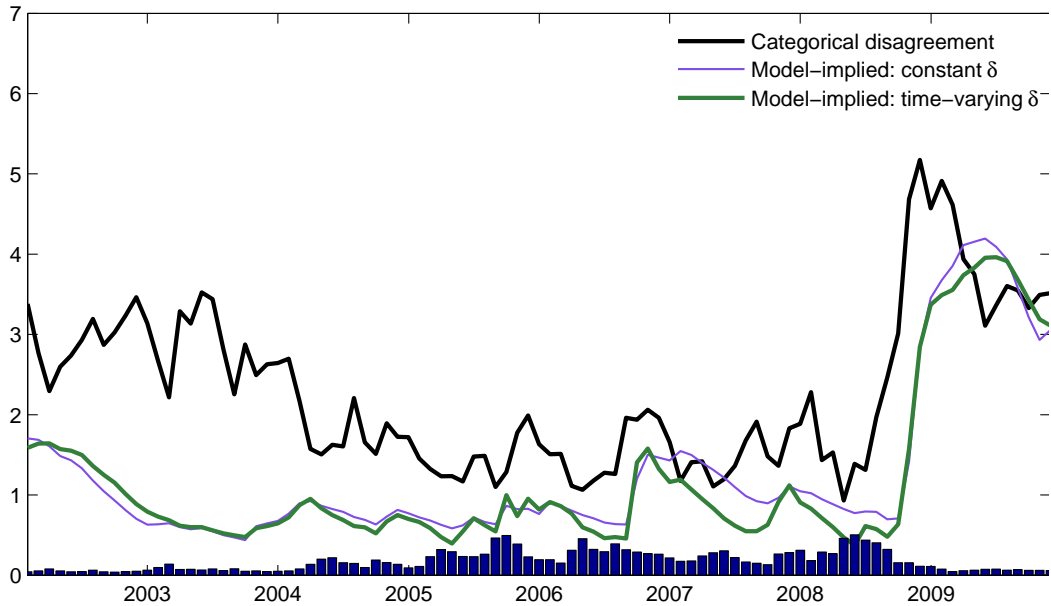
Figure 10
Sticky information model: categorical expectations

Table 8
Correlations between model-implied series and actual data

	Constant δ:			Time-varying δ:		
	SI	SE	EPI	SI	SE	EPI
Inflation expectations						
Jan 1978 - Jul 1987	0.867	0.834	.	0.893	0.857	.
Aug 1987 - Sep 2001	0.753	0.724	0.592	0.708	0.634	0.533
Oct 2001 - Dec 2009	0.561	0.580	0.298	0.611	0.635	0.120
Full sample	0.861	0.863	.	0.875	0.871	.

Table 9
Correlations between model-implied series and actual data

	Constant δ:			Time-varying δ:		
	SI	SE	EPI	SI	SE	EPI
Quantitative disagreement						
Jan 1978 - Jul 1987	0.699	0.425	.	0.646	0.270	.
Aug 1987 - Sep 2001	0.120	0.203	0.219	0.135	0.226	0.254
Oct 2001 - Dec 2009	0.559	0.525	0.351	0.418	0.521	0.486
Full sample	0.522	0.486	.	0.475	0.443	.
Categorical disagreement						
Jan 1978 - Jul 1987	-0.404	0.378	.	-0.311	0.518	.
Aug 1987 - Sep 2001	0.269	0.242	0.297	0.278	0.252	0.301
Oct 2001 - Dec 2009	0.617	0.641	0.359	0.682	0.728	0.413
Full sample	0.241	0.435	.	0.336	0.516	.

CONCLUSIONS

Conclusions

- empirical evidence for the US: more intense information flows reduce belief heterogeneity

- complements the results for EU countries (ECB WP)

- distinction between different sources of information flow (sender vs. receiver perspective)

- distinction between categorical and quantitative disagreement

- models of information diffusion

  - time-varying δ: mapping into observables
  - difficult to match observed *levels* of disagreement