Tails of inflation forecasts and tales of monetary policy

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Risk management and monetary policy

- Central bankers pay attention to measures other than central tendency of inflation expectations
- However, bulk of literature focuses on linear decision rules/symmetric losses. Decisions are made conditional on point inflation forecasts.
- Does the distribution around point inflation forecasts play a role in the conduct of monetary policy?
    - In particular extreme/asymmetric inflation risks

Approach

- We introduce a measure of risk: inflation-at-risk (I@R)
  - Tails in the distribution of inflation forecasts
  - Typically the top and bottom 5% quantiles
- We use individual survey data (US & EA) to estimate these indicators
  - Probabilistic assessment of inflation scenarios
- Disentangling upside and downside risks
  - Not possible with the usual indicators (mean forecast, uncertainty, disagreement)

Contributions

- Document evolution of I@R
  - Intriguing patterns of temporal variation
- Show that I@R contains information about future inflation
  - Greater asymmetry to upside risk signals an increase in inflation
- Show that the Fed reacts to I@Rs
  - Greater upside risk amplifies monetary contraction

Related literature: Empirics

- Estimating conditional second moment of future inflation: Engle (1982), Stock & Watson (2007)
- Constructing survey-based disagreement uncertainty measures: Rich & Tracy (2010)
- Estimating deflation probability: Kilian & Manganelli (2007), Christensen, Lopez & Rudebusch (2011)
- Estimating 3rd and 4th order moments of forecast distributions: Garcia & Manzanares (2010), Knüppel & Schultefrankenfeld (2011)

Related literature: Theory

- Central banking and risk management: Kilian & Manganelli (2008)
- Asymmetric preferences of the CB: Ruge-Murcia (2003), Killian & Manganelli (2008)
- Monetary with robust control: Orphanides & Williams (2007), Hansen & Sargent (2010), Woodford (2011)...
- Uncertainty shocks and macroeconomic fluctuations: Bloom (2009), Bloom, Jaimovich & Floetotto (2011)...

Data: Surveys of professional forecasters

- US (Philadelphia Fed)
  - Since 1969/Quarterly/$\simeq$ 30 institutions
  - 1Y GDP deflator inflation within the US
- Euro area (ECB)
  - Since 1999/Quarterly/$\simeq$ 60 institutions
  - 1Y headline inflation within the Euro-area
- Provide
  - Individual mean point forecasts
  - Individual probabilistic assessments for a range of inflation scenarios

Individual distributions of inflation risk

- Smoothing individual discontinuous probability distributions
  - Engelberg, Manski & Williams (2009)
  - Best fit of a beta distribution: $\widehat{F}_{it}(\pi_{t+h})$
  - Individual quantiles: $\widehat{q}_{it}(p) = \widehat{F}_{it}^{-1}(p)$
- Other individual information
  - Point forecasts: $\widehat{\pi}^{e}_{it,t+h}$
  - Individual variance of point estimates: $\widehat{\sigma}^2_{it}$ (using $\widehat{\pi}^{e}_{it,t+h}$ and $\widehat{F}_{it}(\pi_{t+h})$)

Measures of inflation risks

- Mean point forecasts (consensus):

$$\widehat{\text{MPF}}_t = (1/n_t)\sum_i \widehat{\pi}^e_{it,t+h}$$

- Disagreement:

$$\widehat{\text{DIS}}_t = (1/n_t)\sum_i (\widehat{\pi}^e_{it,t+h} - \widehat{\text{MPF}}_t)^2$$

- Uncertainty:

$$\widehat{\text{UNC}}_t = (1/n_t)\sum_i \widehat{\sigma}^2_{it}$$

Measures of inflation risks

- Inflation-at-risk:

$$\widehat{\text{I@R}}_t(p) = (1/n_t)\sum_i \widehat{q}_{it}(p)$$

- Special case: median,

$$\widehat{\text{MED}}_t = (1/n_t)\sum_i \widehat{q}_{it}(.5)$$

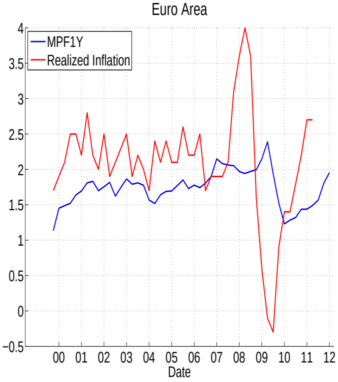
- Interquantile-range (dispersion):

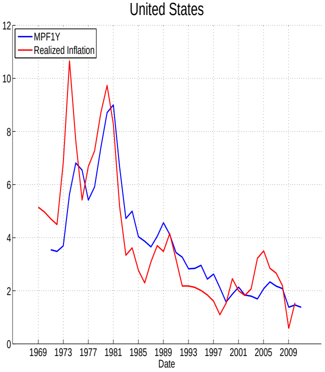
$$\widehat{\text{IQR}}_t(p) = (1/n_t)\sum_i [\widehat{q}_{it}(1-p) - \widehat{q}_{it}(p)]$$

- Asymmetry:

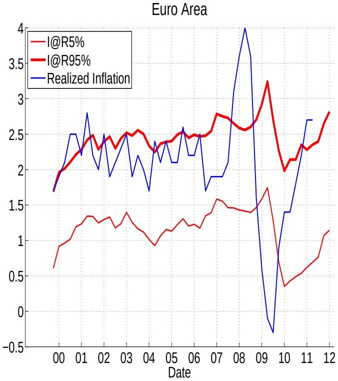
$$\widehat{\text{ASY}}_t(p) = (1/n_t)\sum_i \{[\widehat{q}_{it}(1-p) - \widehat{q}_{it}(.5)] - [\widehat{q}_{it}(.5) - \widehat{q}_{it}(p)]\}$$

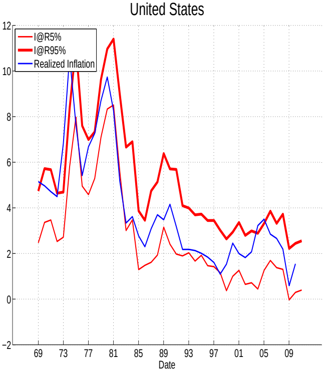
I@R in the EA & the US - Realizations and MPF



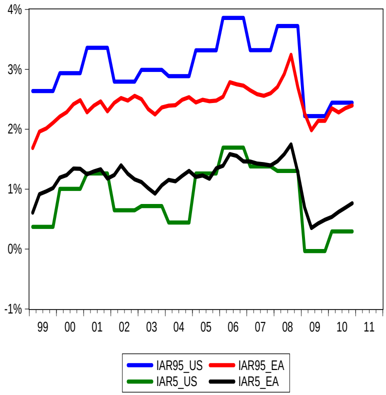


I@R in the EA & the US - Realizations and I@R

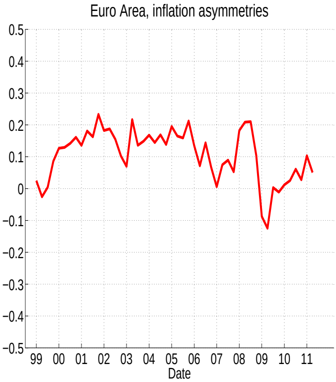


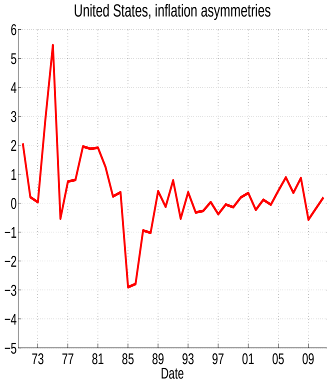


I@R in the EA & the US - Overlapping sample comparison



I@R in the EA & the US - Asymmetries in the risks





The information content of I@R

- We estimate

$$\pi_{t+k} = a_k + b_k \pi^e_{t+k|t} + \beta_k * Z_t + c_k \mathrm{IQR}^k_t(p) + d_k \mathrm{ASY}^k_t(p) + e_{t+k}$$

- Baseline specification
  - Risk $p = 5\%$
  - Horizon: $k = 1, 2, 3$ years
  - Expected inflation: MPF^k_t
  - Controls: $Z_t = (\text{Output gap}_t, \text{Energy price inflation}_t)$

The information content of I@R

- Specification preferred to

$$\pi_{t+k} = a_k + b_k \pi^e_{t+k|t} + \beta_k * Z_t + c_k \mathrm{I@R}^k_t(1-p) + d_k \mathrm{I@R}^k_t(p) + e_{t+k}$$

- Reason why
  - $I@R^k_t(p)$, $I@R^k_t(1-p)$ and $\pi^e_{t+h|t}$ are strongly correlated
  - collinearity issues

The information content of I@R

	(1)	(2)	(3)	(4)	(5)
$k = 1$ year ahead					
MPF	0.688	0.716	0.693	0.716	0.519
	[6.913]	[7.761]	[7.231]	[7.612]	[6.593]
IQR		-0.162		-0.136	-0.135
		[-1.299]		[-1.091]	[-1.827]
ASY			3.925	3.845	3.576
			[2.861]	[2.634]	[2.773]
Lagged inf					0.215
					[2.128]
intercept	0.342	0.57	0.356	0.546	0.579
	[0.966]	[1.227]	[0.979]	[1.106]	[1.489]
$\overline{R}^2$	0.81	0.811	0.823	0.824	0.831

The information content of I@R

	(1)	(2)	(3)	(4)	(5)
$k = 2$ years ahead					
MPF	0.903	0.941	0.905	0.935	0.648
	[3.597]	[3.89]	[4.204]	[4.422]	[2.481]
IQR		-0.226		-0.178	-0.175
		[-1.181]		[-0.86]	[-1.037]
ASY			7.306	7.204	6.729
			[2.643]	[2.549]	[2.162]
Lagged inf					0.349
					[1.305]
intercept	0.523	0.841	0.563	0.812	0.797
	[0.821]	[1.058]	[0.846]	[1.025]	[1.097]
$\overline{R}^2$	0.511	0.512	0.558	0.558	0.575

The information content of I@R

	(1)	(2)	(3)	(4)	(5)
$k = 3$ years ahead					
MPF	0.936	0.979	0.935	0.969	0.425
	[3.804]	[3.965]	[3.984]	[4.303]	[1.284]
IQR		-0.256		-0.206	-0.194
		[-1.148]		[-0.902]	[-1.193]
ASY			7.857	7.746	6.639
			[2.092]	[2.029]	[1.854]
Lagged inf					0.768
					[1.742]
intercept	0.75	1.117	0.811	1.104	0.905
	[1.027]	[1.15]	[0.984]	[1.063]	[1.151]
$\overline{R}^2$	0.303	0.304	0.356	0.355	0.443

The information content of I@R

- We estimate

$$\pi_{t+k} = a_k + b_k \pi^e_{t+k|t} + \beta_k * Z_t + c_k \mathrm{UNC}^k_t + d_k \mathrm{ASY}^k_t + e_{t+k}$$

- Expected inflation:
  - MED^k_t
  - π_t
- Uncertainty:
  - survey-based uncertainty
  - disagreement
  - realized VOL
  - GARCH
- Others:
  - forecast errors
  - linear extrapolation

The information content of I@R

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$k = 1$ year ahead								
EXP	0.705	1.181	0.514	0.407	0.475	0.51	0.668	0.516
	[3.319]	[5.003]	[5.909]	[2.539]	[2.796]	[5.744]	[2.627]	[6.929]
UNC	-0.291	-0.028	-0.275	0.489	0.354	0.122	-0.232	-n0.13
	[-1.191]	[-0.149]	[-1.652]	[2.022]	[1.444]	[0.543]	[-n1.507]	[-2.076]
ASY	3.68	3.315	3.652	3.489	2.843	3.587	3.996	0.493
	[2.205]	[2.125]	[2.724]	[2.579]	[2.122]	[2.509]	[2.892]	[1.225]
LAG	0.03	-0.649	0.213	0.198	0.222	0.211	-0.619	0.225
	[0.183]	[-2.329]	[1.958]	[1.748]	[1.865]	[1.873]	[-3.053]	[2.807]
intercept	0.653	0.743	0.527	0.357	0.357	0.317	0.16	0.538
	[1.768]	[2.332]	[1.43]	[1.195]	[1.06]	[0.935]	[0.293]	[1.617]
$\overline{R}^2$	0.838	0.829	0.831	0.838	0.84	0.831	0.34	0.822

The information content of I@R

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$k = 2$ years ahead								
EXP	0.505	1.414	0.644	0.487	0.582	0.624	0.623	0.662
	[1.526]	[4.235]	[2.429]	[1.588]	[2.024]	[2.486]	[1.825]	[2.423]
UNC	-0.237	-0.098	-0.387	0.7	0.55	0.049	-0.247	-0.126
	[-0.666]	[-0.324]	[-0.927]	[1.663]	[2.328]	[0.204]	[-1.238]	[-0.904]
ASY	6.668	6.477	6.829	6.615	5.583	6.8	7.036	1.545
	[1.811]	[1.989]	[2.217]	[2.298]	[2.05]	[2.202]	[2.56]	[1.826]
LAG	0.357	-1.168	0.345	0.316	0.358	0.348	-0.371	0.345
	[1.017]	[-4.371]	[1.283]	[1.286]	[1.337]	[1.328]	[-1.021]	[1.202]
intercept	1.06	1.00	0.746	0.526	0.514	0.521	0.47	0.653
	[1.692]	[1.794]	[1.093]	[0.854]	[0.805]	[0.8]	[0.659]	[0.966]
$\overline{R}^2$	0.549	0.575	0.575	0.59	0.596	0.573	0.219	0.556

The information content of I@R

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$k = 3$ years ahead								
EXP	0.226	1.626	0.427	0.244	0.395	0.33	0.813	0.434
	[0.63]	[4.457]	[1.287]	[0.673]	[1.225]	[1.007]	[1.969]	[1.36]
UNC	-0.445	-0.325	-0.565	0.76	-0.065	-n0.522	-0.312	-0.145
	[-1.051]	[-0.905]	[-1.259]	[2.12]	[-n0.287]	[-1.343]	[-1.67]	[-1.184]
ASY	6.599	6.734	6.757	6.552	6.882	6.952	7.073	1.576
	[1.65]	[1.882]	[1.869]	[1.973]	[1.763]	[1.897]	[2.215]	[1.893]
LAG	0.826	-1.223	0.761	0.726	0.768	0.797	-0.2	0.752
	[1.806]	[-4.859]	[1.719]	[1.716]	[1.776]	[1.886]	[-0.647]	[1.643]
intercept	1.195	0.962	0.923	0.635	0.629	0.892	0.357	0.791
	[1.651]	[1.491]	[1.184]	[0.892]	[0.913]	[1.138]	[0.44]	[1.121]
$\overline{R}^2$	0.432	0.472	0.444	0.459	0.44	0.454	0.241	0.425

Monetary policy reaction to I@R

- Let i_t be the interest rate targeted by the central bank, we investigate

$$\Delta i_t^Q = \alpha + \beta * X_t + \gamma \mathrm{IQR}_t^k + \delta \mathrm{ASY}_t^k + u_t$$

- Baseline specification, controls: X_t
  - MPF_t^k, Lagged inflation, Output gap$_t$, Energy price inflation$_t$)
  - (Risk $p = 5\%$)

Monetary policy reaction to I@R

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Δi_t^Q	Δi_t^M	Δi_t^M	Δi_t^M	Δi_t^M
Sample period	1969-2011	1969-2011	1969-1979	1981-2011	1990-2011
IQR_t^h	-.08	-.05	-.32	-.02	-.04
	[-1.53]	[-1.15]	[-2.01]	[-.99]	[-1.46]
ASY_t^h	2.12	.93	1.27	1.13	.93
	[2.32]	[1.78]	[1.06]	[1.91]	[2.60]

Monetary policy reaction to I@R

- Endogenous reaction of I@R to policy?

$$\Delta i_t^M = \alpha + \beta * X_t + \gamma \mathrm{IQR}_t^h + \delta \mathrm{ASY}_t^h + u_t$$

- Shifts in policy?
  - Pre-Volcker: 1969–1979
  - Post-Volcker: 1981–2011
  - Great-moderation/Great recession: 1990–2011

Monetary policy reaction to I@R

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Δi_t^Q	Δi_t^M	Δi_t^M	Δi_t^M	Δi_t^M
Sample period	1969-2011	1969-2011	1969-1979	1981-2011	1990-2011
IQR_t^h	-.08	-.05	-.32	-.02	-.04
	[-1.53]	[-1.15]	[-2.01]	[-n.99]	[-1.46]
ASY_t^h	2.12	.93	1.27	1.13	.93
	[2.32]	[1.78]	[1.06]	[1.91]	[2.60]

Conclusion

- We introduced new survey-based measures of inflation risks
- We showed that
  - these measures have explanatory power of future inflation realizations beyond standard linear predictions
  - monetary authorities interact with these risks
- Our risk measure is model free
- Challenge: correspondance between our purely data driven measure and underlying structural interpretation