QUASI EX-ANTE INFLATION FORECAST UNCERTAINTY

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Aims

- How to estimate, using time series data, inflation uncertainty net of the effects of monetary policy decisions?
- How to assess an impact of monetary policy on the distribution of inflation forecast uncertainty

Plan

1 Introduction: why uncertainty and not volatility?

2 *Ex-post* and *ex-ante* uncertainties: assumptions, interpretation and modelling

3 The trick: approximation of the *ex-ante* from *ex-post* uncertainty

4 Empirical results

5 Conclusions

1. Introduction: why uncertainty and not volatility?

Volatility: observed or perceived dispersion (unconditional or conditional)

Measures:

- standard deviation
- identified ARCH/GARCH components
- stochastic volatility

Uncertainty: there is something in the air, which causes shortening investment contracts, increasing insurance premia, generates real option effect ('get-me-cash-quick, I'm worried'), *etc*.

Measures:

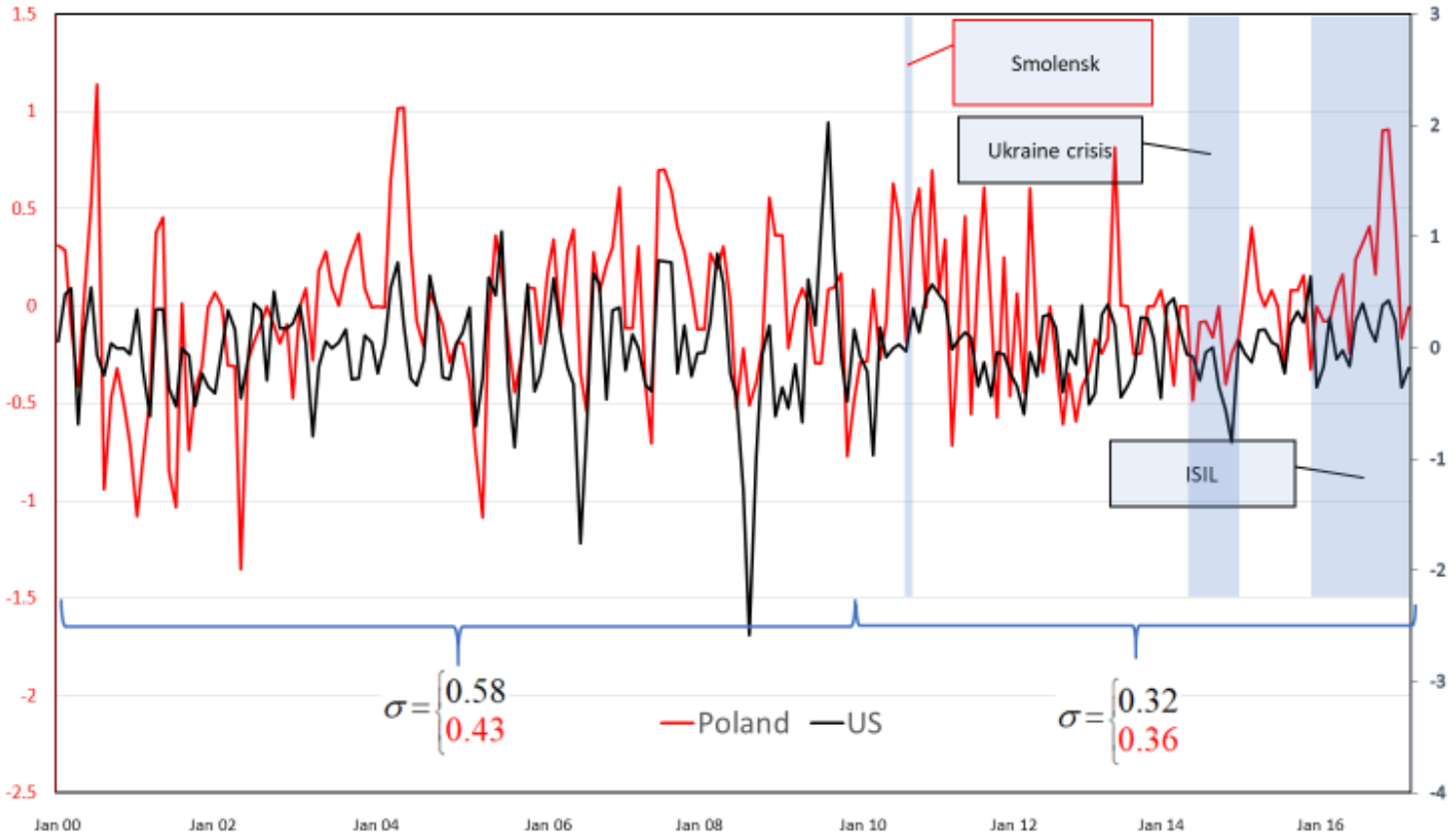
Knightian

- Text-mining and micro data: Baker, Bloom and Davis, QJE, 2016, Caldara and Iacoviello, FRB, 2016; Jurado, Ludvigson and Ng, AER, 2015

Non-Knightian (forecast)

- *Ex-ante* direct experts' assessments, uncertainty by disagreement (SPF's) forecasters; Clements, JBES, 2014 and others
- Distribution of *ex-post* forecast errors (this paper)

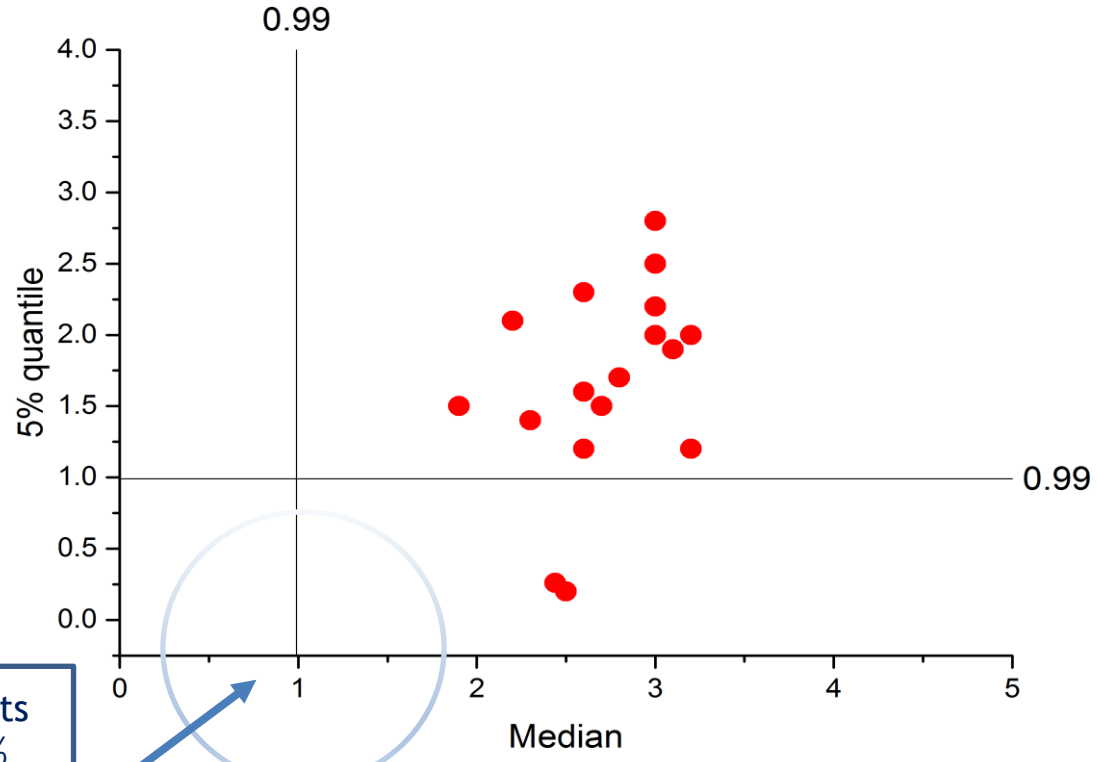
Example: First differences of CPI inflation, Jan 2000 – Apr 2017



After January 2010 volatility *decreased*, and uncertainty *increased*

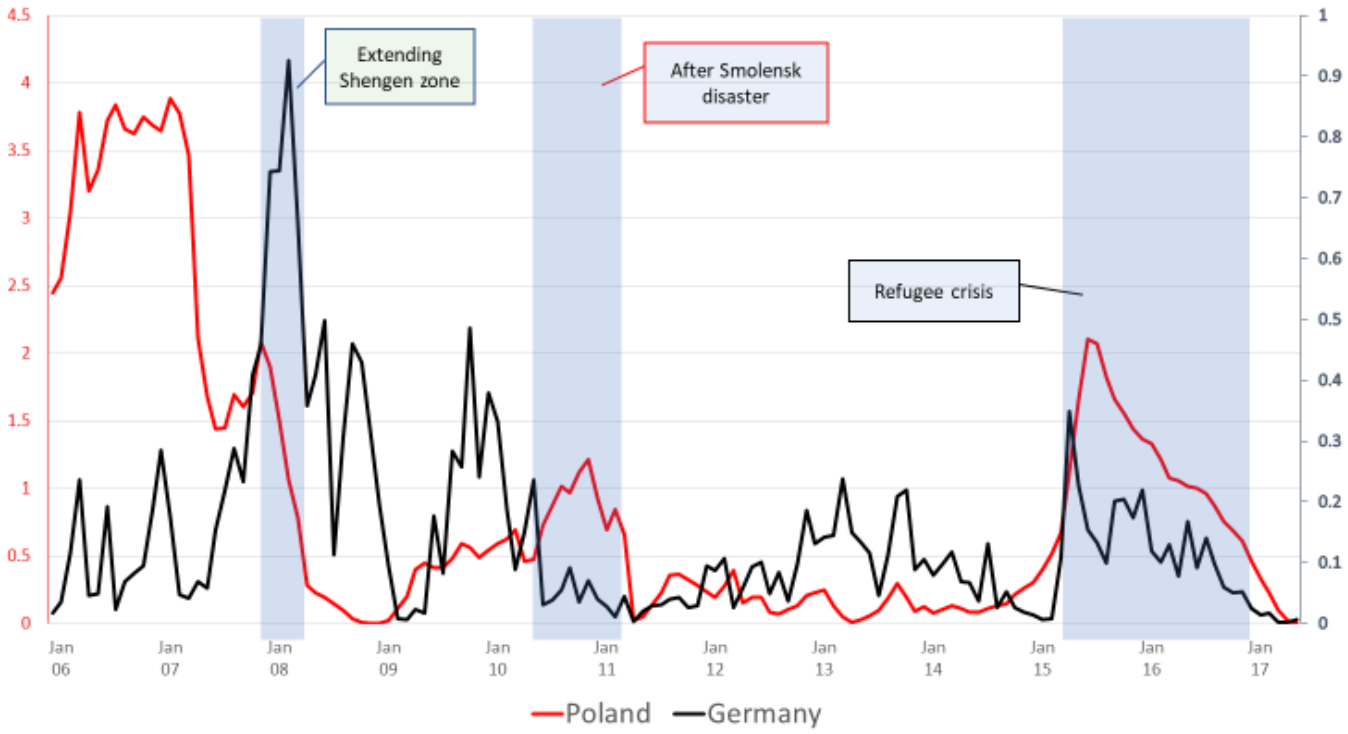
What's wrong with direct assessment? A lot!

Forecasts of annual average inflation and GDP in the 3rd Quarter of 2011 for 2013 according to the NBP Survey of Professional Forecasters (Poland) distributional forecast and realisations (0.99%)



Unbiased forecasts with realistic 5% quantile should be here

Ex-post forecast uncertainty, Germany and Poland, Nov 2005-Apr 2017



Methodology: temporal aggregation (by the inverted Samuelson discount function) of the GARCH-adjusted squares of ARMA-GARCH inflation forecast errors with forecast horizons from 1 to 24.

2. *Ex-post* and *ex-ante* uncertainties: assumptions, interpretation and modelling

Following Clements' (JBES, 2014):

At the population level, distributions of the *ex-post* and *ex-ante* uncertainties *should be identical*, if:

[1] E*x-ante* uncertainty is free from problems signalled above

[2] The series of data used for computing *ex-post* uncertainty (scaled *h*-steps ahead forecast errors) is stationary and ergodic in first three moments

We argue that:

- Even if [1] and [2] above are fulfilled, the *ex-post* and *ex-ante* uncertainties might differ, due to possible *policy effects undertaken on the basis of forecasts*
- If a policy is efficient, then variance of the *ex-post* distribution of uncertainty should be smaller than that of the *ex-ante* distribution

Modelling distribution of *ex-post* uncertainty

U - random variable which represents h-steps ahead uncertainty (ARMA-GARCH forecast errors scaled by conditional variance)

$$U = X + \alpha \cdot Y \cdot I_{Y>\tau_{up}} + \beta \cdot Y \cdot I_{Y<\tau_{low}}, \qquad (X,Y) \sim N\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}\sigma^2 & \rho\sigma^2\\ \rho\sigma^2 & \sigma^2\end{bmatrix}\right)$$

The distribution of U is called the *weighted skew normal distribution* (WSN, Charemza, Díaz and Makarova, 2015) and denoted as $U \sim \mathrm{WSN}_{\sigma}(\alpha, \beta, m, k, \rho)$.

Interpretation

X: distribution in the absence of any effective policy action

Y: distribution of warning signals

α, β: measure effects of the respective anti-inflationary (α) and pro-inflationary (β) monetary policy on the uncertainty

$\tau_{low}, \tau_{up}, \sigma^2$: 'policy thresholds' and variance of X and Y

ρ: coefficient explaining the degree of expertise (knowledge) of the signallers (*Orphanides-Williams, forecasters*, 2005, RED)

What if we do not believe the exact assessments but have lesser doubts regarding stationarity and third-order ergodicity of series of *ex-post* uncertainty?

3.'The trick': approximation of *ex-ante* from *ex-post* uncertainty (*quasi ex-ante* uncertainty)

The policy-unaffected uncertainty can partially be extracted as:

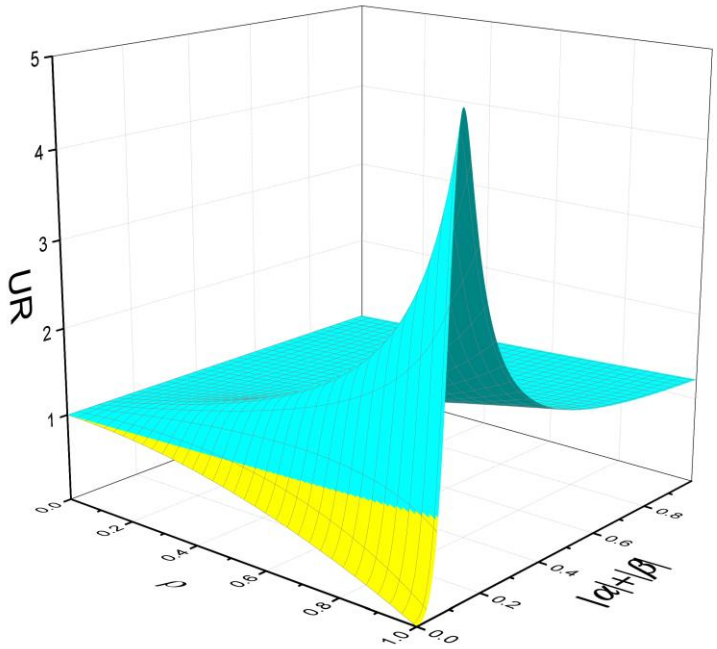
$$V = U - E(X \mid Y) = U - \rho Y = X - \rho Y + \alpha \cdot Y \cdot I_{Y>\bar{m}} + \beta \cdot Y \cdot I_{Y<\bar{k}}$$

Variance of V, σ_V^2, is a scalar measure of the *quasi ex-ante* uncertainty

Uncertainty Ratio: $\mathrm{UR} = \dfrac{\sigma_V^2}{RMSE_U^2}$ (can be computed using the estimated parameters of WSN)

For an effective policy we expect that $\mathrm{UR}>1$.

UR for the case where $\sigma^2 = 1$, $\alpha = \beta$, $\bar{m} = -\bar{k} = 1$ and for different values of ρ . Values of UR smaller than one are in a lighter shade (yellow)



Reasons for $UR < 1$

1 Overreaction to forecast signals (Morris & Shin, AER, 2002; Svensson, AER, 2006).

2. Frequent reaction to irrelevant forecast signals (Charemza and Ladley, IJF, 2016).

$|\alpha| + |\beta|$: compound strength of monetary policy

The concept of UR_{max}: $UR_{max}(\rho)$ - maximum of UR for a given ρ. The ratio of $NUR = UR / UR_{max}$ tells about possibility for policy improvement

Empirical results

Data:

ARMA-GARCH forecast errors for annual CPI inflation (monthly data) for 38 countries:

32 OECD countries

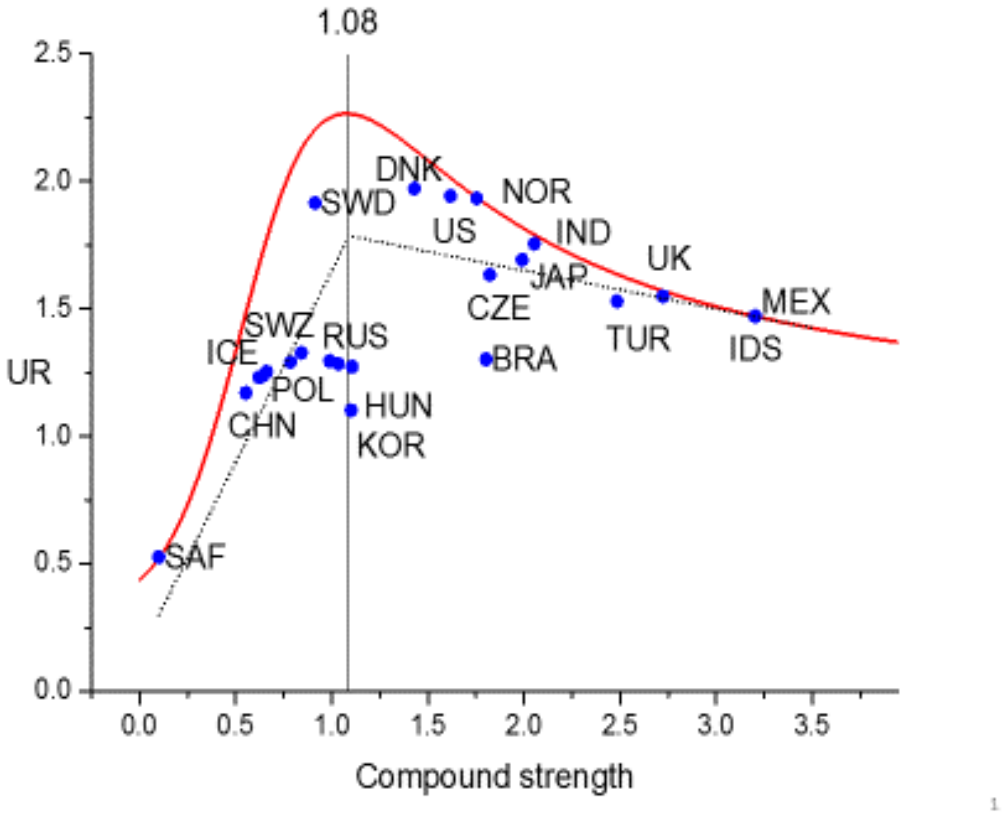
5 BRICS countries (Brazil, China, Russian Federation, India, and South Africa)

Indonesia

Data ends at March 2017

- Sequences of forecast errors are obtained in the *pseudo out-of-sample* way (Stock and Watson, 2007) for forecast horizons h= 1, …,24
- Observations on the uncertainty is obtained by scaling the forecast errors by the conditional standard deviation
- Parameters of WSN are estimated by the *simulated minimum distance method* (SMDE) with Hellinger (twice squared) criterion function

Theoretical and empirical UR's for IT countries, $h=12$, $\rho=0.75$



Red line: slice at $\rho=0.75$ of the earlier blue-yellow plot

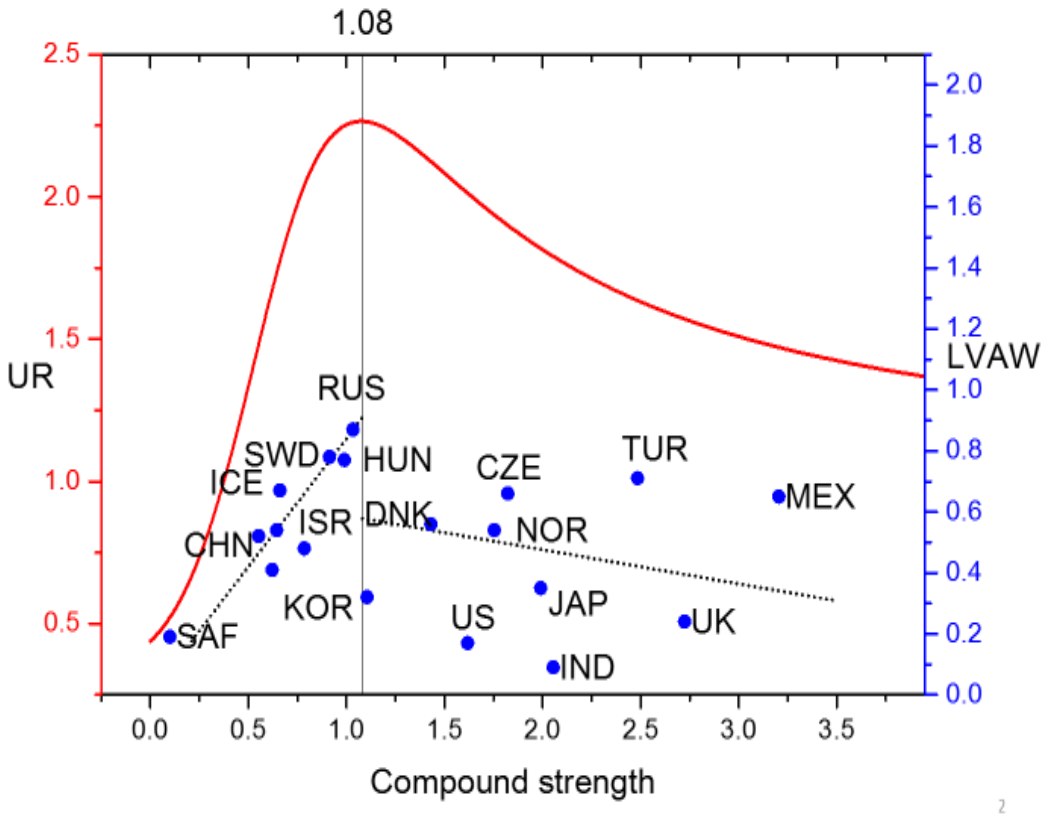
Compound strength=$|\alpha|+|\beta|$

$\mathrm{UR}_{\max}=1.08$

Distance of empirical points from the red line is due to asymmetry ($\alpha \neq \beta$).

UR's and central banks' independence (in fact, dependence), $h=12$, $\rho=0.75$

data: LVAW, Dincer and Eichengreen, (IJCB, 2014)



Red line: slice at $\rho=0.75$ of the earlier blue-yellow plot

Compound strength= $|\alpha|+|\beta|$

$\mathrm{UR}_{\max}=1.08$

As expected, the relationship between strength and measures of central banks' independence is positive for $\mathrm{UR}<\mathrm{UR}_{\max}$ and negative otherwise

Aggregated *quasi ex-ante* forecast uncertainty measures across horizons (long aggregation, that is by the inverted Samuelson discount function)
Data up to February 2013, BRICS countries, UK & US

Country	$RMSE_U$	σ_V	UR	NUR	σ
BRA	21.7	24.4	1.02	0.82	3.29
CHN	8.88	10.2	1.05	0.84	3.98
IND	23.4	27.4	1.17	0.94	3.78
RUS	22.4	25.0	0.98	0.79	3.99
SAF	5.51	6.71	**1.20**	**0.96**	3.76
UK	14.6	16.8	1.15	0.92	1.84
US	7.26	8.67	1.19	0.95	1.62

- Highest URs and NURs are in red
- No IT in India until 2016
- SAF and UK: reputable IT
- US: clandestine IT since 2012

It can be concluded that once monetary policy targets inflation, the monetary authorities should not allow the policies of inflation targeting and exchange rate stabilisation to be mixed, as they were in China and Russia before 2013

4.Conclusions

- We propose the concept of the *quasi ex-ante* forecast uncertainty which is (to a degree) free from effects of economic policy
- Ratio of the *quasi ex-ante* to *the ex-post* uncertainty (measured by RMSE), called the *uncertainty ratio*, quantifies the effects of economic policy in reducing uncertainty
- Inflation uncertainty ratio helps explaining the non-linear relationship between the strength of monetary policy and measures of central banks' independence
- Empirical findings reconfirm Barro (1986, JME) arguments on the consistency and reputation of the monetary policy

Computation of UR using the estimated parameters of WSN:

$$\mathrm{UR} \overset{def}{=} \frac{\sigma_V^2}{RMSE_U^2} = 1 + 2\rho \frac{-(\alpha D_m + \beta D_k) - \rho/2}{RMSE_{U^*}^2} - \frac{\left[E(U^*)\right]^2}{RMSE_{U^*}^2} \quad ,$$

where $U^* \sim \mathrm{WSN}_1(\alpha, \beta, m, k, \rho)$, $m = \bar{m}/\sigma$ and $k = \bar{k}/\sigma$,

$$E(U^*) = \alpha \cdot \varphi(m) - \beta \cdot \varphi(k), \; D_a = \int_{|a|}^{+\infty} t^2 \varphi(t) dt = 1 - \Phi(|a|) + |a|\varphi(a) \quad .$$

UR is equal to unity, if:

$\rho = 0$ and $bias^2(U) = 0$, or $\rho = -2\left[(\alpha D_m + \beta D_k) + bias^2(U)\right]$.

Note that UR does not depend on σ, but on the ratios $m = \bar{m}/\sigma$ and $k = \bar{k}/\sigma$