Dynamics of Monetary Policy Uncertainty and the Macroeconomy

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"Improving the public's understanding of the central bank's objectives and policy strategies reduces economic and financial uncertainty and thereby allows business and households to make more informed decisions."

$\sim$ Ben S. Bernanke, Chairman of the Federal Reserve
Speech to the Cato Institute 25th Annual Monetary Conference, November 17, 2007.

"The more fully the public understands what the function of the Federal reserve system is and on what grounds and on what indications its policies and actions are based, the simpler and easier will be the problems of credit administration in the United States."

$\sim$ Federal Reserve Board, Annual Report, 1923, p. 38.

Federal Reserve lacks transparency

- Evidence suggests transparency leads to greater stability and better macroeconomic outcomes.
- Dual mandate - what is the relative importance of price stability versus maximum employment?
- Magnitude of interest rate responses?

Purpose

Measure monetary policy uncertainty (MPU); measure effect on:

1. The *level* of output, employment, and inflation.
2. The *volatility* output, employment, and inflation.

Avoid DSGE to impose few assumptions on structure of the macroeconomy.

- Cecchetti and Krause (2002)
  - 60 countries
  - Transparency and credibility leads to greater macroeconomic stability.
- Cecchetti, Flores-Langunes, and Krause (2006)
  - 20 countries
  - Better monetary policy explains 80% reduction in macroeconomic volatility since early 1980s.
- Cecchetti and Ehrmann (2002) - world
  Bernanke and Mishkin (1997) - United States
  - Policy focus on inflation stability leads to greater inflation and output stability.

- Grier and Perry (2000); Fountas (2001); Fountas, Karanasos, and Kim (2002, 2006), Grier et al. (2004), Fountas and Karanasos (2007)
- Find inflation uncertainty (as evidenced of from heteroskedasticity) decreases output growth.
- Do not focus specifically on uncertainty caused by *monetary policy*.
- Do not separate uncertainty from volatility.

- Taylor (1993) rule reasonably approximates theory and practice of monetary policy behavior.
- Taylor rule coefficients change.
  - Taylor (1999), Clarida, Gali, and Gerler (2000), Orphanides (2003)
- Interest rate smoothing, stronger response to output growth, lower trend inflation.
  - Coibion and Gorodnichenko (2009)

Ideal situations for constant gain learning

- Precedence of structural changes
- No a-priori knowledge on menu of structural changes and probability distributions
- Forecasting rule, but no knowledge of parameter values, or the structure of the whole economy.

Constant gain learning mechanism

- Every period, run a Taylor-rule least-squares regression on previous data.
- Weighted least squares - more recent observations have more weight.
- Regression forecast serves as expectation.

Empirical Taylor Rule

Monetary policy adjusts federal funds rate in response to:

- Inflation
- Output *growth*.
- Unemployment
- Past federal funds rate.

Agents' forecasts allow for time-varying coefficients, without imposing structure.

$$r_t = \alpha_{t,0} + \alpha_{t,r} r_{t-1} + \alpha_{t,\pi} \pi_{t-1} + \alpha_{t,g} g_{t-1} + \alpha_{t,u} u_{t-1} + \epsilon_t$$

Notation

Variables:
r_t: Federal Funds rate
π_t: inflation rate
g_t: growth rate
u_t: unemployment rate.
ϵ_t unexplained monetary policy.

Time Varying Coefficient Estimates:
$\alpha_{t,r}$: interest rate smoothing.
$\alpha_{t,\pi}$: response of interest rate to inflation.
$\alpha_{t,g}$: response of interest rate to growth.
$\alpha_{t,u}$: response to unemployment.
$\alpha_{t,0}$: related to average interest rate.

OLS Regression

$$\hat{\alpha}_t = \left(\sum_{\tau=0}^{t} X_\tau X_\tau' \right)^{-1} \left(\sum_{\tau=0}^{t} X_\tau' r_\tau \right)$$

- $X_\tau = [r_{t-1} \; \pi_{t-1} \; g_{t-1} \; u_{t-1}]'$ is vector of regressors.
- Predicted current interest rate: $E_t^* r_t = X_t' \hat{\alpha}_t$
- Unexplained policy: $\hat{\epsilon}_t = r_t - X_t' \hat{\alpha}_t$

Recursive Formulation

The OLS regression coefficients can be rewritten as:

$$\hat{\alpha}_t = \alpha_{t-1} + \gamma_t R_t^{-1} X_t (r_t - X_t' \hat{\alpha}_t)$$

$$R_t = R_{t-1} + \gamma_t (X_t X_t' - R_{t-1}),$$

where $\gamma_t = 1/t$ is the **learning gain**.

Constant-Gain Learning

Recursive Formulation

$$\hat{\alpha}_t = \alpha_{t-1} + \gamma R_t^{-1} X_t (r_t - X_t' \hat{\alpha}_t)$$

$$R_t = R_{t-1} + \gamma (X_t X_t' - R_{t-1}),$$

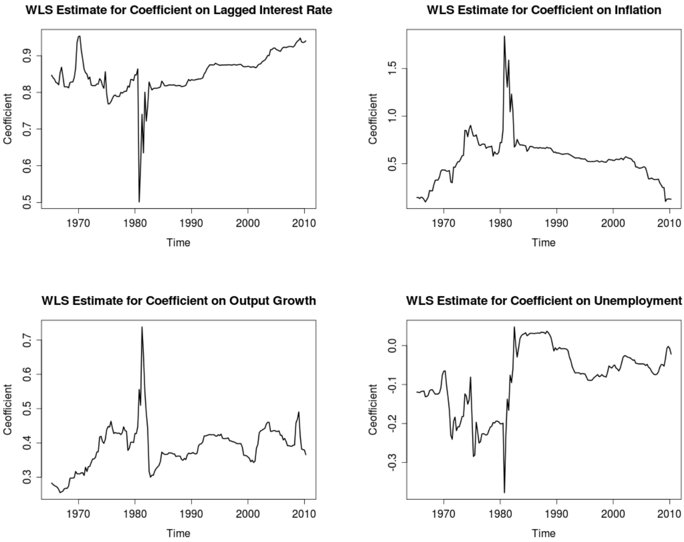
- Learning gain, $\gamma \in (0, 1)$, is constant, equal to the weight assigned to most recent observation.
- Typical estimates for $\gamma \sim 0.02$ (Milani (2008), Slobodyan and Wouters (2008)).

Standard Formulation

$$\hat{\alpha}_t = \left((1-\gamma) \sum_{\tau=1}^{t} \gamma^{\tau} X_{t-\tau} X_{t-\tau}' \right)^{-1} \left((1-\gamma) \sum_{\tau=1}^{t} \gamma^{\tau} X_{t-\tau} r_{t-\tau} \right).$$

Weight on $t - \tau$ observation declines geometrically with τ: $\omega_\tau = (1-\gamma)\gamma^\tau$.

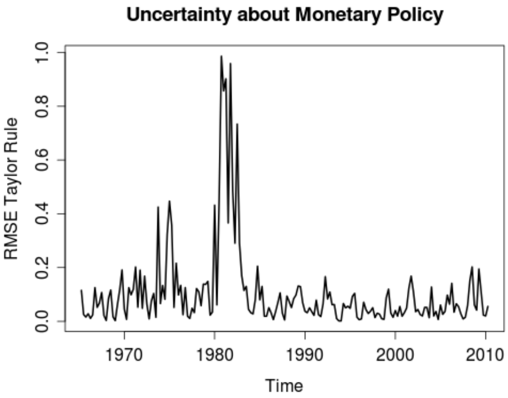
Evolving Estimates of Monetary Policy



- Unexplained monetary policy = time-varying residuals from constant gain least squares
- Larger variance of the residual implies
  - Larger variances for short-term and long-term forecasts.
  - Greater environment of uncertainty
- Isolates uncertainty due specifically to unpredictable monetary policy.
- MPU = Root weighted sum squared residuals:

$$MPU_t = m_{\gamma,t} = \sqrt{(1-\gamma)\sum_{\tau=1}^{t}\gamma^{\tau}(r_{t-\tau} - x'_{t-\tau}\hat{\alpha}_{t-\tau})^2}.$$

- Use calibrated values for $\gamma = 0.01, 0.02, 0.05$.


Uncertainty about Monetary Policy
RMSE Taylor Rule
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010
Time

Vector Autoregression (VAR)

- Measure the impact of MPU of levels of output growth, inflation, and unemployment.
- Augment VAR(1) with MPU to measure impact of MPU on levels

$$
\begin{aligned}
g_t = &\quad \beta_{g,0} + \beta_{g,g} g_{t-1} + \beta_{g,\pi} \pi_{t-1} + \beta_{g,u} u_{t-1} + \beta_{g,r} r_{t-1} + \beta_{g,\delta} + \lambda_g m_{\gamma,t} + \nu_{g,t} \\
\pi_t = &\quad \beta_{\pi,0} + \beta_{\pi,g} g_{t-1} + \beta_{\pi,\pi} \pi_{t-1} + \beta_{\pi,u} u_{t-1} + \beta_{\pi,r} r_{t-1} + \beta_{\pi,\delta} + \lambda_\pi m_{\gamma,t} + \nu_{\pi,t} \\
u_t = &\quad \beta_{u,0} + \beta_{u,g} g_{t-1} + \beta_{u,\pi} \pi_{t-1} + \beta_{u,u} u_{t-1} + \beta_{u,r} r_{t-1} + \beta_{u,\delta} + \lambda_u m_{\gamma,t} + \nu_{u,t},
\end{aligned}
$$

Autoregressive Conditional Volatility

- Measure the impact of MPU on macroeconomic volatility
- Residuals from VAR(1) subject to ARCH(1)
- Augmented with (squared) MPU

$$
\begin{aligned}
\eta^2_{g,t} = &\quad \theta_{0,g} + \theta_{g,g} \eta^2_{g,t-1} + \mu_g m^2_{\gamma,t} + \upsilon_{g,t} \\
\eta^2_{\pi,t} = &\quad \theta_{0,\pi} + \theta_{\pi,g} \eta^2_{\pi,t-1} + \mu_\pi m^2_{\gamma,t} + \upsilon_{\pi,t} \\
\eta^2_{u,t} = &\quad \theta_{0,u} + \theta_{u,g} \eta^2_{u,t-1} + \mu_u m^2_{\gamma,t} + \upsilon_{u,t}
\end{aligned}
$$

Dependent Variable:	Inflation (π_t)		Unemployment (u_t)		Output Growth (g_t)	
Constant	0.338	(0.239)	0.312***	(0.103)	0.296	(0.259)
r_{t-1}	0.064**	(0.026)	0.000	(0.011)	-0.032	(0.026)
g_{t-1}	0.435***	(0.117)	0.013	(0.050)	-0.044	(0.119)
π_{t-1}	0.040	(0.082)	-0.211***	(0.033)	0.313***	(0.085)
u_{t-1}	-0.024	(0.025)	0.967***	(0.013)	0.085**	(0.033)
MPU_t	-0.017	(0.088)	0.070	(0.046)	-0.072	(0.112)
R^2	0.367		0.971		0.175	

Heteroskedastic robust standard errors in parentheses.
* Significant at the 10% level. ** Significant at the 5% level.
*** Significant at the 1% level.

Fail to find evidence that monetary policy uncertainty affects these variables.

MPU Impact on Volatility: ARCH(1) Results

	Inflation Volatility		Unemployment Volatility		Output Growth Volatility	
Constant	0.321***	(0.109)	0.057***	(0.013)	0.487***	(0.101)
η_{t-1}^2	0.207***	(0.073)	0.086	(0.074)	0.112	(0.075)
MPU_t^2	0.022	(0.015)	0.006***	(0.002)	0.033**	(0.014)
R^2	0.058		0.083		0.053	

[1] Standard errors in parentheses.

* Significant at the 10% level. ** Significant at the 5% level.

*** Significant at the 1% level.

- Monetary policy uncertainty leads to less stability in unemployment and output growth.
- Fail to find evidence monetary policy uncertainty affects inflation volatility.

Conclusions

Macroeconomic Impact of MPU

- We do not find evidence that MPU affects the *average level* of unemployment, inflation, or output growth.
- We do find evidence that MPU adversely affects the stability of unemployment and output growth.
- Especially important as the Fed is conducted with unprecedented problems, and left with nontraditional policies.

Next steps

- Simulate counterfactual
- Quantify time-varying MPU impact on output, inflation, unemployment.