Optimal Monetary Policy

Lars E.O. Svensson
Sveriges Riksbank
www.princeton.edu/svensson

Norges Bank, November 2008
Outline

(Some parts build on Adolfson-Laséen-Lindé-Svensson 08a,b) (Sole responsibility...)

- What is optimal monetary policy (in theory and in practice)?
- Alternatives to optimal monetary policy?
- The loss function: Welfare or mandate?
- Interest-rate smoothing
- Resource utilization, potential output
- Commitment (in a timeless perspective)
- Conclusions, summary
What is optimal monetary policy (in theory)?

- Best way to achieve CB’s monetary-policy mandate
- Flexible inflation targeting: Set instrument rate so as to stabilize both inflation around inflation target and the real economy (resource utilization, output gap)
- Loss function (quadratic)

\[
E_t \sum_{\tau=0}^{\infty} \delta^\tau L_{t+\tau}
\]

\[
L_t = (\pi_t - \pi^*)^2 + \lambda (y_t - \bar{y}_t)^2
\]

- Model (linear)

\[
\begin{bmatrix}
X_{t+1} \\
Hx_{t+1|t}
\end{bmatrix} = A \begin{bmatrix}
X_t \\
x_t
\end{bmatrix} + B i_t + \begin{bmatrix}
C \\
0
\end{bmatrix} \varepsilon_{t+1}
\]

\(X_t\) predetermined variables in quarter \(t\), \(x_t\) forward-looking variables, \(i_t\) instrument rate, \(\varepsilon_{t+1}\) i.i.d. shocks
What is optimal monetary policy (in theory)?

- **Target variables**

\[ Y_t = \begin{bmatrix} \pi_t - \pi^* \\ y_t - \bar{y}_t \end{bmatrix} \]

\[ Y_t = D \begin{bmatrix} X_t \\ x_t \\ i_t \end{bmatrix} , \]

- **Loss function**

\[ L_t = Y_t' \Lambda Y_t \]

\( \Lambda \) positive semidefinite matrix of weights

\[ \Lambda = \begin{bmatrix} 1 & 0 \\ 0 & \lambda \end{bmatrix} \]
What is optimal monetary policy (in theory)?

- Minimize intertemporal loss function subject to model, under commitment in a timeless perspective
- Optimal policy, policy function, explicit instrument rule

\[ i_t = F_i \begin{bmatrix} X_t \\ \Xi_{t-1} \end{bmatrix} \]

\[ \Xi_{t-1} \] vector of Lagrange multipliers of model equations for forward-looking variables, from optimization in previous period

\[ \Xi_t = M_{\Xi X} X_t + M_{\Xi \Xi} \Xi_{t-1} \]
What is optimal monetary policy (in theory)?

Solution, optimal equilibrium

\[
\begin{bmatrix}
  x_t \\
  i_t
\end{bmatrix} =
\begin{bmatrix}
  F_x \\
  F_i
\end{bmatrix}
\begin{bmatrix}
  X_t \\
  \Xi_{t-1}
\end{bmatrix}
\]

\[
Y_t = \bar{D}
\begin{bmatrix}
  X_t \\
  \Xi_{t-1}
\end{bmatrix}
\]

\[
\begin{bmatrix}
  X_{t+1} \\
  \Xi_t
\end{bmatrix} = M
\begin{bmatrix}
  X_t \\
  \Xi_{t-1}
\end{bmatrix} +
\begin{bmatrix}
  C \\
  0
\end{bmatrix}
\varepsilon_{t+1}
\]
What is optimal monetary policy (in theory)?

- In theory: Solve for optimal policy function once and for all, then set instrument rate according to

  \[ i_t = \begin{bmatrix} F_x \\ F_i \end{bmatrix} \begin{bmatrix} X_t \\ \Xi_{t-1} \end{bmatrix} \]

  \[ \Xi_t = M\Xi X_t + M\Xi\Xi \Xi_{t-1} \]

- Not so in practice
What is optimal monetary policy (in practice)?

- Forecast targeting (mean forecast, approximate certainty equivalence)
- Choose instrument rate path so that the forecast of inflation and resource utilization “looks good”
- “Looks good”: Inflation goes to target and resource utilization (output gap) goes to normal (zero) at an appropriate pace
- Choose instrument-rate path (forecast) so as to minimize intertemporal loss function of forecast of inflation and resource utilization
What is optimal monetary policy (in practice)?

- Projections (conditional mean forecasts)
  \( z_{t+\tau,t} \) projection in period \( t \) of realization of variable \( z_{t+\tau} \) in period \( t + \tau \)
  \( z^t \equiv \{z_{t+\tau,t}\}_{\tau=0} \equiv \{z_t, z_{t+1}, \ldots\} \) projection path in period \( t \) of variable \( z_t \)

- Projection model (projection in period \( t \) for horizon \( \tau \geq 0 \), \( \varepsilon_{t+\tau,t} = 0 \))

\[
\begin{bmatrix}
X_{t+\tau+1,t} \\
Hx_{t+\tau+1,t}
\end{bmatrix} = A 
\begin{bmatrix}
X_{t+\tau,t} \\
x_{t+\tau,t}
\end{bmatrix} + B_i_{t+\tau,t}
\]

\[
\gamma_{t+\tau,t} = D 
\begin{bmatrix}
X_{t+\tau,t} \\
x_{t+\tau,t} \\
i_{t+\tau,t}
\end{bmatrix}
\]
What is optimal monetary policy (in practice)?

- Set of feasible projections \( \mathcal{T}(X_{t|t}) \) \( \equiv \) set of projections \( (i^t, Y^t, X^t, x^t) \) that satisfy the projection model for given \( X_{t,t} = X_{t|t} \) (estimated state of the economy)

- Loss function over projections (with “commitment term”, Svensson-Woodford 05)

\[
L(Y^t, x_{t,t} - x_{t,t-1}, \Xi_{t-1,t-1}) \equiv \\
\sum_{\tau=0}^{\infty} \delta^\tau Y'_{t+\tau,t} \Lambda Y_{t+\tau,t} + \frac{1}{\delta} \Xi'_{t-1,t-1}(x_{t,t} - x_{t,t-1})
\]

- Optimal policy projection (OPP) \( (\hat{i}^t, \hat{Y}^t) \) minimizes \( L(Y^t, x_{t,t} - x_{t,t-1}, \Xi_{t-1,t-1}) \) subject to \( (i^t, Y^t, x_{t,t}) \in \mathcal{T}(X_{t|t}) \)

- Linear set of feasible projections, convex loss function, OPP unique
What is optimal monetary policy (in practice)?

- OPP will satisfy \( (\Xi_{t-1,t} = \Xi_{t-1,t-1}) \)

\[
\begin{bmatrix}
\hat{x}_{t+\tau,t} \\
\hat{i}_{t+\tau,t}
\end{bmatrix} =
\begin{bmatrix}
F_x \\
F_i
\end{bmatrix}
\begin{bmatrix}
X_{t+\tau,t} \\
\Xi_{t+\tau-1,t}
\end{bmatrix}
\]

\[
Y_{t+\tau,t} = \bar{D} \begin{bmatrix}
X_{t+\tau,t} \\
\Xi_{t+\tau-1,t}
\end{bmatrix}
\]

\[
\begin{bmatrix}
X_{t+\tau+1,t} \\
\Xi_{t+\tau,t}
\end{bmatrix} = M
\begin{bmatrix}
X_{t+\tau,t} \\
\Xi_{t+\tau-1,t}
\end{bmatrix}
\]

- \( \hat{i}^t \) and \( \hat{i}_t \) depend on \( X_{t|t} \) (state of the economy) and \( \Xi_{t-1,t-1} \) (commitment)
What is optimal monetary policy (in practice)?

- Policy decision ($\hat{i}_t, \hat{Y}_t$): Implementation?
- $E_{t,t}$ is determined
- Announce $\hat{i}_t$ and $\hat{Y}_t$ (possibly more), set $i_t = \hat{i}_{t,t}$
- Private sector-expectations $E_t^p x_{t+1}$ are formed
- $x_t, Y_t$ are determined in period $t$
- In period $t + 1$, $\varepsilon_{t+1}$ is realized and $X_{t+1}$ is determined
- New policy decision in period $t + 1$ given $X_{t+1|t+1}, E_{t,t}$. 
What is optimal monetary policy (in practice)?

- Determinacy?
- May require out-of-equilibrium commitment (explicit or implicit). Deviate from $\hat{i}_{t,t}$ if economy deviates from optimal projection (Taylor principle, Svensson-Woodford 05)

\[
i_t = \hat{i}_{t,t} + \varphi(\pi_t - \hat{\pi}_t)
\]

\[
i_t = \hat{i}_{t,t} + \varphi[\pi_t - \pi^* + \frac{\lambda}{\kappa}(y_t - \bar{y}_t) - (y_{t-1} - \bar{y}_{t-1})]
\]
What is optimal monetary policy (in practice)?

- Judgment?

- Add judgment $z^t$ (add factors, Svensson 05, Svensson-Tetlow 05): $\mathcal{T}(X_{t|t}, z^t)$

  $$z^{t+1} = A_z z^t + \eta^{t+1}$$

- $\hat{i}^t$ and $\hat{i}_t$ depend on $X_{t|t}, z^t$ (everything relevant) and $\mathbb{E}_{t-1,t}$
What is optimal monetary policy (in practice)?

- Note:
  
  Object of choice is $i^t$, instrument rate path, not policy function $F_i$:

  Choose $i^t$ so as to minimize $L(Y^t, x_{t,t} - x_{t,t-1}, \Xi_{t-1,t-1})$ subject to $(i^t, Y^t, x_{t,t}) \in T(X_{t|t})$
What is optimal monetary policy (in practice)?

- Riksbank, February 2008: Subset of $\mathcal{T}(X_t|t)$, feasible projections $(X^t, x^t, i^t, Y^t)$

- Riksbank chose Main Scenario
Alternatives to optimal monetary policy?

- Add hoc policy
- With or without explicit instrument-rate path?
- Projections assuming historical policy function
  - Why follow historical policy (new board members)
  - Bad response for some shocks (ALLS)
- Simple instrument rule (Taylor-type rules, cross-checking only)
- No CB follows simple instrument rule
- All central banks use more information than the arguments of a simple instrument rule
- Revealed preference: CB deviates from simple instrument rules in order to do better policy
Why optimal monetary policy?

- Forecast targeting (Svensson 05, Woodford 07) better policy, and arguably better prescription: All info that affects the forecast of the target variables affects the instrument-rate path and current instrument-rate setting; all info that has no impact on forecast has no impact on instrument rate path and current setting.

- More explicit optimal policy: Try to make explicit and more systematic what is already going on implicitly.
The loss function: Welfare or mandate?

- Welfare-based loss function
  - Quadratic approximation of utility of representative agent
  - Very model-dependent; not robust
  - Very complex; all distortions show up
  - Difficult to verify
  - Bad history

- Simple loss function
  - Interpretation of mandate (price stability, medium-term inflation target, avoid (unnecessary) real-economy fluctuations)
  - Flexible inflation targeting: Stabilize inflation around inflation target and real economy (resource utilization, output gap)
  - Standard quadratic
Loss function: Parameters?

- Parameters?
  - Estimate: $\lambda_y = 1.1$, $\lambda_{\Delta i} = 0.37$
  - Vote
  - Revealed-preference experiments

- If not agreement on parameters
  - Generate alternative feasible policy projections by OPPs for different loss function parameters
  - Efficient alternative feasible policy projections to choose between
Interest-rate smoothing: $\lambda_{\Delta i}(i_t - i_{t-1})^2$?

- Empirical, but difficult to rationalize
- Not disturb markets
- Result of uncertainty, learning, estimation of current state of economy, Kalman filtering implies serial correlation
- Commitment, history dependence
- Less so recently: Fed, Riksbank, Bank of England
- Instrument-rate path adjustment, not just current instrument rate
Resource utilization, output gap, potential output

- Stability of real economy (resource utilization)
- Measures of resource utilization (gaps: output, employment, unemployment)
- Output gap between output and potential output: Potential output?
- (Stochastic) trend, unconditional flexprice, conditional flexprice, constrained efficient, efficient minus constant
- Capital and other state variables
Commitment term in loss function (Svensson-Woodford 05, Marcet-Marimon 98): \( \frac{1}{\delta} \mathbb{E}_{t-1}'(x_t - x_{t|t-1}) \)

- Cost of deviating from previous expectations
- Requires whole vector of Lagrange multipliers and forward-looking variables (23 in Ramses)
Commitment: Calculating initial $\Xi_{t-1}$

Adolfson-Laséen-Lindé-Svensson 08a

1. Assume past policy optimal: Equation for $\Xi_{t-1}$

$$\Xi_{t-1} = M_{\Xi X} X_{t-1} + M_{\Xi \Xi} \Xi_{t-2} = \sum_{\tau=0}^{\infty} (M_{\Xi \Xi})^\tau M_{\Xi X} X_{t-1-\tau}$$

2. Assume past policy systematic: Combine first-order conditions for shadow prices $\xi_t$ and $\Xi_t$ and estimated instrument rule with model equation, solve for $\Xi_{t-1}$

$$\bar{A}' \begin{bmatrix} \xi_{t+1} | t \\ \Xi_t \end{bmatrix} = \frac{1}{\delta} \bar{H}' \begin{bmatrix} \xi_t \\ \Xi_{t-1} \end{bmatrix} + \bar{W} \begin{bmatrix} X_t \\ x_t \\ i_t \end{bmatrix}$$

$$i_t = f_{iX} X_t + f_{ix} x_t$$
Conclusions, summary

- Do optimal monetary policy more explicitly
- Optimize over feasible set of projections rather than choosing policy function
- Loss function: Interpretation of CB mandate rather than welfare
- Loss function: Parameters
- Feasible in medium-sized DSGE models (Adolfson-Laséen-Lindé-Svensson 08a)
- Better than alternatives
- More work on measures of resource utilization, potential output
- Less interest-rate smoothing?
- Commitment in a timeless perspective feasible