

# Credible Forward Guidance

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<sup>1</sup>The views expressed in this presentation are not necessarily those of the Federal Reserve Board of Governors or the Federal Reserve System.

**Question:** What is the optimal **credible** forward guidance (FG) policy?

**Context:**

One particular form of FG policy at the ELB:


**“lower-for-longer” / “makeup” / “overheating commitment” policy**

- ▶ CB promises to keep the policy rate at the ELB for an extended period so as to generate a temporary overheating.
- ▶ Very effective (Eggertsson and Woodford (2003)).
- ▶ But, CB has an incentive to renege on this promise, ex post:  
**Time-inconsistency problem.**

Central banks have not adopted this overheating commitment policy.<sup>2</sup>

- ▶ The time-inconsistency problem was one key reason.
- ▶ See Bullard (2013), Carney (2012), Cœuré (2013), Plosser (2013), Williams (2011, 2012) [and other speeches referenced in Appendix G of our paper or Nakata (2015) : “Credibility of Optimal Forward Guidance at the Interest Rate Lower Bound.”].

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<sup>2</sup>...except for the Bank of Japan and the Czech National Bank. 

## Benoît Cœuré (ECB)

*"The main challenge of such [commitment-type] guidance is its inherent inconsistency over time and thus lack of credibility. When the time comes, the central bank may be tempted to deviate from its prior commitment: once the benefits of higher inflation expectations in terms of front-loaded spending have been reaped, the central bank may not be willing to pay the bill in terms of higher inflation afterwards. [...]"*

*This is a possible explanation why, in practice, central banks have refrained from using forward guidance in a way that implies a major change in strategy." (September 2013)*

However, there is a growing interest in adopting this type of policy in future crises.

- ▶ Bernanke (2018), Williams (2018), Yellen (2018).
- ▶ Key issue in the current Federal Reserve strategy review (see Clarida (2019) and September 2019 FOMC Minutes).

*“I believe the FOMC should seriously consider pursuing a **lower-for-longer or makeup strategy** for setting short rates when the zero lower bound binds and should articulate its intention to do so before the next zero lower bound episode.”*

Janet Yellen (2018), “Comments on Monetary Policy at the Effective Lower Bound”

A way to overcome the criticism that the commitment policy is time-inconsistent: **Reputation**

Nakata (2018) (“Reputation and Liquidity Traps,” *RED*) shows that the *optimal* commitment policy can be made time-consistent if

- ▶ (i) reneging on the promise leads to loss of reputation, making lower-for-longer policies ineffective in future crises.
- ▶ (ii) crises occur with sufficient frequency.
- ▶ (iii) loss of reputation lasts for sufficiently long.

However, Nakata (2018) is silent about what CB can credibly achieve if the *optimal* commitment policy is not credible.

# What We Do

We characterize the best allocations the central bank can **credibly achieve** when the optimal commitment policy is not credible.

- ▶ by analyzing a series of the *optimal sustainable policy (OSP) problems* in a sticky-price model with ELB.
  - ▶ CB's optimization problem is subject to a sustainability constraint.
  - ▶ ...assuming that, if deviation from the OSP occurs, the economy falls into a discretionary regime (as in Nakata (2018)) for N periods.

# Main Results

Even when the optimal commitment policy (OCP) is not credible, CB can still credibly adopt lower-for-longer policies.

- ▶ Shorter ELB duration and smaller overheating of the economy under optimal sustainable policy (OSP) than under OCP.
- ▶ Welfare cost of ELB is substantially smaller under OSP than under optimal discretionary policy.

OSP is less history-dependent than OCP.

- ▶ Easier for CB to explain to the public.



# Related Literature

- ▶ Credibility in macroeconomics:
  - ▶ Classic papers: Stokey (1991), Chari and Kehoe (1990), Chang (1998), Phelan and Stacchetti (2001).
  - ▶ Inflation bias: Barro and Gordon (1983), Rogoff (1987).
  - ▶ Stabilization bias: Kurozumi (2008), Sunakawa (2015).
  - ▶ ELB: Nakata (2018), Walsh (2018), Dong and Young (2019).
- ▶ Monetary policy at the ELB:
  - ▶ Reifschneider and Williams (2000), Eggertsson and Woodford (2003), Jung et al. (2005), Adam and Billi (2006)

# Outline of the Talk

- ▶ Model with a static Phillips curve
  - ▶ Setup
  - ▶ Results
- ▶ Model with a forward-looking Phillips curve

# Model

Private-sector equilibrium conditions:

$$y_t(s^t) = \mathbb{E}_t y_{t+1}(s^{t+1}) - \sigma(i_t(s^t) - \mathbb{E}_t \pi_{t+1}(s^{t+1}) - s_t)$$

$$\pi_t(s^t) = \kappa y_t(s^t)$$

$$i_t(s^t) \geq i_{ELB}$$

Notation:  $s^t := \{s_j\}_{j=1}^t$ .

A state-contingent sequence of output, inflation, and the policy rate,  $\{y_t(s^t), \pi_t(s^t), i_t(s^t)\}$ , is called *an outcome*.

- ▶ an outcome that satisfies EE, PC, and ELB constraint is called *a competitive outcome*.

# An exogenous shock ( $s_t$ )

Governed by a two-state Markov shock:

- ▶ In the normal/high state,  $s_t = r^* > 0$ .
- ▶ In the crisis/low state  $s_t = r_c < 0$ .
- ▶ Crisis frequency:  $\text{Prob}(s_{t+1} = r_c | s_t = r^*) = p_H$ .
- ▶ Crisis persistence:  $\text{Prob}(s_{t+1} = r_c | s_t = r_c) = p_L$ .

Notation:  $\mathbb{S} := \{r^*, r_c\}$ .

# Value

$$V_t(s^t) = u(y_t(s^t), \pi_t(s^t)) + \beta \mathbb{E}_t V_t(s^{t+1})$$

with

$$u(y, \pi) = -\frac{1}{2}[\pi^2 + \lambda y^2]$$

# Three types of outcomes

- ▶ Discretionary outcome [“optimal discretionary policy (ODP)”].
- ▶ Commitment outcome [“optimal commitment policy (OCP)”].
- ▶ **Sustainable outcomes** [“optimal sustainable policies (OSPs)”].

# Discretionary outcome

At each period  $t$ , the discretionary CB's problem is given by

$$W_t(s_t) = \max_{i_t, y_t, \pi_t} u(y_t) + \beta \mathbb{E}_t W_{t+1}(s_{t+1})$$

subject to to the private-sector equilibrium conditions at time  $t$  and taking as given  $\{W_{t+1}(\cdot), y_{t+1}(\cdot), \pi_{t+1}(\cdot)\}$ .

Let  $\{W_d(\cdot), i_d(\cdot), y_d(\cdot), \pi_d(\cdot)\}$  be the time-invariant value and policy functions that solve this problem and in which the normal-state policy rate is positive.

**The discretionary outcome** is defined as, and denoted by  $\{i_{d,t}(s^t), y_{d,t}(s^t), \pi_{d,t}(s^t)\}_{t=1}^{\infty}$  such that  $y_{d,t}(s^t) = y_d(s_t)$ ,  $\pi_{d,t}(s^t) = \pi_d(s_t)$ , and  $i_{d,t}(s^t) = i_d(s_t)$ .

# Commitment outcome

At the beginning of  $t = 1$ , the central bank chooses a state-contingent sequence,  $\{i_t(s^t), y_t(s^t), \pi_t(s^t)\}_{t=1}^{\infty}$ , to maximize

$$V_1(s_1)$$

subject to the private sector equilibrium conditions for all  $t$ .

The commitment/Ramsey outcome is the solution to this problem and is denoted by  $\{i_{c,t}(s^t), y_{c,t}(s^t), \pi_{c,t}(s^t)\}_{t=1}^{\infty}$ . The sequence of values associated with the commitment outcome is denoted by  $\{V_{c,t}(s^t)\}_{t=1}^{\infty}$ .



# Sustainable outcomes

For any positive integer  $N$  (duration of “reputation loss”), at the beginning of  $t = 1$ , the central bank chooses a state-contingent sequence,  $\{i_t(s^t), y_t(s^t), \pi_t(s^t)\}_{t=1}^{\infty}$ , to maximize

$$V_1(s_1)$$

subject to the private sector equilibrium conditions and a sustainability constraint for all  $t$  and after all  $s^t$ .

$$V_t(s^t) \geq W_d^N(s_t),$$

where

- ▶ for  $N = 1$ :  $W_d^1(s) = \max u(y, \pi) + \beta \mathbb{E}[V_1(s')|s]$
- ▶ for  $N \geq 2$ :  $W_d^N(s) = \max u(y, \pi) + \beta \mathbb{E}[W_d^{N-1}(s')|s]$

Note:  $W_d^{\infty}(s_t) = W_d(s_t)$ .

The sustainable outcome with  $N$ -period reputation loss is the solution to this problem and is denoted by  $\{i_{s,t}^N(s^t), y_{s,t}^N(s^t), \pi_{s,t}^N(s^t)\}_{t=1}^{\infty}$ . The sequence of values associated with the sustainable outcome is denoted by  $\{V_{s,t}^N(s^t)\}_{t=1}^{\infty}$ .

Once we compute **the sustainable outcome**, we can construct a plan—a pair of central bank and private-sector strategies—that induces it and that is sustainable.

CB strategy ( $\sigma_{g,t}$ ): A sequence of functions mapping a history of shocks and a history of policy rates (up to the previous period) into today's policy rate.

- ▶  $\sigma_{g,1} : \mathbb{S} \rightarrow \mathbb{R}$ , and  $\sigma_{g,t} : \mathbb{R}^{t-1} \times \mathbb{S}^t \rightarrow \mathbb{R}$  for all  $t \geq 2$ .

PS strategy ( $\sigma_{p,t}$ ): A sequence of functions mapping a history of shocks and a history of policy rates into today's inflation and output.

- ▶  $\sigma_{p,t} : \mathbb{R}^t \times \mathbb{S}^t \rightarrow \mathbb{R} \times \mathbb{R}$  for all  $t$ .

\*\*\*Note that a plan induces an outcome.

A plan is said to be sustainable (credible/time-consistent) if “neither CB/private-sector agents have incentives to deviate from the instruction given by the plan.”

Construct the **revert-to-discretion plan** in which

- ▶ the economy follows the sustainable outcome as long as the central bank chooses a policy rate consistent with the sustainable outcome.
- ▶ if the central bank deviates from the policy rate consistent with the sustainable outcome, the economy will be in the discretionary regime for  $N$  periods. [“the central bank loses reputation”; “punishment”]

By construction,

- ▶ the **revert-to-discretion plan** induces **the sustainable outcome**.
- ▶ the **revert-to-discretion plan** is sustainable (because  $V_{s,t}(s^t) \geq W_d^N(s_t)$ )

## Outcome

- Commitment outcome
- Sust. outcome ( $N=\infty$ )
- Sust. outcome ( $N=60$ )
- Sust. outcome ( $N=20$ )
- Discretionary outcome

## Plan

✖ Ramsey plan

✖ RTD plan ( $N=\infty$ )

✖ RTD plan ( $N=60$ )

✖ RTD plan ( $N=20$ )

✖ RTD plan ( $N=0$ )

**A set of sustainable  
plans**

Note: RTD means Revert-To-discretion.

# Outline of the Talk

- ▶ Model with a static Phillips curve
  - ▶ Setup
  - ▶ **Results**
- ▶ Model with a forward-looking Phillips curve

# Solution Method

We recurisify the infinite-horizon optimization problem by the method of Kehoe and Perri (2002) (a modification of Marcet and Marimon (2017)).

We then use a time-iteration method.

Table: Parameter Values

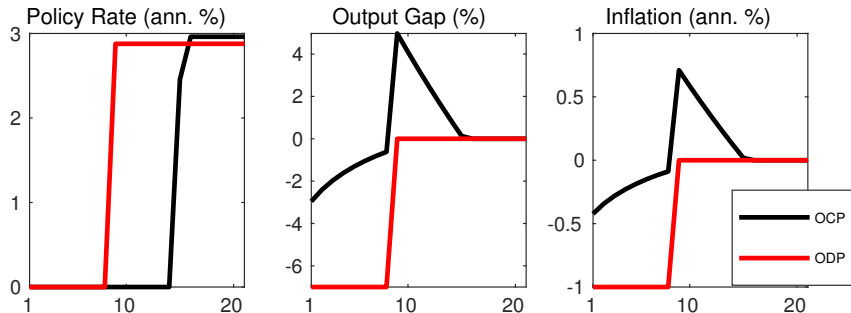
Parameter	Description	Values
$\beta$	Discount factor	0.9925
$\sigma$	IES	1
$\kappa$	Slope of the Phillips Curve	0.25/7
$i_{ELB}$	Effective lower bound	0
$N$	Punishment duration	$[20, 60, \infty]$
$p_H$	Frequency of the crisis state	0.5/100
$p_L$	Persistence of the crisis state	3/4
$r^*$	Natural-rate in the normal state	3/400
$r_c$	Natural-rate in the crisis state	**Chosen so that $y_d(s_t = r_c) = -0.07$

\*\*The recession severity consistent with Boneva, Braun, and Waki (2016).

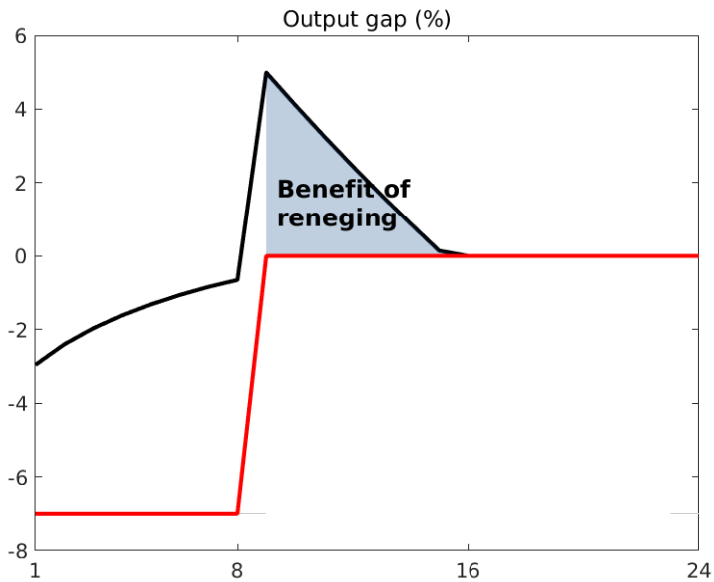
\*Note that the value of  $\lambda$  does not matter for allocations in the model with a static Phillips curve.



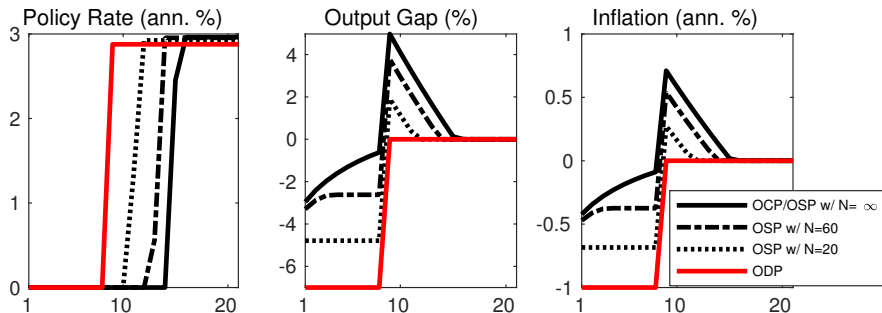
# Discretionary and commitment outcomes



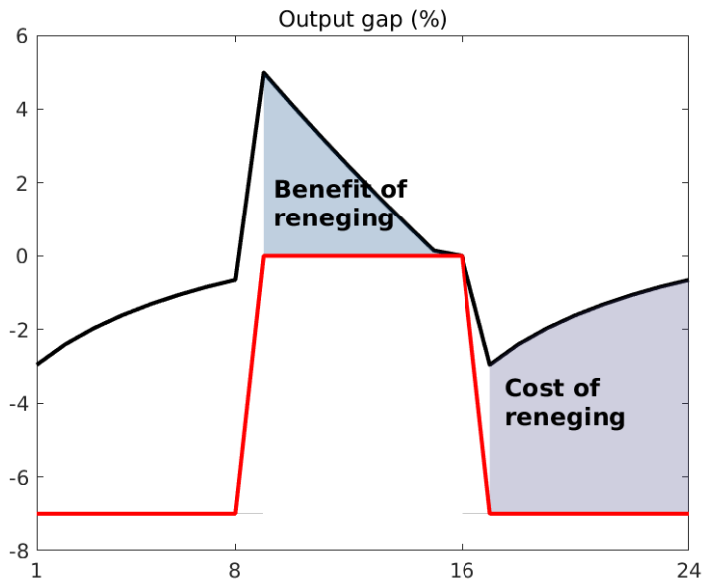
OCP: Optimal commitment policy, ODP: Optimal discretionary policy



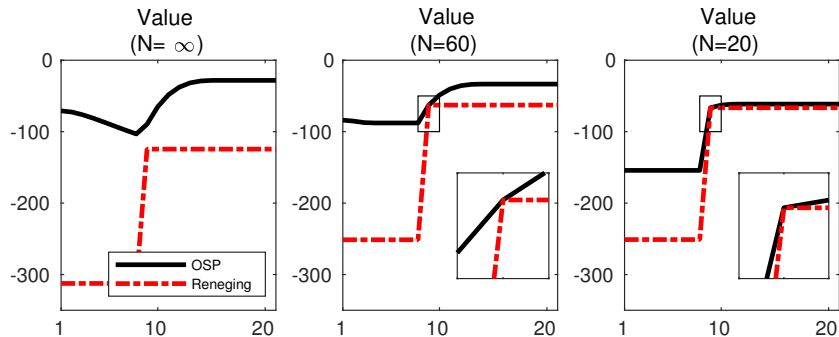
# Sustainable outcomes



OCP: Optimal commitment policy, ODP: Optimal discretionary policy, OSP: Optimal sustainable policy



# Sustainable outcomes



# Mechanism

Benefit and cost of reneging on the lower-for-longer promise:

- ▶ Benefit: Eliminate the temporary overheating of the economy.
- ▶ Cost: cannot promise any overheating in future crises.

For the promise to be credible, the cost of reneging has to be larger than, or equal to, its benefit.

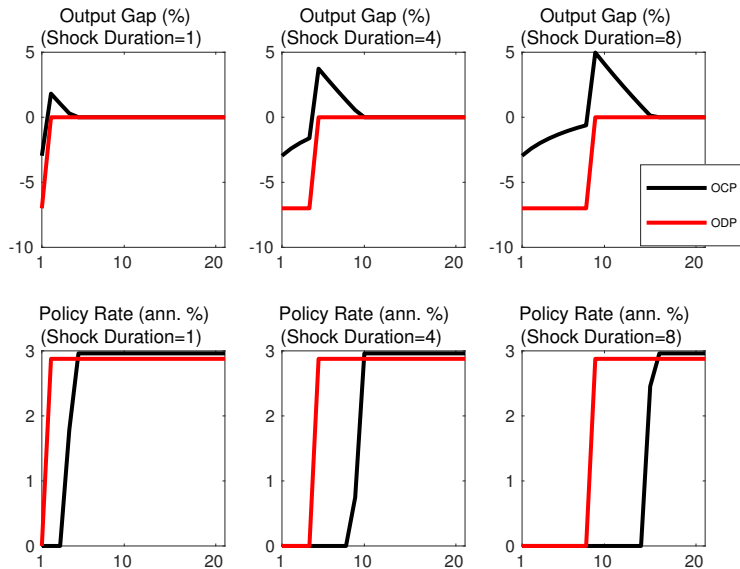
- ▶ when the punishment lasts for shorter, the cost is smaller.
- ▶ so, for the promise to be credible, the promised overheating has to be smaller.

# Welfare

Table: Welfare Cost of ELB

	$\text{abs}(\mathbb{E}[V])$
Optimal Commitment	29.5 (0.23)
Optimal Sustainable ( $N = \infty$ )	29.5 (0.23)
Optimal Sustainable ( $N = 60$ )	34.6 (0.27)
Optimal Sustainable ( $N = 20$ )	63.4 (0.49)
Optimal Discretion	128.1 (1)

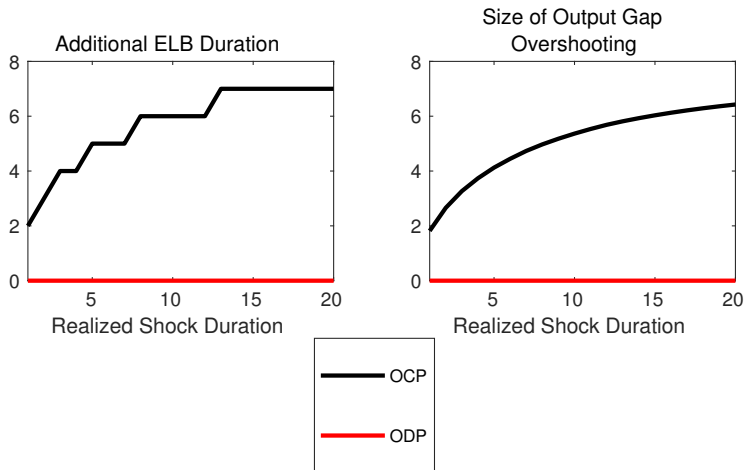
# History-dependence



OCP: Optimal commitment policy, ODP: Optimal discretionary policy

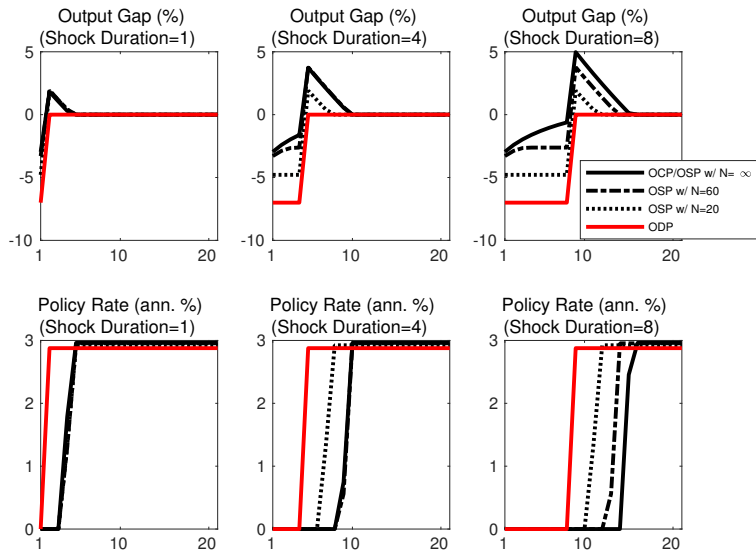


# History-dependence



OCP: Optimal commitment policy, ODP: Optimal discretionary policy

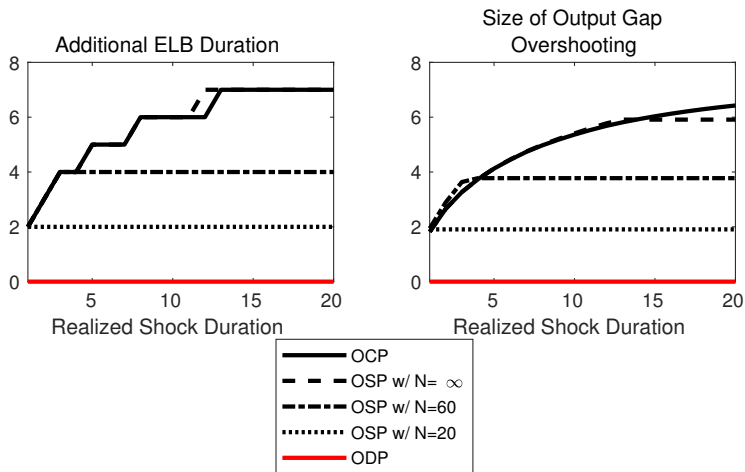
# History-dependence



OCP: Optimal commitment policy, ODP: Optimal discretionary policy, OSP: Optimal

sustainable policy

# History-dependence



OCP: Optimal commitment policy, ODP: Optimal discretionary policy, OSP: Optimal sustainable policy

# History-dependence

When  $N$  is sufficiently small, there is no history-dependence under OSP:

- ▶ OSP becomes (almost) identical to “simple FG” policies of Walsh (2018).

One key criticism against OCP is that it is too complex for the public to understand it.

- ▶ Our OSP is less complex than the OCP, and thus overcomes this criticism.

# “Reasonable” value for $N$ (I)

Table: Tenure duration of chairpersons

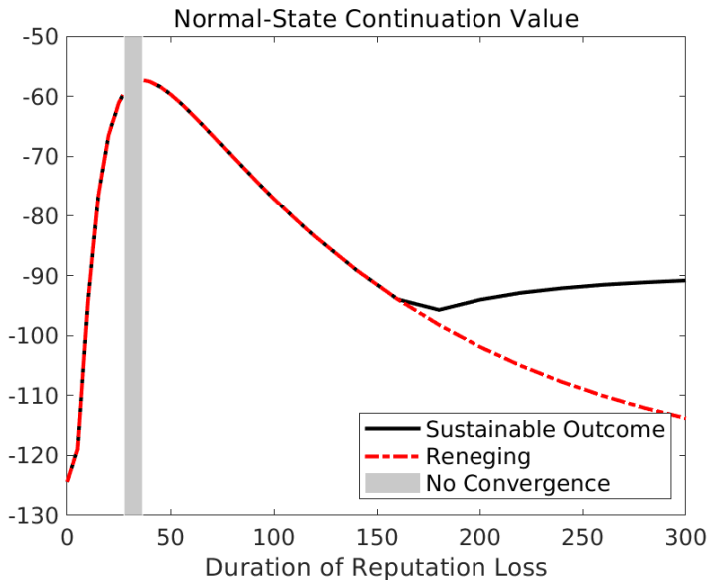
	Average in yrs (since 1946)	Max in yrs (since 1946)
FRB*	8.1	18.8 (Martin)
ECB	6.5	8 (Trichet)
Bank of Canada	9.7	14 (Boey)
Bank of Japan	4.9	8.5 (Ichimada)
Bank of England	8.5	12 (Cobbold)
Riksbank	6.1	18 (Asbrink)
Swiss National Bank	7.4	11 (Leutwiler)

\*The tenure of Alan Greenspan lasted for 18 years and 6 months.

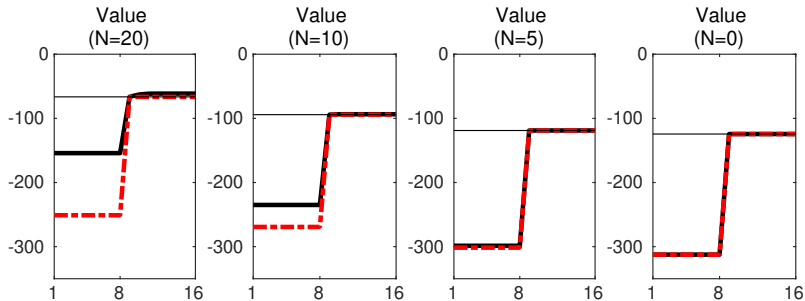
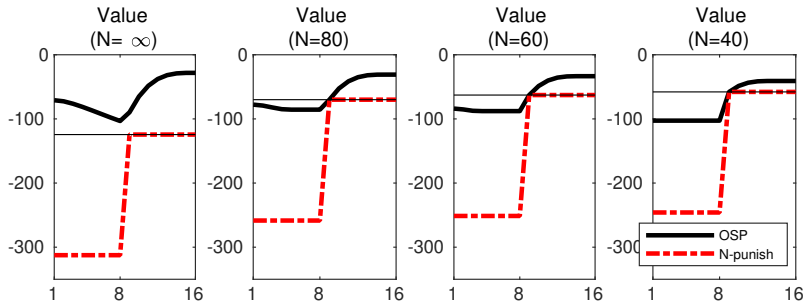
## “Reasonable” value for $N$ (II)

Two ways to refine the set of sustainable plans:

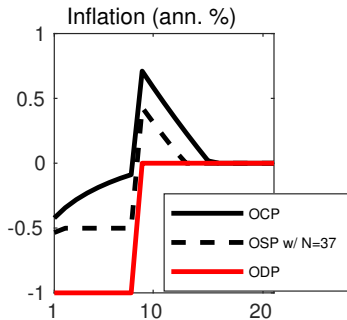
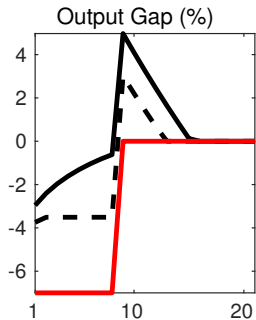
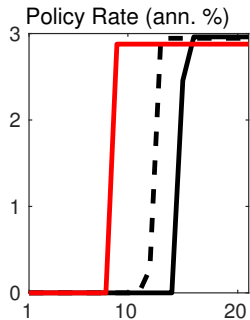
- ▶ Renegotiation-proofness of Farrell and Maskin (1989)
  - ▶ A sustainable plan is renegotiation-proof if there is no opportunity for Pareto-improvement.
  - ▶ No chance for reputation to work in models with benevolent gov't.
  - ▶  $N = 0$ .
- ▶ Renegotiation-proofness (or intertemporal consistency) of Pearce (1987)
  - ▶ A sustainable plan with the least severe punishment is renegotiation-proof.
  - ▶ Makes more sense in models with benevolent gov't (Matsuyama (1997)).
  - ▶  $N = 37$ .



Note: Value under the sustainable outcome after a crisis that has lasted for 8 quarters.







# Outline of the Talk

- ▶ Model with a static Phillips curve
  - ▶ Setup
  - ▶ Results
- ▶ Model with a forward-looking Phillips curve

## Private-sector equilibrium conditions:

$$y_t(s^t) = \mathbb{E}_t y_{t+1}(s^{t+1}) - \sigma(i_t(s^t) - \mathbb{E}_t \pi_{t+1}(s^{t+1}) - s_t)$$

$$\pi_t(s^t) = \kappa y_t(s^t) + \beta \mathbb{E}_t \pi_{t+1}(s^{t+1})$$

$$i_t(s^t) \geq i_{ELB}$$

## An exogenous shock ( $s_t$ ):

- ▶ The same two-state Markov shock as before.

## Value:

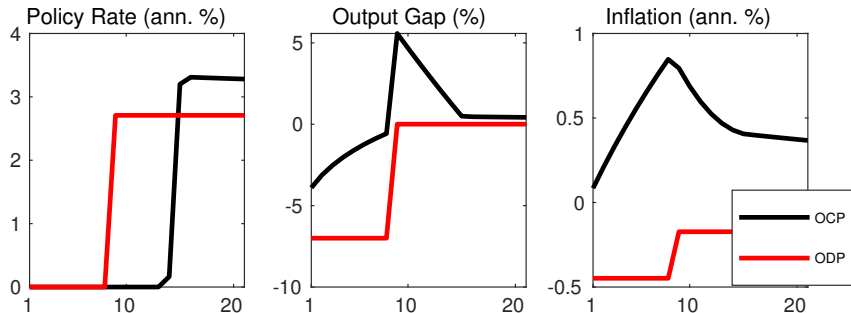
- ▶  $V_t(s^t) = u(\pi_t(s^t), y_t(s^t)) + \beta \mathbb{E}_t V_t(s^{t+1})$
- ▶  $u(\pi, y) = -\frac{1}{2}[\pi^2 + \lambda y^2]$

Table: Parameter Values

Parameter	Description	Values
$\beta$	Discount factor	0.9925
$\sigma$	IES	1
$\kappa$	Slope of the Phillips Curve	0.005
$\lambda$	Weight on $y_t^2$	0.0625**
$i_{ELB}$	Effective lower bound	0
$N$	Punishment duration	$[80, 160, \infty]$
$p_H$	Frequency of the crisis state	0.5/100
$p_L$	Persistence of the crisis state	0.5
$r^*$	Natural-rate in the normal state	3/400
$r_c$	Natural-rate in the crisis state	**Chosen so that $y_d(s_t = r_c) = -0.07$

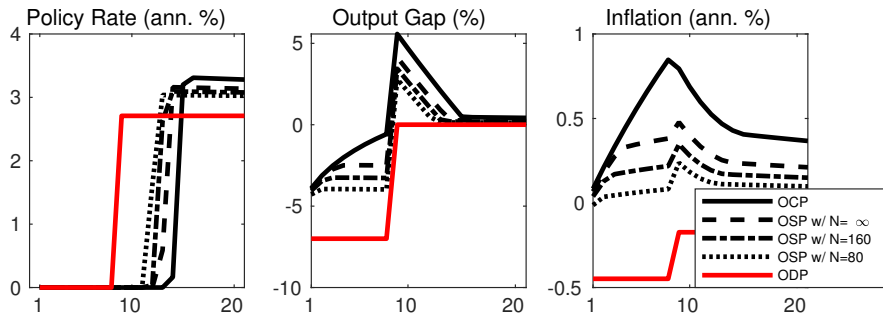
\*\*This  $\lambda$  implies equal weights on (annualized) inflation and output volatility.

# Discretionary and commitment outcomes



OCP: Optimal commitment policy, ODP: Optimal discretionary policy

# Sustainable outcomes



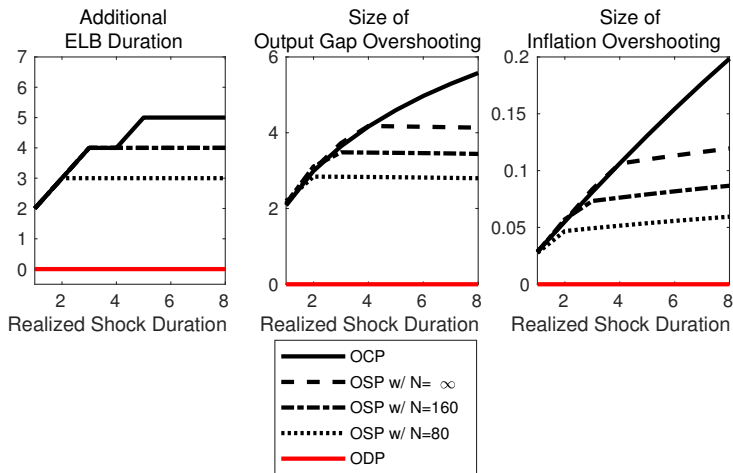
OCP: Optimal commitment policy, ODP: Optimal discretionary policy, OSP: Optimal sustainable policy

# Welfare

Table: Welfare Cost of ELB

	$\text{abs}(\mathbb{E}[V])$
Optimal Commitment	26.8 (0.39)
Optimal Sustainable ( $N = \infty$ )	27.1 (0.39)
Optimal Sustainable ( $N = 160$ )	28.0 (0.40)
Optimal Sustainable ( $N = 80$ )	29.9 (0.43)
Optimal Discretion	68.9 (1)

# History-dependence



OCP: Optimal commitment policy, ODP: Optimal discretionary policy, OSP: Optimal sustainable policy



# Summary

- ▶ Even when the optimal commitment policy (OCP) is not credible, CB can still credibly promise to temporarily overheat the economy.
  - ▶ Shorter ELB duration (and smaller overshooting of inflation and output) under optimal sustainable policy (OSP) than under OCP.
  - ▶ Welfare cost of ELB is substantially smaller under OSP than under optimal discretionary policy.
- ▶ OSP is less history-dependent than OCP.
  - ▶ Easier for CB to communicate with public.

# Extra slides

# Digression

There are two time-invariant solutions to the discretionary CB's problem (see Armenter (2017), Nakata (2018), and Nakata and Schmidt (2018)).

- ▶ one in which the ELB binds only in the crisis state.
- ▶ the other in which the ELB binds in both states.
- ▶ Possible to construct sunspot equilibria “fluctuating” between them. See Nakata and Schmidt (2019): “Simple Analytics of Expectations-Driven Liquidity Traps”.

We use the solution in which the ELB binds only in the crisis state in constructing the discretionary outcome.

# Two objects (I)

1. **Outcome:** A state-contingent sequence of output, inflation, and the policy rate,  $\{y_t(s^t), \pi_t(s^t), \pi_t(s^t)\}$ , is called *an outcome*.

- ▶ an outcome that satisfies EE, PC, and ZLB constraint is called *a competitive outcome*.

Formally, an outcome is a sequence of functions mapping a history of states into today's inflation, output, and the policy rate.

- ▶  $\sigma_t : \mathbb{S}^t \rightarrow \mathbb{R} \times \mathbb{R} \times \mathbb{R}$  for all  $t$ .

Notation:  $\mathbb{S} := \{r^*, r_c\}$

## Two objects (II)

**2. Plan:** A plan is a pair of government and private-sector strategies,  $\sigma_g = \{\sigma_{g,t}\}_{t=1}^{\infty}$  and  $\sigma_p := \{\sigma_{p,t}\}_{t=1}^{\infty}$ .

$\sigma_{g,t}$ : A sequence of functions mapping a history of states and a history of the policy rates (up to the previous period) into today's policy rate.

- ▶  $\sigma_{g,1} : \mathbb{S} \rightarrow \mathbb{R}$ , and
- ▶  $\sigma_{g,t} : \mathbb{R}^{t-1} \times \mathbb{S}^t \rightarrow \mathbb{R}$  for all  $t \geq 2$ .

$\sigma_{p,t}$ : A sequence of functions mapping a history of states and a history of the policy rates into today's inflation and output.

- ▶  $\sigma_{p,t} : \mathbb{R}^t \times \mathbb{S}^t \rightarrow \mathbb{R} \times \mathbb{R}$  for all  $t$ .

\*\*\*Note that a plan induces an outcome.

# Definition of sustainability

A plan,  $(\sigma_g, \sigma_p)$ , is *sustainable/credible* if

- ▶ (i) after any history  $i^t$  and  $s^t$ , the continuation of  $\sigma_p$  and  $\sigma_g$  induce a competitive outcome, and
- ▶ (ii) after any history  $i^{t-1}$  and  $s^t$ , the sequence of the policy rates induced by  $\sigma_g$  maximizes the government's objective given  $\sigma_p$ .

An outcome is said to be sustainable if there is a sustainable plan that induces it.

When a certain plan A is sustainable and the plan A induces a certain outcome  $\alpha$ , we say that the outcome  $\alpha$  can be made sustainable by the plan A.

# Revert-to-discretion plan

Government strategy,  $\sigma_g^{rtd}$ :

- ▶  $\sigma_{g,1}^{rtd} = i_{c,1}(s_1)$  for any  $s_1 \in \mathbb{S}$
- ▶  $\sigma_{g,t}^{rtd}(i^{t-1}, s^t) = i_{c,t}(s^t)$  if  $i_k = i_{c,k}(s^k)$  for all  $k \leq t-1$ ,
- ▶  $\sigma_{g,t}^{rtd}(i^{t-1}, s^t) = i_{d,t}(s^t)$  otherwise.

Private-sector strategy,  $\sigma_p^{rtd}$ :

- ▶  $\sigma_{p,t}^{rtd}(i^t, s^t) = (y_{c,t}(s^t), \pi_{c,t}(s^t))$  if  $i_k = i_{c,k}(s^k)$  for all  $k \leq t$
- ▶  $\sigma_{p,t}^{rtd}(i^t, s^t) = (y_{br}(s_t, i_t), \pi_{br}(s_t, i_t))$  otherwise.<sup>3</sup>

where

$$y_{br}(s_t, i_t) = E_t y_{d,t+1}(s^{t+1}) - \sigma \left[ [i_t - E_t \pi_{d,t+1}(s^{t+1})] - s_t \right]$$

$$\pi_{br}(s_t, i_t) = \kappa y_{br}(s_t, r_t) + \beta E_t \pi_{d,t+1}(s^{t+1})$$

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<sup>3</sup>Subscript *br* stands for *best response*.