Credible Forward Guidance

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[1] 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, time-consistent, forward guidance (FG) policy?

Context:

One well-known form of FG policy at the ELB:

"lower-for-longer"/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.[2]

- 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 Nakata (2015) : "Credibility of Optimal Forward Guidance at the Interest Rate Lower Bound.").

[2]...except for the Bank of Japan.

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).

"*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 intension 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" policy ineffective in future crises.
- (ii) crises occur with sufficient frequency.
- (iii) loss of reputation lasts for a sufficiently long period.

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

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 communicate to the public.

Related Literature

- Reputation in macroeconomics:
  - Classics: Stokey (1991), Chari and Kehoe (1990), Chang (1998), Phelan and Stacchettei (2001).
  - Inflation bias: Barro and Gordon (1983), Rogoff (1987).
  - Stabilization bias: Kurozumi (2008), **Sunakawa (2015)**.
  - ELB: **Nakata (2018)**, Walsh (2018), Chung and Nakata (work-in-progress).
- 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:

$$\begin{aligned} y_t(s^t) &= \mathbb{E}_t y_{t+1}(s^{t+1}) - \sigma(i_t(s^t) - \mathbb{E}_t \pi_{t+1}(s^{t+1}) - s_t) \\ \pi_t(s^t) &= \kappa y_t(s^t) \\ i_t(s^t) &\geq i_{ELB} \end{aligned}$$

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

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

Three outcomes

- Discretionary outcome [“optimal discretionary policy (ODP)”].
- Commitment outcome [“optimal commitment policy (OCP)”].
- Sustainable outcome [“optimal sustainable policy (OSP)”].

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 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 and a sustainability constraint for all t and after all s^t.

$$V_t(s^t) \geq W_d(s_t).$$

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

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 states and a history of the policy rates (up to the previous period) into today's policy rate.

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

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

- $\sigma_{p,t} : \mathbb{R}^t \times \mathbb{S}^t \to \mathbb{R} \times \mathbb{R}$ 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 has ever deviated from the policy rate consistent with the sustainable outcome, the economy follows the discretionary outcome. ["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 $V_{s,t}(s^t) \geq W_d(s_t)$)

Sustainable outcome w/ finite punishment

Sustainability constraint with N-period punishment:

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

where, for $k = 1$,

$$W_d^1(s) = \max \quad u(y, \pi) + \beta \mathbb{E}[V_1(s')|s]$$

and, for $k \geq 2$,

$$W_d^k(s) = \max \quad u(y, \pi) + \beta \mathbb{E}[W_d^{k-1}(s')|s]$$

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Solution Method

We recurisify the infinite-horizon optimization problem by the method of Kehoe and Perri (2002) and Sunakawa (2015) (a modification of Marcet and Marimon (2017)).

We then use a time-iteration method.

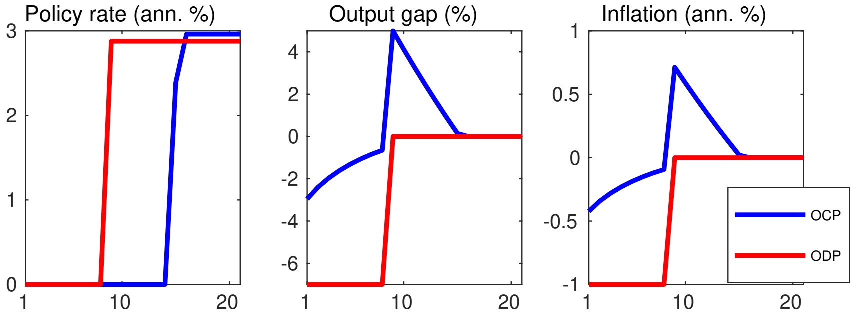
Table: Parameter Values

Parameter	Description	Values
β	Discount factor	0.9925
σ	IES	1
κ	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 $y_d(s_t = r_c) = -0.07$

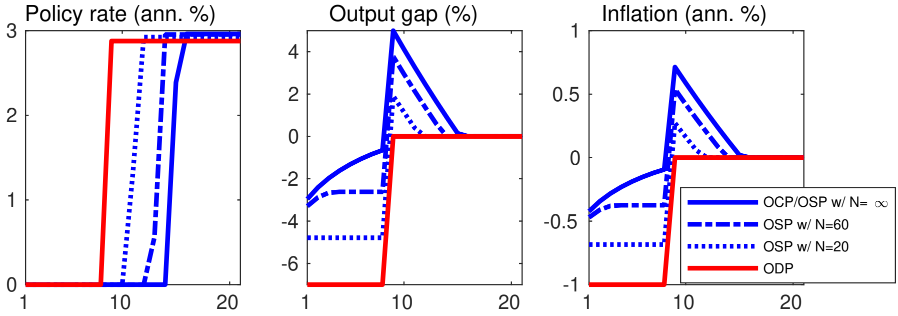
**The recession severity consistent with Boneva, Braun, and Waki (2016).

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

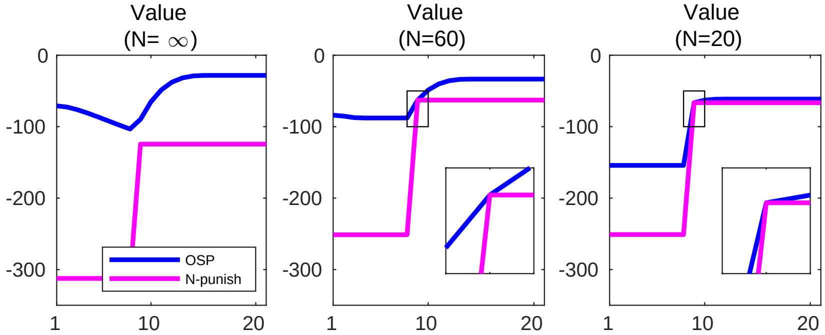
Discretionary and commitment outcomes



Sustainable outcomes



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 has to be larger than, or equal, to the 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

	abs($\mathbb{E}[V]$)
Optimal Commitment	29.5 (0.23)
Optimal Sustainable ($N = \infty$)	29.5 (0.23)
Optimal Sustainable ($N = 100$)	31.0 (0.24)
Optimal Sustainable ($N = 60$)	34.6 (0.27)
Optimal Sustainable ($N = 20$)	63.3 (0.49)
Optimal Discretion	128.1 (1)

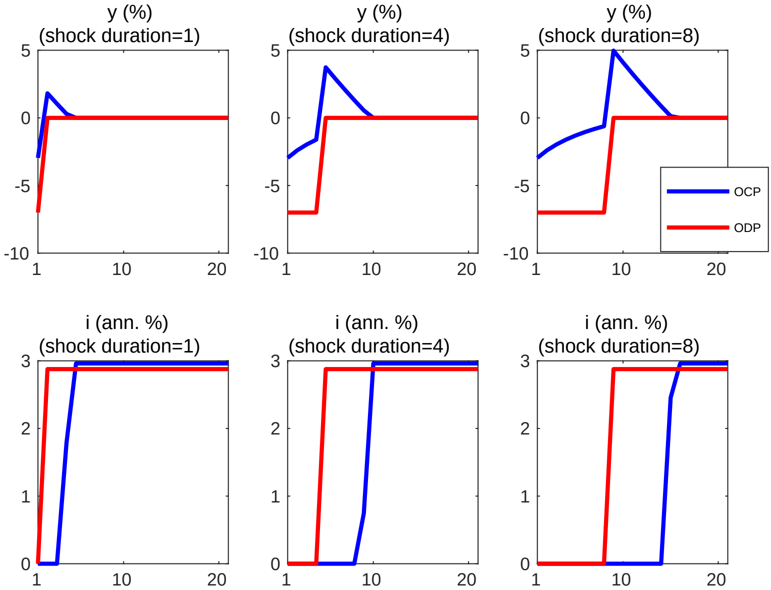
- Even with $N = 20$, the welfare cost of ELB is about half as large as under the optimal discretion.

Table: Tenure duration of chairpersons

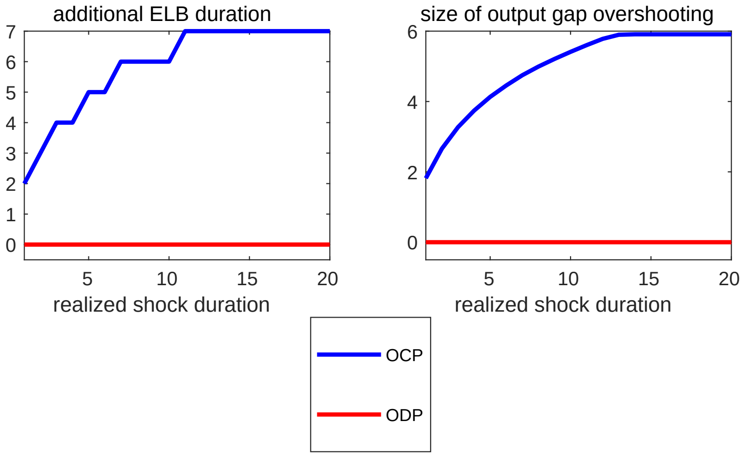
	Average in yrs (since 1946)	Max in yrs (since 1946)
FRB	8.1	18.8 (Martin)
ECB	6.5	8 (Trichet)
Bank of Canada	9.7	14 (Boey)
Bank of Japan	4.9	8.5 (Ichimada)
Bank of England	8.5	12 (Cobbold)
Riksbank	6.1	18 (Asbrink)
Swiss National Bank	7.4	11 (Leutwiler)

Note: The tenure of Alan Greenspan lasted for 18 years and 6 months.

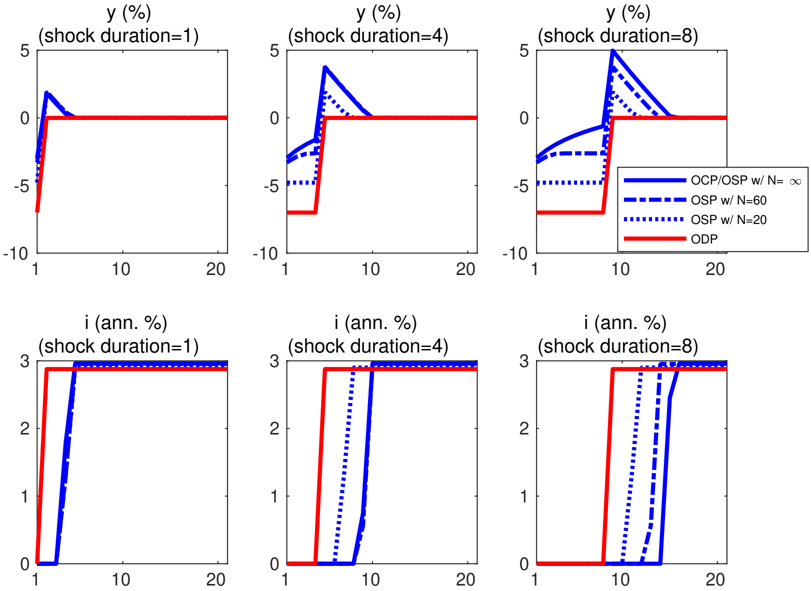
History-dependence



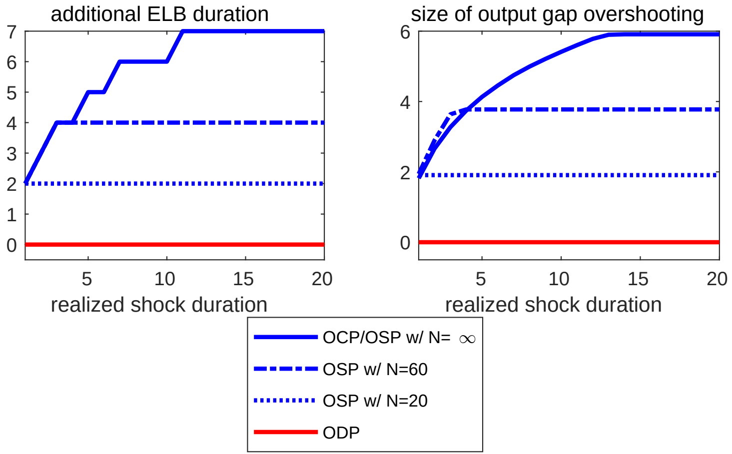
History-dependence



History-dependence



History-dependence



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).
- Under the simple FG policies of Walsh (2018), the policy rate is kept for a fixed duration, $k \geq 1$, after the shock disappears regardless of the realized duration of the shock.
- after k periods, the policy rate is set according to a Taylor rule.

History-dependence

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

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

Outline of the Talk

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Private-sector equilibrium conditions:

$$
\begin{aligned}
y_t(s^t) &= \mathbb{E}_t y_{t+1}(s^{t+1}) - \sigma\big(i_t(s^t) - \mathbb{E}_t \pi_{t+1}(s^{t+1}) - s_t\big) \\
\pi_t(s^t) &= \kappa y_t(s^t) + \beta \mathbb{E}_t \pi_{t+1}(s^{t+1}) \\
i_t(s^t) &\geq i_{ELB}
\end{aligned}
$$

An exogenous shock (s_t):

- The same two-state Markov shock as before.

Value:

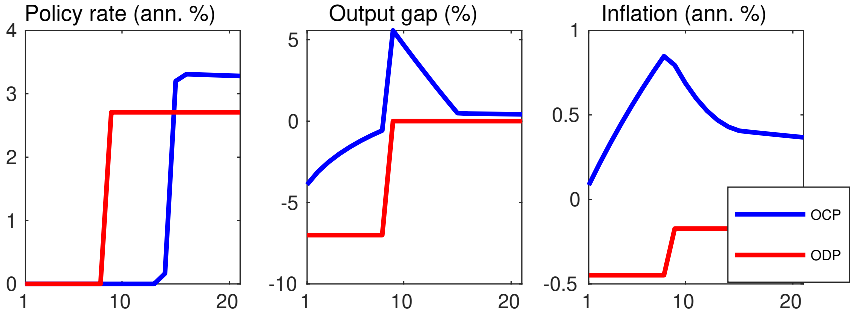
- $V_t(s^t) = u(\pi_t(s^t), y_t(s^t)) + \beta \mathbb{E}_t V_t(s^{t+1})$
- $u(\pi, y) = -\frac{1}{2}\left[\pi^2 + \lambda y^2\right]$

Table: Parameter Values

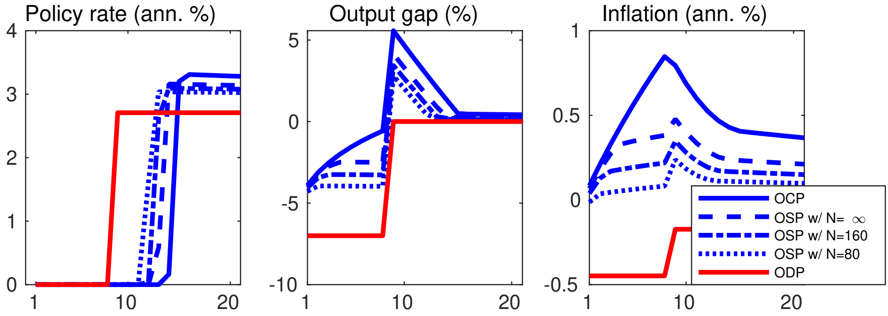
Parameter	Description	Values
β	Discount factor	0.9925
σ	IES	1
κ	Slope of the Phillips Curve	0.005
λ	Weight on y_t^2	0.0625^{**}
i_{ELB}	Effective lower bound	0
N	Punishment duration	$[80, 160, \infty]$
p_H	Frequency of the crisis state	$0.5/100$
p_L	Persistence of the crisis state	0.5
r^*	Natural-rate 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 λ implies equal weights on (annualized) inflation and output volatility.

Discretionary and commitment outcomes



Sustainable outcomes

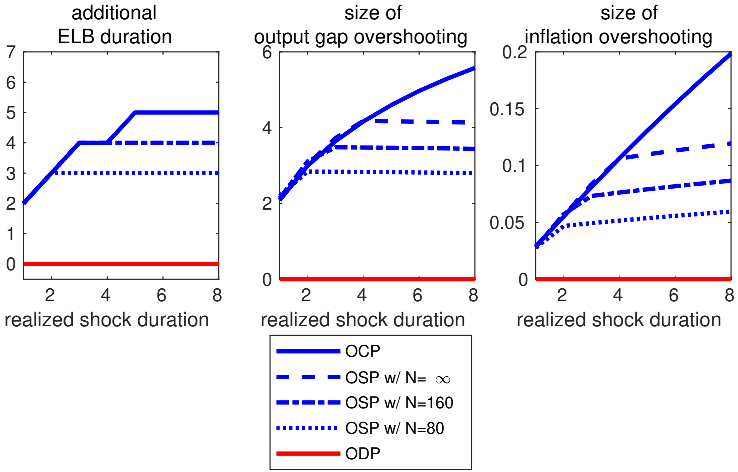


Welfare

Table: Welfare Cost of ELB

	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



Summary

- Even when the commitment policy 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 optimal commitment policy (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.

- $\sigma_t : \mathbb{S}^t \to \mathbb{R} \times \mathbb{R} \times \mathbb{R}$ 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.

- $\sigma_{g,1} : \mathbb{S} \to \mathbb{R}$, and
- $\sigma_{g,t} : \mathbb{R}^{t-1} \times \mathbb{S}^t \to \mathbb{R}$ 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.

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

***Note that a plan induces an outcome.

Definition of sustainability

A plan, (σ_g, σ_p), is *sustainable/credible* if

- (i) after any history i^t and s^t, the continuation of σ_p and σ_g induce a a competitive outcome, and
- (ii) after any history i^{t-1} and s^t, the sequence of the policy rates induced by σ_g maximizes the government's objective given σ_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 α, we say that the outcome α can be made sustainable by the plan A.

Revert-to-discretion plan

Government strategy, σ_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, σ_g^{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.[3]

where

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

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

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[3]Subscript *br* stands for *b*est *r*esponse.