Make-up Strategies with Finite Planning Horizons but Forward-Looking Asset Prices*

Stéphane Dupraz
Banque de France

Hervé Le Bihan
Banco de España
Banque de France

Julien Matheron
Banque de France

EEA-ESEM, Milan

August 23, 2022

* The views expressed do not necessarily represent those of the Banco de España, the Banque de France or the Eurosystem

Motivation

- "Low for long" policies in the new normal of low natural rates
  - Forward Guidance: now part of the regular toolbox of central banks ▸ ECB FG
  - Make-up strategies: Strategy reviews of Fed (2020) & ECB (2021) ▸ Statements
- FG and make-up strategies rely strongly on forward-looking expectations
  - Theoretically: RE Very forward-looking $\rightarrow$ Incredibly strong effects: FG puzzle
  - Empirically: At best debatable for HH and firms (e.g. Coibion et al. 2020)
- Scope for models that relax RE and reduce effects of "low-for-long" policies
- Yet effects of FG on asset prices well documented (e.g. Swanson 2021)

  $\rightarrow$ Effects on asset prices may be enough to make "low-for-long" policies effective

Our purpose

- Study FG and Make-up strategies in a New-Keynesian model amended with:
  1. **Finite Planning Horizons (FPH)** à la Woodford (2019)
     - A leading "bounded rationality" alternative to full RE
     - Induces extra discounting of the future
  2. **Forward-Looking Asset Prices (FLAP)**, similar to Bernanke, Kiley, Roberts (2019)
     - Financial markets incorporate exp. future policy into long-term nominal rates

- Questions (Answer Previews):
  - Is the model still subject to the FG puzzle? No
  - Are make-up strategies effective? Yes, but credibly so
  - Does the ELB strengthen the case for make-up strategies? Not necessarily

Related Literature

- Finite Planning Horizons: Woodford (2019), Gust et al. (2021), Woodford Xie (2021), Xie (2020)
- Solutions to the FG puzzle: Del Negro et al (2012), Gabaix (2020), Farhi Werning (2019), Angeletos Lian (2018), MacKay et al. (2016), Campbell et al. (2019), Coenen et al. (2019), ECB-Fore TF (2022), etc.
- Model-consistent asset prices: BKR (2019), Hebden et al. (2020) using FRB/US
- Assessment of make-up strategies in a low r* world: BKR (2019), Hebden et al.(2020), Busetti et al. (2020), Coenen et al. (2021), Erceg et al.(2021), ECB(2021), etc.

Finite Planning Horizons: Woodford (2019)

- Agents rationally plan up to horizon h in the future.
- Beyond $t+h$ they assume aggregate variables (Π, Y, R,...) back to steady state
- Additional assumption: geometric distribution of h

  $p(h) = (1-\rho)\rho^h \rightarrow$ Average planning horizon $\bar{H} = \rho/(1-\rho)$
- Results in a NK IS & PC model with extra discounting ρ:

$$y_t = \nu_t^y - \sigma(r_t - \boldsymbol{\rho} E_t(\pi_{t+1})) + \boldsymbol{\rho} E_t(y_{t+1} - \nu_{t+1}^y), \qquad (\text{IS}^{FPH})$$

$$\pi_t = \nu_t^p + \kappa(y_t - y_t^e) + \beta \boldsymbol{\rho} E_t(\pi_{t+1}). \qquad (\text{PC}^{FPH})$$

- Implies agents discount future path of policy rates at ρ; IS iterated forward:

$$y_t = E_t \sum_{k=0}^{\infty} \boldsymbol{\rho}^k (\nu_{t+k}^y - \sigma(r_{t+k} - \boldsymbol{\rho}\pi_{t+k+1}))$$

Our FLAP assumption

- Households have access to financial markets; can borrow/save at any maturity n
- Financial markets satisfy AOA and have rational expectations:

$$r_{t,n} = \frac{1}{n} \sum_{i=0}^{n-1} E_t(r_{t+i})$$

- Households can directly observe the $r_{t,n}$'s: as if have RE on future policy rates
- Yet still not RE on inflation and output, hence on consequences of future policy
- Similar to BKR (2019) and Hebden et al (2020) in FRB-US semi-structural model

The NK FPH-FLAP model

- Model can be cast in matrix form and solved by forward iteration ▸ Details

Proposition

The FPH-FLAP New-Keynesian model solves the recursive system

$$y_t = \nu_t^y - \sigma(r_t - \rho E_t(\pi_{t+1})) + \rho E_t(y_{t+1} - \nu_{t+1}^y) - \sigma(1-\rho)E_t(\xi_{t+1}),$$

$$\pi_t = \nu_t^p + \kappa(y_t - y_t^e) + \beta\rho E_t(\pi_{t+1}),$$

$$\xi_t = \beta r_t + \beta E_t(\xi_{t+1}).$$

- Relative to textbook NK model, features:
  - FPH added discounting at rate ρ, but also
  - Extra forward looking component resulting from FLAP, with disc. at rate β
- Can be solved using standard methods – with and without ELB (e.g. Occbin)

Assessing the FG puzzle in the FPH-FLAP NK model

FG experiment (à la McKay et al. 2016): at date t central bank announces

i Cut in policy rate by 100 bps in quarter $t + n$

ii Rate pegged to steady-state value from t to $t + n - 1$

iii Will revert to standard policy rule in $t + n + 1$ (so economy back to steady state)

Definition

A model is <u>*not*</u> *subject to FG puzzle iff:*

The impact response of all endogenous variables to an FG announcement converges to 0 as the announcement horizon n increases to infinity.

An analytical result: Condition for ruling out the FG puzzle

Proposition

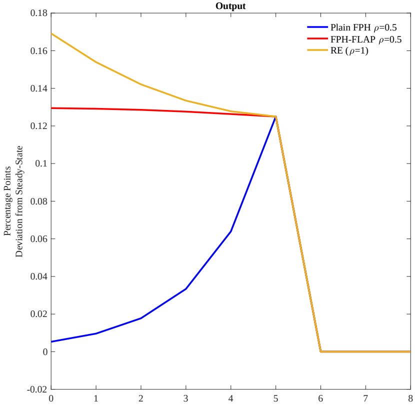
- *The FPH-FLAP model is **not** subject to the FG puzzle iff $\boldsymbol{\rho < \rho^*}$, where :*

$$\rho^* = \frac{1 + \sigma\kappa + \beta - \sqrt{(1 + \sigma\kappa + \beta)^2 - 4\beta}}{2\beta}.$$

- *Same condition holds for ruling out the FG puzzle in the plain FPH model.*

- Existence of FG puzzle depends only on the strength of GE amplifying effects
- Quantitative assessment of FG shock, n=5 quarters
  - Standard calibration of standard parameters ▸ Calibration
  - Implies $\rho^* = 0.86$
  - Baseline value of FPH parameter $\rho = 0.5$ (Gust et al. 2021); alternative $\rho = 0.8$

FG shock: IRF to the announcement of an interest-rate cut in $n = 5$ quarters



- Under RE: very strong impact effect. FG puzzle
- Under FPH: near-zero impact effect. Π and Y hardly increase before $t+4$.
- Under FPH-FLAP: significant impact effect; slightly larger effect at t than at $t+5$

Assessing Make up strategies

- **Approach**: Stochastic simulations to compute various moments
  - RMSD from inflation target and steady-state output, average deviation from target
  - ELB constraint $r_t = \max\{\text{elb}, r_t^*\}$ taken into account (ELB=0%): non-linear simul.
- **Alternative strategies**: through interest-rate rules (as in e.g. ECB 2021)
  - IT: Taylor rule with inertia ($\rho_{TR} = 0.85$) ▸ History-Dependence

$$r_t^* = \rho_{TR} r_{t-1} + (1 - \rho_{TR})(\phi_\pi \pi_t^{1a} + \phi_y (y_t - y_t^e)) + \nu_t^r$$

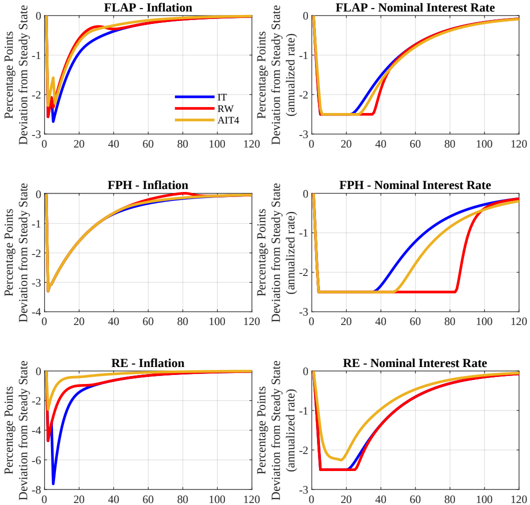
  - AIT: Responds to π_t^{Ta} average inflation over past T years ($T = 4$ and $T = 8$)

$$r_t^* = \rho_{TR} r_{t-1} + (1 - \rho_{TR})(\pi_t^{1a} + \phi_y (y_t - y_t^e) + (\phi_\pi - 1) \times T \times \pi_t^{Ta}) + \nu_t^r$$

  - Reifschneider Williams (RW) rule from Reifschneider-Williams (2000)

$$r_t^* = r_t^{IT} - \alpha_{RW} Z_t, \text{with } Z_t = Z_{t-1} + d_t, \text{and } d_t = r_t - r_t^{IT}$$

Illustration: Effect of "low-for-long" policies in response to a recession shock



Virtually no effect under plain FPH < FPH-FLAP < Suspiciously high effects under RE

Policy Simulations: Main Results

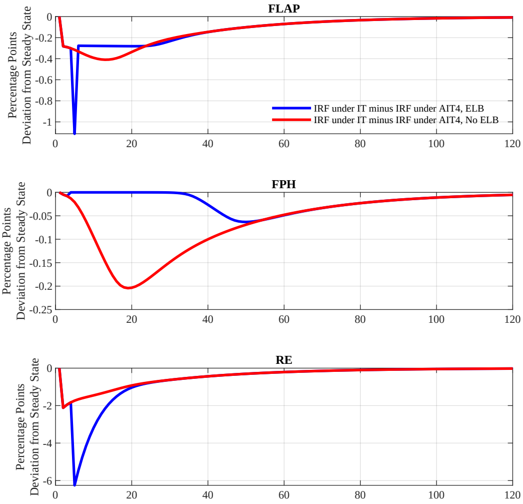
Panel A: Model FLAP			
	ELB frequency (percent)	Mean inflation gap	RMSD. inflation
IT	12.34	-0.09	1.36
RW	19.58	0.06	1.26
AIT 4 years	14.29	-0.11	1.20
Panel B: Model FPH (Rescaled Shocks)			
IT	16.91	-0.01	1.22
RW	33.80	0.02	1.24
AIT 4 years	23.85	-0.04	1.19
Panel C: Model RE (Rescaled Shocks)			
IT	6.67	-0.20	1.82
RW	7.97	0.06	1.13
AIT 4 years	1.61	-0.00	0.50

▸ Detailed tables ▸ Decomposing the bias

- **RE**: Make-up strategies strongly reduce RMSD/IT. Also remove deflationary bias
- **FPH**: Poor performance of make-up strategies. RW even increases RMSD(π)/IT
- **FLAP**: Make-up strategies reduce RMSD/IT. Only asymm. rule (RW) removes the deflationary bias

ELB & the extra performance of AIT vs IT - Diff in Diff comparison

- Difference in IRF: IT minus AIT
  - After a recession shock
  - With ELB vs without ELB
- **FPH-FLAP (and plain FPH)**: ELB constrains policy in near future too: future rates cannot be as low as AIT prescribes
- **RE**: Idem, but strong deflation spirals at ELB under IT: much to reduce with AIT



IRF for π_t

Policy Simulations: Without the ELB

RMSD of Inflation (pp) with ELB

	FLAP	FPH	RE
IT	1.36	1.22	1.82
RW	1.26	1.24	1.13
AIT 4 years	1.20	1.19	0.50

RMSD of Inflation (pp) without ELB

	FLAP	FPH	RE
IT	1.18	1.17	1.17
RW	1.18	1.17	1.17
AIT 4 years	1.00	1.10	0.47

▸ Detailed tables

- Recall that AIT, PLT are more stabilizing than IT even absent the ELB (Svensson 1999, Woodford 2003)
- Under RE, ELB $\nearrow$ stabilization benefits of AIT/IT: RMSD(π) $\searrow$ 73% vs. $\searrow$ 60%
- Under FPH-FLAP (and plain FPH), opposite: RMSD(π) $\searrow$ 12% vs. $\searrow$ 15%

Conclusion

Main messages

- FG and make-up strategies are effective under finite planning horizon

  — Provided information on future rates adequately reflected in asset prices

- Forward-looking asset prices do not send the model back into the FG puzzle

  $\rightarrow$ Credible results

- Positive gains of AIT over IT when taking into account the ELB

  $\rightarrow$ But would be even larger absent the ELB.

Areas for future extensions

- FPH-FLAP in a model with more frictions and dynamics, optimal monetary policy

APPENDIX

Fed & ECB Strategy Statements

"[...] following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time."

Fed, Statement on Longer-Run Goals and Monetary Policy Strategy, August 2020

"When the economy is operating close to the lower bound on nominal interest rates, it requires especially forceful or persistent monetary policy action to avoid negative deviations from the inflation target becoming entrenched. This may also imply a transitory period in which inflation is moderately above target."

ECB, Monetary Policy Strategy Statement, July 2021

▸ Back

ECB rates FG, April 2022

"Any adjustments to the key ECB interest rates will take place some time after the end of the Governing Council's net purchases under the APP and will be gradual. [...] the Governing Council expects the key ECB interest rates to remain at their present levels until it sees inflation reaching 2% well ahead of the end of its projection horizon and durably for the rest of the projection horizon, and it judges that realised progress in underlying inflation is sufficiently advanced to be consistent with inflation stabilising at 2% over the medium term. "

ECB, Combined monetary policy decisions and statement, April 2022

Back

FPH-FLAP Model and solution procedure (sketched)

- IS and PC system perceived by agents with planning horizon h:
  - For horizons $j < h$, same recursion as under RE

$$y_{t+j}^{h-j}(h) = \nu_{t+j}^{y} - \sigma(r_{t+j} - E_{t+j}(\pi_{t+j+1}^{h-j-1}(h))) + E_{t+j}(y_{t+j+1}^{h-j-1}(h) - \nu_{t+j+1}^{y}),$$
$$\pi_{t+j}^{h-j}(h) = \kappa(y_{t+j}^{h-j}(h) - y_{t+j}^{e}) + \nu_{t+j}^{p} + \beta E_{t+j}(\pi_{t+j+1}^{h-j-1}(h)),$$

  - For horizons $j > h$, new recursion:

$$y_{t+j}(h) = -\sigma\beta r_{t+j} + \beta E_{t+j}(y_{t+j+1}(h)),$$
$$\pi_{t+j}(h) = 0.$$

- Discounting at rate β in the consumption equation of the new recursion:

$$y_{t+h}^{0}(h) = -\sigma E_{t+h} \sum_{k=0}^{\infty} \beta^{k} r_{t+h+k}$$

- Arises from consumption function, no longer amplified by the Keynesian Cross

Model in matrix form for given h

- Define $Y_t = (y_t, \pi_t)'$, $a_t = (\nu_t^y, \nu_t^p - \kappa y_t^e)$.

$$\forall j \leq h-1, \;\; Y_{t+j}^{h-j}(h) = C\mathrm{E}_{t+j}(Y_{t+j+1}^{h-j-1}(h)) + D^r r_{t+j} + D^a a_{t+j} + D^{a+}\mathrm{E}_{t+j}(a_{t+j+1}),$$

$$j = h: \; Y_{t+h}^0(h) = C\mathrm{E}_{t+h}(Y_{t+h+1}(h)) + D^r r_{t+h} + D^a a_{t+h},$$

$$\forall j \geq h+1, \;\; Y_{t+j}(h) = C_2\mathrm{E}_{t+j}(Y_{t+j+1}(h)) + D_2^r r_{t+h},$$

- Iterate forward:

$$Y_t^h(h) = \mathrm{E}_t \left(\sum_{j=0}^{h} C^j D^r r_{t+j} + \sum_{j=h+1}^{\infty} C^{h+1} C_2^{j-(h+1)} D_2^r r_{t+j} + \sum_{j=0}^{h} C^j D^a a_{t+j} + \sum_{j=0}^{h-1} C^j D^{a+} a_{t+1+j} \right).$$

Back

Aggregation

- Aggregation across planning horizons h:

$$Y_t = \mathrm{E}_t \sum_{j=0}^{\infty} \left(\sum_{h=0}^{j-1} (1-\rho)\rho^h C^{h+1} C_2^{j-(h+1)} D_2^r + \sum_{h=j}^{\infty} (1-\rho)\rho^h C^j D^r \right) r_{t+j}$$

$$+ \mathrm{E}_t \sum_{j=0}^{\infty} (\rho C)^j D^a a_{t+j} + \mathrm{E}_t \sum_{j=0}^{\infty} (\rho C)^j \rho D^{a+} a_{t+j+1}$$

- With some algebra:

$$BY_t = \rho A E_t(Y_{t+1}) + f_a a_t + f_r r_t + \rho f_{a+} E_t(a_{t+1}) + (1-\rho) A E_t(z_{t+1})$$

where $z_t = C_2 E_t(z_{t+1}) + D_2^r r_t$

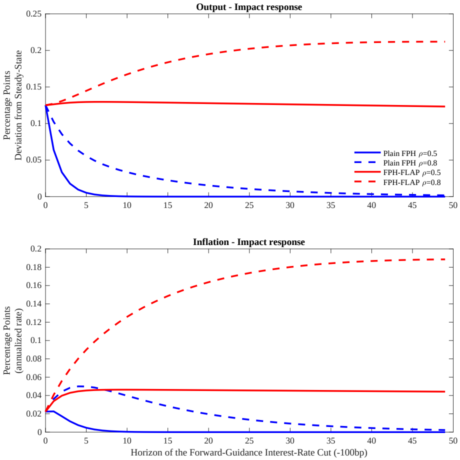
Back

Model calibration

Parameter	Interpretation	Value
ρ	FPH	0.5000
β	Subjective discount factor	0.9988
θ	Substitution elasticity between intermediate goods	6.0000
ϕ	Inverse elasticity of production wrt labor	1.4286
ψ	Inverse Frisch elasticity	2.0000
σ	Intertemporal substitution elasticity	0.5000
α	Probability of not resetting prices	0.6600
ρ_{TR}	Interest rate smoothing	0.8500
ϕ_π	Policy response to inflation	1.5000
ϕ_y	Policy response to the output gap	0.1250
ρ_y	Persistence of preference shocks	0.9641
$100 \times \sigma_y$	Standard deviation of preference shocks	1.1490
ρ_r	Persistence of monetary policy shocks	0.0000
$100 \times \sigma_r$	Standard deviation of monetary policy shocks	0.1460
ρ_p	Persistence of cost-push shocks	0.3830
$100 \times \sigma_p$	Standard deviation of cost-push shocks	0.2443

Back

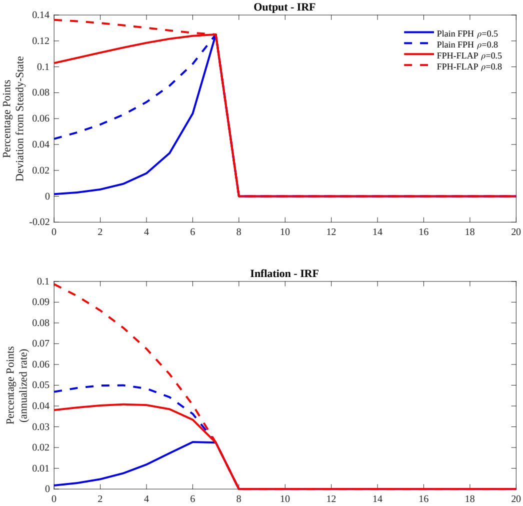
Impact effect of FG shock as a function of the announcement horizon



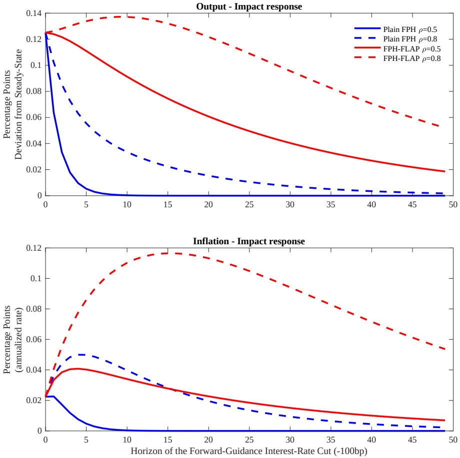
- Under plain FPH: rapidly declining pattern
- Under FPH-FLAP: hump-shape pattern – ultimately slow decline

Back

Robustness: IRF of FG shock under financial frictions extension



Robustness: Impact effect of FG shock under financial frictions extension



- Perpetual youth to model financial constraints (Del Negro et al. 2012)
- Adds discounting in consumpt. function: $\beta \to \beta(1-\lambda)$, $\lambda =$P(borrowing constr)
- Strong difference between FPH and FLAP robust (here for $\beta(1-\lambda) = 0.96$)

History-Dependence in the standard IT Taylor rule, and KR rules

- Abstracting from ELB constraint, IT (Taylor rule with inertia) is equivalent to:

$$r_t^* = \phi_\pi \bar{\pi}_t + \phi_y \bar{x}_t + \sum_{k=0}^{\infty} \rho_{TR}^k \nu_{t-k}^r, \qquad \text{(Kiley-Roberts)}$$

$$\text{where } \bar{\pi}_t = \sum_{k=0}^{\infty} (1-\rho_{TR}) \rho_{TR}^k \pi_{t-k}^{1a}$$

$$\bar{x}_t = \sum_{k=0}^{\infty} (1-\rho_{TR}) \rho_{TR}^k x_{t-k}$$

- Responds to weighted averages of past π^{1a} and x: history-dependent
- (Should it be considered an AIT/make-up strategy?)
- Equivalence breaks once ELB: (KR) records deficits of accommodation at ELB
- Also consider:

$$r_t^* = \phi_\pi \bar{\pi}_t + \phi_y x_t + \sum_{k=0}^{\infty} \rho_{TR}^k \nu_{t-k}^r \qquad \text{(Kiley-Roberts - } \pi \text{ only)}$$

Back

Implications for average bias: Inspecting through conditional moments

Panel A: Model FLAP				
	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$
IT	-2.23	0.23	2.42	1.07
RW	-1.05	0.30	1.68	1.09
AIT 4 years	-1.69	0.18	1.99	0.94
Panel B: Model FPH (Rescaled Shocks)				
	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$
IT	-1.76	0.34	1.84	0.99
RW	-0.95	0.47	1.44	1.05
AIT 4 years	-1.44	0.40	1.58	0.95
Panel C: Model RE (Rescaled Shocks)				
	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$
IT	-4.23	0.17	4.89	1.06
RW	-1.62	0.19	1.74	1.06
AIT 4 years	-1.32	0.02	1.44	0.46

▸ Detailed tables ▸ Back

- AIT under FPH-FLAP (and plain FPH):
  - at ELB: moderate reduction of size of deflations.
  - outside ELB: stabilization of upward deviations from target.

Policy Simulations Results

Panel A: Model FLAP

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	12.34	10.59	-0.26	-0.09	0.26	3.43	1.36	2.11
RW	19.58	26.40	0.16	0.06	0.17	3.11	1.26	2.17
AIT 4 years	14.29	14.97	-0.31	-0.11	0.26	2.98	1.20	2.17
AIT 8 years	14.63	15.96	-0.26	-0.09	0.24	2.76	1.12	2.15
Price level targeting	13.26	13.39	-0.02	-0.00	0.21	2.64	1.08	2.07
AIT 4 years – Fixed coeff	12.07	11.84	-0.24	-0.08	0.24	3.43	1.36	2.06
AIT 8 years – Fixed coeff	11.50	11.16	-0.20	-0.07	0.23	3.43	1.36	2.03

Panel B: Model FPH (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	16.91	14.60	-0.02	-0.01	0.46	3.58	1.22	2.53
RW	33.80	57.95	0.07	0.02	0.10	3.63	1.24	2.63
AIT 4 years	23.85	21.68	-0.11	-0.04	0.80	3.49	1.19	3.19
AIT 8 years	28.89	31.78	-0.19	-0.07	1.10	3.45	1.17	3.75
Price level targeting	-	-	-	-	-	-	-	-
AIT 4 years – Fixed coeff	16.87	15.71	-0.02	-0.01	0.44	3.60	1.23	2.51
AIT 8 years – Fixed coeff	16.46	15.41	-0.01	-0.01	0.42	3.61	1.23	2.46

Panel C: Model RE (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	6.67	11.94	-0.20	-0.20	0.11	1.30	1.82	1.64
RW	7.97	15.79	0.01	0.06	0.10	0.69	1.13	1.64
AIT 4 years	1.61	10.42	-0.01	-0.00	0.04	0.52	0.50	1.15
AIT 8 years	0.50	8.36	0.00	0.00	0.03	0.50	0.36	0.97
Price level targeting	0.15	5.52	0.00	-0.00	0.02	0.50	0.36	0.85
AIT 4 years – Fixed coeff	5.17	12.52	-0.10	-0.09	0.08	1.08	1.45	1.51
AIT 8 years – Fixed coeff	3.67	9.67	-0.03	-0.01	0.07	0.91	1.18	1.41

Back

Policy Simulations Results: KR rules

Panel A: Model FLAP

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	12.34	10.59	-0.26	-0.09	0.26	3.43	1.36	2.11
KR	16.01	18.50	-0.21	-0.07	0.23	3.39	1.35	2.13
KR inflation only	17.15	10.26	-0.22	-0.07	0.27	3.45	1.38	2.23
KR r_{TR}=0.95	14.97	8.24	-0.12	-0.04	0.22	3.51	1.40	2.09
RW	19.58	26.40	0.16	0.06	0.17	3.11	1.26	2.17

Panel B: Model FPH (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	16.91	14.60	-0.02	-0.01	0.46	3.58	1.22	2.53
KR	21.08	24.03	-0.01	-0.01	0.43	3.58	1.22	2.55
KR inflation only	21.43	12.65	-0.02	-0.01	0.45	3.54	1.22	2.60
KR r_{TR}=0.95	19.30	11.51	0.01	0.00	0.36	3.59	1.24	2.40
RW	33.80	57.95	0.07	0.02	0.10	3.63	1.24	2.63

Panel C: Model RE (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	6.67	11.94	-0.20	-0.20	0.11	1.30	1.82	1.64
KR	8.23	16.25	-0.09	-0.06	0.10	0.97	1.44	1.64
KR inflation only	8.84	13.00	-0.11	-0.08	0.11	1.02	1.53	1.69
KR r_{TR}=0.95	2.57	5.87	0.00	0.01	0.04	1.00	1.16	1.24
RW	7.97	15.79	0.01	0.06	0.10	0.69	1.13	1.64

Back

Policy Simulations Results: No ELB

Panel A: Model FLAP

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	0.00	-	0.06	0.02	0.06	2.81	1.18	2.41
RW	0.00	-	0.06	0.02	0.06	2.81	1.18	2.41
AIT 4 years	0.00	-	0.04	0.01	0.06	2.28	1.00	2.48
AIT 8 years	0.00	-	0.03	0.01	0.06	2.12	0.94	2.44
Price level targeting	0.00	-	0.01	-0.00	0.06	2.18	0.96	2.33
AIT 4 years – Fixed coeff	0.00	-	0.06	0.02	0.06	2.84	1.19	2.34
AIT 8 years – Fixed coeff	0.00	-	0.06	0.02	0.06	2.89	1.21	2.29

Panel B: Model FPH (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	0.00	-	0.08	0.03	0.08	3.44	1.17	3.05
RW	0.00	-	0.08	0.03	0.08	3.44	1.17	3.05
AIT 4 years	0.00	-	0.07	0.02	0.11	3.26	1.10	4.06
AIT 8 years	0.00	-	0.06	0.02	0.14	3.15	1.06	4.95
Price level targeting	0.00	-	-0.01	-0.00	0.39	3.24	1.10	7.17
AIT 4 years – Fixed coeff	0.00	-	0.08	0.03	0.08	3.46	1.18	3.01
AIT 8 years – Fixed coeff	0.00	-	0.08	0.03	0.08	3.48	1.19	2.93

Panel C: Model RE (Rescaled Shocks)

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation gap	Mean nominal interest rate gap	RMSD. output gap	RMSD. inflation	RMSD. nominal interest rate
IT	0.00	-	0.01	0.03	0.04	0.66	1.17	1.75
RW	0.00	-	0.01	0.03	0.04	0.66	1.17	1.75
AIT 4 years	0.00	-	0.00	0.01	0.03	0.49	0.47	1.17
AIT 8 years	0.00	-	0.00	0.00	0.03	0.50	0.35	0.98
Price level targeting	0.00	-	0.00	-0.00	0.02	0.50	0.36	0.86
AIT 4 years – Fixed coeff	0.00	-	0.01	0.02	0.04	0.74	1.11	1.59
AIT 8 years – Fixed coeff	0.00	-	0.01	0.02	0.04	0.81	1.10	1.47

Back

Policy Simulations Results: Conditional Moments

Panel A: Model FLAP

	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$E[r \mid ELB]$	$E[r \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$	$\sqrt{E[r^2 \mid ELB]}$	$\sqrt{E[r^2 \mid \overline{ELB}]}$
IT	-2.23	0.23	-2.50	0.60	2.42	1.07	2.50	2.02
RW	-1.05	0.30	-2.50	0.75	1.68	1.09	2.50	2.03
AIT 4 years	-1.69	0.18	-2.50	0.67	1.99	0.94	2.50	2.08
AIT 8 years	-1.35	0.14	-2.50	0.65	1.74	0.92	2.50	2.05
AIT 4 years – Fixed coeff	-2.17	0.22	-2.50	0.57	2.39	1.09	2.50	1.97
AIT 8 years – Fixed coeff	-2.20	0.21	-2.50	0.53	2.40	1.10	2.50	1.94

Panel B: Model FPH (Rescaled Shocks)

	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$E[r \mid ELB]$	$E[r \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$	$\sqrt{E[r^2 \mid ELB]}$	$\sqrt{E[r^2 \mid \overline{ELB}]}$
IT	-1.76	0.34	-2.50	0.98	1.84	0.99	2.50	2.48
RW	-0.95	0.47	-2.50	1.27	1.44	1.05	2.50	2.57
AIT 4 years	-1.44	0.40	-2.50	1.69	1.58	0.95	2.50	3.27
AIT 8 years	-1.19	0.39	-2.50	2.34	1.43	0.97	2.50	3.98
AIT 4 years – Fixed coeff	-1.75	0.34	-2.50	0.96	1.83	1.00	2.50	2.45
AIT 8 years – Fixed coeff	-1.77	0.33	-2.50	0.92	1.86	1.01	2.50	2.40

Panel C: Model RE (Rescaled Shocks)

	$E[\pi \mid ELB]$	$E[\pi \mid \overline{ELB}]$	$E[r \mid ELB]$	$E[r \mid \overline{ELB}]$	$\sqrt{E[\pi^2 \mid ELB]}$	$\sqrt{E[\pi^2 \mid \overline{ELB}]}$	$\sqrt{E[r^2 \mid ELB]}$	$\sqrt{E[r^2 \mid \overline{ELB}]}$
IT	-4.23	0.17	-2.50	0.27	4.89	1.06	2.50	1.55
RW	-1.62	0.19	-2.50	0.30	1.74	1.06	2.50	1.54
AIT 4 years	-1.32	0.02	-2.50	0.07	1.44	0.46	2.50	1.12
AIT 8 years	-0.74	0.01	-2.50	0.04	0.80	0.35	2.50	0.96
AIT 4 years – Fixed coeff	-3.43	0.13	-2.50	0.20	3.89	1.03	2.50	1.44
AIT 8 years – Fixed coeff	-2.75	0.10	-2.50	0.15	2.89	1.04	2.50	1.36

Back