Shock-dependent Cognitive Discounting and the Forward Guidance Puzzle

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- Ongoing debate on natural interest rates suggest a potential return to a low-rate environment—where **effective lower bound episodes are likely to occur more frequently—developing appropriate frameworks to study the impact of forward guidance regained its importance.**

- **Standard monetary DSGE models are not suited to study anticipated monetary policy** because they generated unrealistic FG effects: **forward guidance puzzle**, Del Negro et al. (2023),McKay et al. (2016), Carlstrom et al. (2015).

- An increasing number of studies implement the bounded rationality hypothesis of Gabaix (2020) to solve the forward guidance puzzle (e.g., Erceg et al. (2021), Pfaeuti and Syrich (2022), and Hohberger et al. (2024)).

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- It relies on cognitively biased agents to obtain a heightened discounting of the future.

- The set-up, referred to as cognitive discounting (CD), is particularly appealing because of its relative simplicity.

What we do and find

- We show that - in the context of Smets and Wouters (2007) - an off-the-shelf implementation of CD to replicate empirically observed forward guidance effects results in a substantial dampening of conventional monetary policy's effectiveness, which contradicts empirical evidence.

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- We find that the coexistence of empirically plausible effects of both conventional monetary policy and forward guidance requires a degree of cognitive discounting that is specific to announcements of future policy shocks.

- The additional discounting on unrealized future monetary actions could be attributed, for example, to credibility constraints in forward guidance communication, in the line of Campbell (2019) and Bodenstein (2012).

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- For the estimation of the model, we further propose a strategy based on system priors, building on Andrade et al. (2019).

- We rely on Brubakk et al. (2022) and Ferreira (2022), who find that conventional monetary policy and forward guidance shocks have similar—or not significantly different—effects on inflation (Swanson (2021)).

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The forward guidance puzzle

Borrowing from McKay (2016), let us consider the Euler equation of the canonical NK monetary policy model:

$$c_t = E_t(c_{t+1}) - \sigma^{-1} E_t(i_t - E_t[\pi_{t+1}] - r_t^n) \tag{1}$$

Iterating forward, we see how consumption depends on the infinite future path of real interest rates,

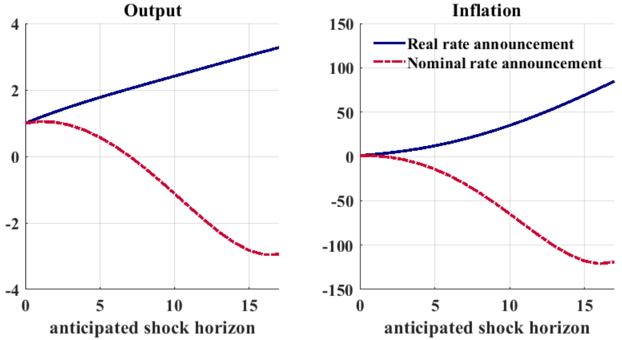
$$c_t = -\sigma^{-1} \sum_{j=0}^{\infty} E_t(i_{t+j} - \pi_{t+1+j} - r_{t+j}^n) \tag{2}$$

Proceeding analogously with the Phillips curve,

$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa c_t \implies \pi_t = \kappa \sum_{j=0}^{\infty} \beta^j E_t[c_{t+j}] \tag{3}$$

A standard NK model

As our laboratory we use the familiar Smets and Wouters (2007) model: a mid-size monetary DSGE model with nominal and real frictions estimated fot the US. The model suffers of the **forward guidance puzzle**:



Cognitive discounting

Expectations formation mechanism: assumes agents are myopic and that they increasingly bias their expectations towards a focal point as the forecasting horizon moves further in time.

$$E_t^{BR}[x_{t+k}] = E_t^{BR}[x_{t+k}^{fp} + \hat{x}_{t+k}] = E_t[x_{t+k}^{fp}] + M^k E_t[\hat{x}_{t+k}] = \bar{x} + M^k E_t[\hat{x}_{t+k}]$$

M denotes the cognitive discount factor, and $\bar{x}$ the steady state. Note that if $|M| < 1$, as agents forecast events further away in time, their projections tend to increasingly concentrate around the variable's steady state.

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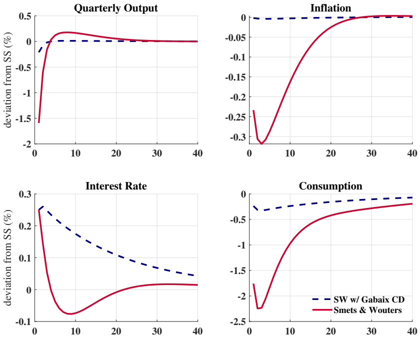
Alternatively we can write agents' expectations as a weighted average,

$$E_t^{BR}[x_{t+k}] = E_t[x_{t+k}^{fp}] + M^k E_t[\hat{x}_{t+k}] = (1 - M^k) E_t[x_{t+k}^{fp}] + M^k E_t[x_{t+k}]$$

which we can further interpret as a weighted average between **full credibility**, $E_t[x_{t+k}]$, and **zero credibility**, $\bar{x}$.

Muted conventional monetary policy

Conventional monetary policy impulse responses for the SW model under rational expectations and under this original bounded rationality specification of Gabaix (2020):



This result is similar to the ones in Hohberger et al. (2024), Brzoza et al. (2022), and Erceg et al. (2021).

Shock-specific CD, idea

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- Consider two sub-models, $\mathscr{M}$ and $\mathscr{M}^{aux}$, exactly the same except $\mathscr{M}^{aux}$ does not feature forward guidance shocks.

Shock-specific CD, idea

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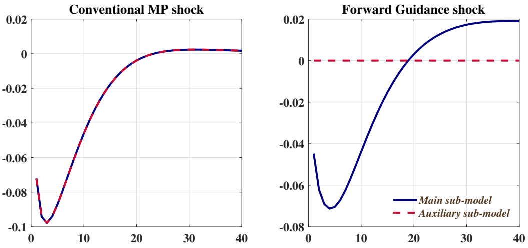
- Consider two sub-models, $\mathscr{M}$ and $\mathscr{M}^{aux}$, exactly the same except $\mathscr{M}^{aux}$ does not feature forward guidance shocks.
- We use the variables of $\mathscr{M}^{aux}$ as focal point of $\mathscr{M}$.

$$E_t^{BR}[x_{t+k}] = (1 - M^k)E_t[x_{t+k}^{fp}] + M^k E_t[x_{t+k}]$$

Shock-specific CD, idea

- If a non-FG shock hits, both models coincide and $x^{fp}_{t+k} = x_{t+k}$, so we have RE.
- If a FG shock hits, model $\mathscr{M}^{aux}$ remains in steady state, then expectations in model $\mathscr{M}$ are

$$E_t^{BR}[x_{t+k}] = (1 - M^k)\bar{x} + M^k E_t[x_{t+k}]$$



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System Priors

- Ex ante probability distributions on desired model properties - e.g. effects, ratios, moments, etc.
- They reshape the parametric probability space so as to condition the estimation on relevant a priori information (Andrle and Benes (2012); close to del Negro and Schorfheide (2015), similar to *endogenous priors* of Christiano et al. (2011))
- Composite prior is written as the product of the marginal and the system priors:

$$p_c(\theta \mid z, h, \mathscr{E}) \propto p_s(z \mid \theta, h, \mathscr{E}) \times p(\theta \mid \mathscr{E})$$

- The posterior is then,

$$\begin{aligned} p(\theta \mid Y, z, \mathscr{E}) &\propto L(Y \mid \theta, \mathscr{E}) \times p_c(\theta \mid z, h, \mathscr{E}) \\ &\propto L(Y \mid \theta, \mathscr{E}) \times p_s(z \mid \theta, h, \mathscr{E}) \times p(\theta \mid \mathscr{E}) \end{aligned}$$

for propeties $Z = h(\theta)$ which are assumed to be distributed according to $Z \sim S(Z)$.

Priors

- Following Brubakk et al. (2022) and Ferreira (2022), we implement the a priori evidences that the IRFs of inflation to a conventional monetary policy shock and to a forward guidance shock of the same magnitude are not significantly different.
- We set $h(\cdot)$ as the euclidean distance between both IRFs for the first 9 periods.
- We then assume a Chi squared distribution with one degree of freedom as the system prior.
- The prior for the CD factor is a $beta(0.5, 0.2)$.
- Rest of priors of SW are maintained.
- Sample is extended till 2019Q4 - to capture the ELB episode following the GFC.
- The model is estimated with Metropolis-Hastings

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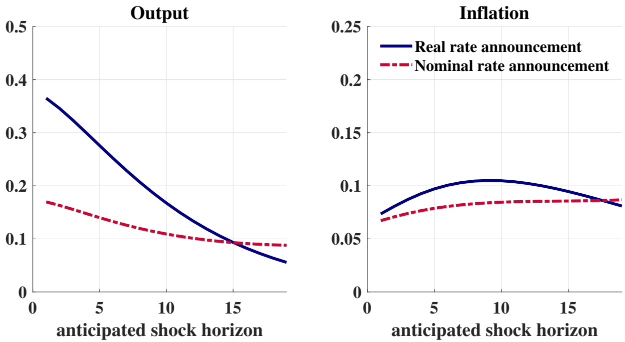
MDD and CD posterior estimates

Structural and exogenous shocks parameters remain largely unchanged. Due to non-disruptive way in which cognitive discounting is introduced.

CD factor	RE	BR^{std}	$BR\ w/o\ SP$	BR	BR^{2CD}
M_{FG}	1*	**0.60**	**0.53**	**0.94**	**0.93**
		(0.44, 0.76)	(0.2, 0.88)	(0.91,0.97)	(0.90,0.96)
M_{rest}	1*	0.60**	1*	1*	**0.993**
		(0.44, 0.76)			(0.99,0.996)
MDD	-2842.2	-2828.4	-2839.7	**-2823.6**	-2866.3

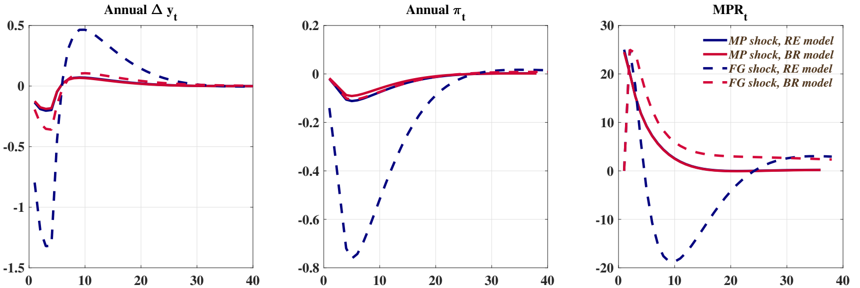
Forward guidance puzzle revisited

The estimated behavioral model, with shocks-specific CD factor and estimated with system priors, successfully resolves the *forward guidance puzzle*.



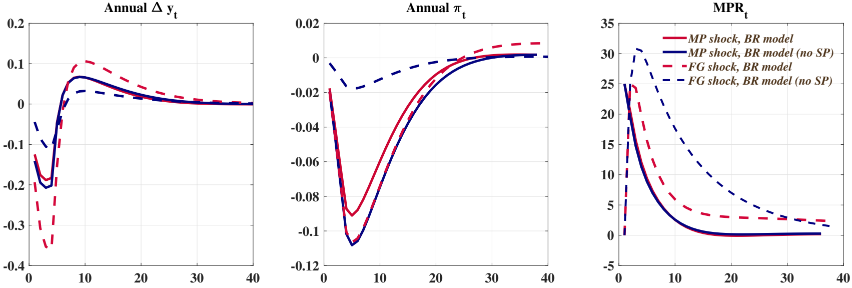
Smets and Wouters (2007) - RE vs CD

- Responses of activity and inflation to the FG shock under RE are excessive (FGP).
- Under **shock-specific CD** response to a FG shock is similar to response to conventional monetary policy shock.
- Furthermore, its similar to response of inflation and activity to a conventional monetary policy shock under RE (**system prior**).



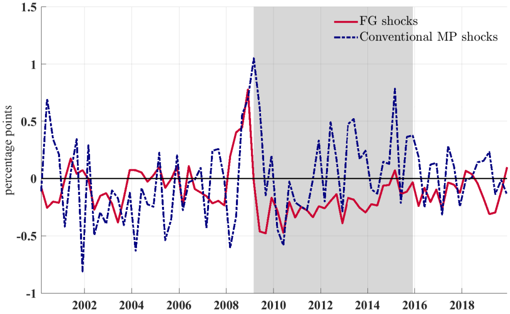
Not using system priors

- IRFs of inflation to a FG shock and a monetary policy shock (of the same magnitude) are similar when imposing system priors.
- That is not the case when we abstract from system priors, as the blue dashed line significantly differs from the solid blue one.



Forward Guidance and the ELB

- We allow for FG shocks since 2000Q1; Nelson (2021) explains that the Federal Reserve started to use forward guidance as a policy tool in the 2000s.
- FG shocks systematically provided further accommodation during the ELB episode, and only started to recede as the lift-off date of the FFR approached.
- Prior to the financial crises, FG shocks move significantly closer to 0, being moderately negative following the early 2000s .



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- We show in the context of the SW model, that an off-the-shelf implementation of CD to replicate empirical evidence on FG effects leads to a significant attenuation of conventional monetary policy's effectiveness.
- We propose a framework featuring shock-specific CD factors and develop a strategy for incorporating them into our model.
- Our approach is simple and straight-forward, facilitating easy extensions to various settings.
- Additionally, we propose the use of system priors in the estimation, which allows to directly incorporate external empirical evidence on the effects of FG shocks.
- We find that the coexistence of empirically plausible effects of both conventional monetary policy and FG requires a degree of CD that is specific to announcements of future policy shocks.
- Successfully resolves the forward guidance puzzle and delivers data-consistent monetary policy responses.
- We argue that in this context the CD parameter has a natural interpretation as a measure of the credibility of monetary policy announcements.

Gracias

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Forward Guidance shocks

Monetary policy in the model is the same as the original except that it features **forward guidance shocks**. This are introduced as usual, i.e.,

$$r_t = \rho r_{t-1} + (1-\rho)[r^{\pi}\pi_t + r^{y}(y_t - y_t^{f})] + r^{\delta y}[(y_t - y_t^{f}) - (y_{t-1} - y_{t-1}^{f})] + \varepsilon_t + \varepsilon_t^{fg} \quad (4)$$

where

$$\varepsilon_t^{fg} = \rho_{FG}\varepsilon_{t-1}^{fg} + e_{t-1}^{fg,1} + e_{t-2}^{fg,2} + e_{t-3}^{fg,3} + e_{t-4}^{fg,4} + e_{t-8}^{fg,8} \quad (5)$$

and $e_t^{fg,i}$ are iid Gaussian shocks with mean 0 and standard deviation σ.

Structural parameters

Parameter	Description	Initial Prior			Posterior RE				Posterior BR			
		distr.	mean	s.d.	mode	mean	pct. 5	pct. 95	mode	mean	pct. 5	pct. 95
ϕ	Adjustment costs	N	4	1.5	4.14	4.32	3.01	5.61	4.50	4.71	3.29	6.12
σ^c	risk aversion	N	1.5	0.375	1.31	1.45	1.05	1.86	1.67	1.60	1.06	2.09
h	external habit degree	B	0.7	0.1	0.46	0.45	0.35	0.55	0.41	0.44	0.32	0.56
χ^w	Calvo parameter wages	B	0.5	0.1	0.78	0.77	0.71	0.84	0.77	0.76	0.70	0.82
σ^L	Frisch elasticity	N	2.0	0.75	1.41	1.52	0.78	2.27	1.56	1.51	0.75	2.24
χ^p	Calvo parameter	B	0.5	0.1	0.64	0.65	0.57	0.72	0.65	0.63	0.56	0.71
ι^w	wages indexation	B	0.5	0.15	0.49	0.49	0.32	0.67	0.50	0.50	0.32	0.67
ι^p	prices indexation	B	0.5	0.15	0.38	0.36	0.22	0.49	0.37	0.34	0.20	0.47
ψ	Capacity utilization cost	B	0.5	0.15	0.38	0.45	0.27	0.63	0.39	0.48	0.28	0.69
Φ	fixed cost share	N	1.25	0.125	1.53	1.54	1.41	1.66	1.50	1.54	1.43	1.66
r^π	Taylor rule inflation feedback	N	1.5	0.25	2.03	2.09	1.81	2.35	2.02	2.06	1.79	2.33
ρ	interest rate persistence	B	0.75	0.10	0.88	0.88	0.86	0.91	0.88	0.88	0.86	0.91
r^y	Taylor rule output level feedback	N	0.125	0.05	0.03	0.05	0.01	0.09	0.07	0.06	0.01	0.10
$r^{\delta y}$	Taylor rule output growth feedback	N	0.125	0.05	0.20	0.20	0.16	0.23	0.18	0.19	0.15	0.22
$\bar{\pi}$	Steady state inflation rate	G	0.625	0.1	0.83	0.84	0.66	1.01	0.82	0.85	0.66	1.03
β	time preference rate in percent	G	0.25	0.1	0.10	0.12	0.05	0.19	0.10	0.12	0.05	0.19
$\bar{L}$	steady state hours	N	0.0	2.0	-2.34	-1.14	-4.71	2.31	1.01	-0.27	-3.92	3.13
$\bar{\gamma}$	net growth rate in percent	N	0.4	0.1	0.42	0.41	0.38	0.45	0.40	0.41	0.36	0.45
α	capital share	N	0.3	0.05	0.17	0.17	0.14	0.20	0.16	0.17	0.14	0.20

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Parameter	Description	Initial Prior			Posterior *RE*				Posterior *BR*			
		distr.	mean	s.d.	mode	mean	pct. 5	pct. 95	mode	mean	pct. 5	pct. 95
ρ_a		B	0.5	0.2	0.98	0.98	0.98	0.99	0.99	0.99	0.98	0.99
ρ_b		B	0.5	0.2	0.89	0.88	0.84	0.92	0.89	0.87	0.83	0.92
ρ_g		B	0.5	0.2	0.98	0.98	0.96	0.99	0.99	0.98	0.97	0.99
ρ_I		B	0.5	0.2	0.64	0.71	0.58	0.83	0.67	0.71	0.59	0.83
ρ_r		B	0.5	0.2	0.14	0.15	0.06	0.23	0.12	0.14	0.06	0.22
ρ_p		B	0.5	0.2	0.99	0.97	0.99	0.96	0.99	0.98	0.97	0.99
ρ_w		B	0.5	0.2	0.99	0.97	0.99	0.94	0.99	0.98	0.97	0.99
μ_p		B	0.5	0.2	0.92	0.90	0.84	0.95	0.91	0.88	0.82	0.95
μ_w		B	0.5	0.2	0.96	0.95	0.92	0.97	0.96	0.95	0.92	0.97
ρ_{ga}		B	0.5	0.25	0.59	0.59	0.50	0.70	0.57	0.58	0.46	0.69
ρ_{FG}		B	0.5	0.2	0.40	0.37	0.16	0.57	0.20	0.25	0.08	0.41
σ_a		IG	0.1	2.0	0.52	0.53	0.48	0.57	0.54	0.53	0.48	0.57
σ_b		IG	0.1	2.0	0.10	0.10	0.08	0.12	0.09	0.10	0.08	0.12
σ_g		IG	0.1	2.0	0.60	0.61	0.56	0.65	0.60	0.61	0.56	0.65
σ_I		IG	0.1	2.0	0.45	0.43	0.36	0.51	0.44	0.43	0.36	0.50
σ_r		IG	0.1	2.0	0.22	0.22	0.20	0.24	0.21	0.22	0.20	0.24
σ_p		IG	0.1	2.0	0.22	0.21	0.19	0.24	0.21	0.21	0.18	0.24
σ_w		IG	0.1	2.0	0.34	0.34	0.31	0.37	0.34	0.34	0.31	0.37
σ_{FG_1}		IG	0.1	2.0	0.03	0.04	0.02	0.06	0.04	0.04	0.02	0.06
σ_{FG_2}		IG	0.1	2.0	0.04	0.04	0.02	0.06	0.04	0.04	0.02	0.06
σ_{FG_3}		IG	0.1	2.0	0.04	0.04	0.02	0.06	0.04	0.04	0.02	0.06
σ_{FG_4}		IG	0.1	2.0	0.04	0.04	0.02	0.06	0.04	0.04	0.02	0.06
σ_{FG_8}		IG	0.1	2.0	0.04	0.04	0.02	0.06	0.04	0.04	0.02	0.06