Discussion of
Monetary policy with persistent supply shocks

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[1]The opinions expressed are personal and do not necessarily reflect those of the ECB or the Eurosystem.

Summary

Great paper!

Discussion

1. Is the paper really about the *persistence* of shocks?
2. What are the benefits of deep learning?
3. Why does optimal policy under commitment not stabilise the price level: a conjecture.
4. What do we learn about the real world?

Is the paper really about the persistence of shocks?

Is the paper about persistent shocks?

- The cost-push shock η_t follows a two-state Markov chain. In regime $s_t = 0$, $\eta_1 = 1$; in regime $s_t = 1$, $\eta_2 = \frac{\varepsilon}{\varepsilon - 1} = \frac{7}{6}$. The law of motion of s_t can be rewritten as an AR(1)

$$s_{t+1} - \bar{s} = \rho_s \left(s_t - \bar{s} \right) + \nu_{t+1}, \qquad \mathsf{E}_t \nu_{t+1} = 0$$

  where

$$\bar{s} \equiv \frac{p_{12}}{p_{21} + p_{12}} = \frac{1}{3}$$

$$\rho_s \equiv 1 - p_{21} - p_{12} = 0.9375$$

- Compare to

$$\rho_A = 0.99, \rho_\tau = 0.90, \rho_g = 0.97$$

- Hence, persistent, but not especially persistent.

... but Markov chain dynamics are different

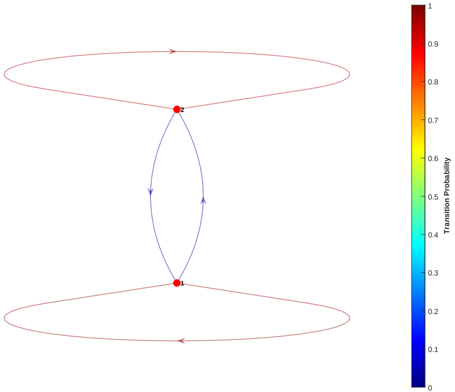

Figure 1: Dynamics of η_t.

Markov chain vs. comparable AR(1) process

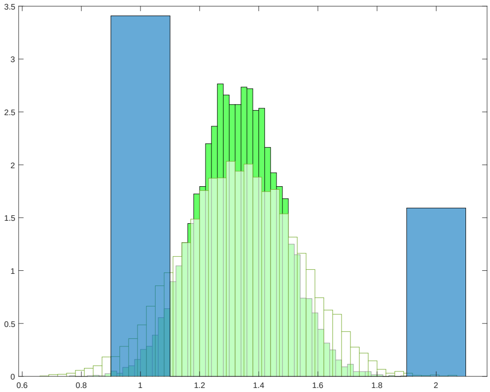

Figure 2: Markov chain in blue; AR(1) process with the same persistence and uncond. mean in green.

Is the paper about persistent shocks?

- There is a sense in which a persistent Markov chain does spend more time "pushed back" to each state than a persistent AR(1) shock.
  - A Markov chain is also heteroschedastic.
- But asymmetry also important in this application: normal times vs. bad times; no "exceptionally good" times
- "Monetary policy with regime-switching supply shocks"? Or "Monetary policy with multiple supply-shock regimes"?

The benefits of deep learning

Could one solve the model with perturbation?

- Problem: the non-stochastic steady state is state-dependent

$$y\left(\eta(s_t)\right) : \frac{1}{\eta(s_t))} = y^{\omega}\left(y - \bar{g}\right)^{\gamma}$$

- Define the ergodic mean $\bar{\eta}$ and use a perturbation function for MS parameters (see Foerster, Rubio-Ramirez, Waggoner and Zha, QE 2016)

$$\eta\left(s, \chi\right) = \chi\eta\left(s\right) + \left(1 - \chi\right)\bar{\eta}$$

so that for $\chi = 0, \eta\left(s, \chi\right) = \bar{\eta}$ and for $\chi = 1, \eta\left(s, \chi\right) = \eta\left(s\right)$

First order approximation I

- Log-linear system in deviation from the efficient equilibrium ($\kappa_x \equiv \kappa \frac{\omega(1-g_y)+\gamma}{1-g_y}$):

$$\pi_t = \kappa_x x_t^e + \beta \mathrm{E}_t \pi_{t+1} + \kappa \xi_t + \kappa \hat{\eta}_t$$

$$x_t^e = \mathrm{E}_t x_{t+1}^e - \frac{1-g_y}{\gamma}\left(i_t - \mathrm{E}_t \pi_{t+1} - r_t^e\right)$$

$$i_t = \beta \psi \pi_t$$

$$r_t^e = \frac{\gamma}{(1-g_y)\,\omega + \gamma}\left[(1+\omega)(\rho_a - 1)\, a_t - \omega \bar{g}_y (\rho_g - 1)\, \hat{g}_t\right]$$

- Notes: $\hat{\eta}_t$ looks like a standard cost-push shock; r_t^e is independent of $\hat{\eta}_t$; nothing new?

First order approximation II

- Expanding $\hat{\eta}_t$ and ignoring other shocks:

$$\pi_t = \kappa_x x_t^e + \beta \mathrm{E}_t \pi_{t+1} + \kappa \left(\ln \eta_t - \ln \bar{\eta} \right)$$

$$x_t^e = \mathrm{E}_t x_{t+1}^e - \frac{1 - g_y}{\gamma} \left(i_t - \mathrm{E}_t \pi_{t+1} \right)$$

$$i_t = \beta \psi \pi_t$$

- $\eta_t = 1$ implies a small negative cost-push shock, positive efficient gap; $\eta_t = \mathcal{M}$ implies a larger positive shock, negative efficient gap.

- Stochastic steady states:

$$\left(1 - \beta\right) \pi_1 - \kappa_x x_1^e = \kappa \left(0 - \ln \bar{\eta} \right)$$

$$\left(1 - \beta\right) \pi_2 - \kappa_x x_2^e = \kappa \left(\ln \mathcal{M} - \ln \bar{\eta} \right)$$

First order approximation III

- Log-linear system in deviation from the flex price equilibrium:

$$\pi_t = \kappa_x x_t + \beta \mathrm{E}_t \pi_{t+1}$$

$$x_t = \mathrm{E}_t x_{t+1} - \frac{1-g_y}{\gamma}\left(i_t - \mathrm{E}_t \pi_{t+1} - r_t^n\right)$$

$$i_t = \beta \psi \pi_t$$

$$r_t^n = \frac{\gamma}{\left(1-g_y\right)\omega + \gamma}\left[\left(1+\omega\right)\left(\rho_a - 1\right)a_t - \omega \bar{g}_y \left(\rho_g - 1\right)\hat{g}_t - \left(\rho_\tau - 1\right)\xi_t + \hat{\eta}_t - \mathrm{E}_t \hat{\eta}_{t+1}\right]$$

Stochastic steady state values under the Taylor rule

		DEQN	1st order
Inflation			
	normal times	-0.9%	-0.7%
	bad times	1.6%	1.4%
Output			
	normal times		0
	bad times		-5.9%
Efficient output gap [?]			
	normal times	-0.1%	1.2%
	bad times	-5.4%	-2.4%
Real interest rates			
	normal times	0.1%	0.3%
	bad times	2.6%	2.5%
Natural rates			
	normal times		0.2%
	bad times		2.6%
Nominal interest rates			
	normal times	-0.8%	-0.4%
	bad times	4.2%	3.8%

The benefits of DEQN

- A slightly less transparent, but more precise solution. Even in a simple model.
  - Show impact of heteroschedasticity?
  - Work with log-variables to maximise comparability with the literature?
- Benefits grow with model complexity/nonlinearity – but also risk of black box feeling?
- Obvious example: version of the model with ZLB.

Why does optimal policy from a timeless perspective not stabilise the price level?

A conjecture on optimal policy from a timeless perspective I

- Shocks happen in the SSS. Expectations can differ from actuals:

$$\pi_s - \kappa_x x_s = \beta \mathrm{E}_s \pi + \kappa \left(\log \eta_s - \log \bar{\eta} \right)$$

$$x_s = \mathrm{E}_s x - \frac{1 - g_y}{\gamma} \left(i_s - \mathrm{E}_s \pi \right)$$

- In state η_1 it becomes feasible to have $x_1 = \pi_1 = 0$

$$0 = \beta \mathrm{E}_1 \pi + \kappa \left(0 - \log \bar{\eta} \right)$$

- In state η_2 it must be $x_2 < 0$

$$x_2 = -\frac{\beta}{\kappa_x} \mathrm{E}_2 \pi - \frac{\kappa}{\kappa_x} \left(\log \mathcal{M} - \log \bar{\eta} \right)$$

A conjecture on optimal policy from a timeless perspective II

- Enter the optimal target rule:

$$p_t - p_{t-1} = -\frac{1}{\varepsilon}(x_t - x_{t-1})$$

- Start from state $\eta_{t_0-1,s=1}$ with $x_{t_0-1,s=1} = \pi_{t_0-1,s=1} = 0$. Normalise the t_0 price level $p_{t_0-1,s=1} = 0$. Then shift to $\eta_{t_0,s=2}$ with $x_{t_0,s=2} < 0$. Target rule implies:

$$p_{t_0,s=2} = -\frac{1}{\varepsilon}x_{t_0,s=2} > 0$$

$$p_{t_0+1,s=2} - p_{t_0,s=2} = 0$$

$$p_{t_0+2,s=2} - p_{t_0+1,s=2} = 0$$

$$\ldots$$

A conjecture on optimal policy from a timeless perspective III

- The optimal target rule of the linearised model can provide some useful intuition.
- The optimal target rule only requires an eventual return to the original price level if all gaps return to zero. Not the case in this model after a regime switch. Price drift possible (and desirable).
- If gaps are non-zero, expectations may differ from realised variables in the SSS – see also Daudignon and Tristani (JMCB, 2025).
- (Alternative conjecture: positive price level drift after inflationary shocks is offset by negative drift after return to normal times. Ruled out in the appendix)

What do we learn about the real world?

Pushing the interpretation of η as a tariff shock

- Consistent with Werning, Lorenzoni and Guerrieri (2025)
- Are tariffs a persistent or permanent state?
- Uncertainty: there may be a very bad state η_3.
- Ramsey more appropriate to characterise optimal reaction to time t_0 "liberation day" announcement? (Or who is right between Trump and the Fed?)

Conclusion

Great paper!