Animal Spirit in the New Keynesian Model: How Does Cognitive Bias Affect Monetary and Fiscal Policies?

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Motivation

- New Keynesian models are widely applied and are used to explore policy issues.
- However, several limitations has been noted, such as forward guidance puzzle, stability at ZLB, effectiveness of fiscal policy.
- Modifications such as HANK, inattention in NK has be proposed in order to resolve the issues.
- This paper proposes an additional parsimonious generalization of the tranditional model to tackle most the issues using a behavioral New Keynesian model.
- In particular, we incorporate behavioral factor (Gabaix (2020)- Cognitive Discounting, and Santoro et al. (2014)- Reference Dependence) into New Keynesian model and study its policy implications.

Behavioral New Keynesian Model, Gabaix (2020)

- Gabaix (2020) develops a framework of Behavioral New Keynesian Model to solve several puzzles in macroeconomics.
- IS Curve:$y_t = mE_t y_{t+1} + \sigma(i_t - E_t\pi_{t+1})$
- NK Phillips Curve:$\pi_t = \beta m^f E_t\pi_{t+1} + \kappa y_t$
- m is the myopia parameter and if m=1 the model converges back to the basic NK model.
- Puzzles: (1) forward guidance puzzle, (2) stability at ZLB, (3) fiscal policy is effective.

Reference Dependence in New Keynesian Model, Santoro et al. (2014)

- Santoro et al. (2014) use the reference model from Köszegi and Rabin(2006) to explain why there exists asymmetric effect of monetary policy in different cycle.
- Gain and loss depend on the reference point of consumption.
- Household suffers from loss aversion and thus the impact of the monetary policy is larger in the contraction period.

Why we need a bridge between two models?

- Santoro et al. (2014) cannot analyze the impact of the fiscal policy and the traditional macroeconomics puzzles still remain (forward guidance puzzle, stability in the ZLB...).
- Gabaix (2020) cannot show asymmetric effect in different business cycle and several arguments contradict with previous empirical literature (Cochrone (2016)).
- We build a model to analyze the monetary policy and fiscal policy in different stage that is simple and solvable.

Setup: Households

- A household has demand for leisure, $1 - N$ and the total consumption, C and he would like to maximise his value function such that:

$$E_t \sum_{s=0}^{\infty} \beta^s [U(C_{t+s}) - \frac{(N_{t+s})^{1+\phi}}{1+\phi}], \tag{1}$$

subject to the budget constraint:

$$k_{t+1} = (1 + r_t)(k_t - c_t + y_t) \tag{2}$$

$$y_t = \omega_t N_t + y_t^f, \tag{3}$$

where β is the time discounting factor, ϕ is the inverse of the Frisch elasticity of the labor supply.

Setup: Firms

- Each firm i produces differentiated goods:

$$Y_t(i) = A_t N_t(i), \tag{4}$$

where A_t is the technology shock follows AR(1) process such that:

$$A_t = \rho_A A_{t-1} + \epsilon_A, \tag{5}$$

where ϵ_A is the technology shock and $\epsilon_A \sim N(0, \sigma_A)$.

- A final goods firm minimizes its cost by choosing the amount of the intermediate goods:

$$Y_t = [\int_0^1 Y_t(i)^{\frac{\epsilon-1}{\epsilon}} di,]^{\frac{\epsilon}{\epsilon-1}} \tag{6}$$

where $\epsilon > 1$ is the elasticity of substitution between intermediate goods.

Setup: Firms

- We assume the standard Calvo's pricing setup with monopolistic competition such that each firm has 1-μ probability to reset its price, and we further assume the government pays a constant subsidy rate, τ_s.
- With the wage be the marginal cost, we can generate the profit function J_t such that:

$$J_t(i) = (1 + \tau_s)(\frac{P_t(i)}{P_t})Y_t(i) - A_t N_t(i), \tag{7}$$

where P_t is the aggregated price index such that:

$$P_t = [\int_0^1 P_t(i)^{1-\epsilon} di.]^{\frac{1}{1-\epsilon}} \tag{8}$$

Cognitive Bias Setup

- *Cognitive Discounting.*- Following Gabaix (2020), we assume household pays attention to any macro variables with myopia parameter m. Then, any macro variable z(X) in rational expectation model $E_t(z(X_{t+k}))$ will become

$$m^k E_t(z(X_{t+k})). \tag{9}$$

- *Reference Dependence.*- Following Santoro et al. (2014), we assume Utility function contains CRRA utility function and loss aversion utility function such that

$$U(C_{t+s}) = V(C_{t+s}) + [G(C_{t+x}, X)], V(C_{t+s}) = \frac{C_{t+s}^{1-\gamma} - 1}{1-\gamma} \tag{10}$$

$$G(X, C_{t+s}) = \begin{cases} \frac{1-exp(-\theta\delta_{t+s})}{\theta}, & \text{iff } \delta_{t+s} \equiv ln(C_{t+s}) - ln(X) > 0 \\ -\lambda\frac{1-exp(\frac{\theta}{\lambda}\delta_{t+s})}{\theta}, & \text{otherwise,} \end{cases}$$

where θ is the sensitivity of the loss-aversion, λ is the degree of loss-aversion, γ is the degree of risk-aversion.

- We assume the simple Taylor's Rule in the log-linearnization term such that:

$$i_t = \phi_\pi \pi_t + \epsilon_t^{mp}, \tag{11}$$

where ϵ_t^{mp} is the monetary policy shock follows an AR(1) process.

Model Solution - IS Curve

- After log linearnization, and we use the lower case letter to represent the log deviation from steady state, we can obtain the non-linear IS Curve as following:

$$y_t = \begin{cases} mE_t y_{t+1} - \sigma_e(i_t - E_t\pi_{t+1}), & \text{if } C_t > X \ \& \ C_{t+1} > X \\ mE_t y_{t+1} - \sigma_r(i_t - E_t\pi_{t+1}), & \text{if } C_t < X \ \& \ C_{t+1} < X, \end{cases} \tag{12}$$

  where $\sigma_e = \frac{1}{\gamma+\theta}$ and $\sigma_r = \frac{1}{\gamma - \frac{\theta}{\lambda}}$.
- $\theta = 0$ and $m = 1$ converge back to the basic IS curve. $\theta > 0$ and $m = 1$ converge back to the IS curve of Santoro et al. (2014). $\theta = 0$ and $m < 1$ converge back to the IS curve of Gabaix (2020).
- $\sigma_e < \sigma_r$:the power of the monetary policy is larger in the contraction than in the expansion.

Model Solution - NK Phillips Curve

- We can also obtain the piece-wise NK Phillips Curve such that:

$$\pi_t = \begin{cases} \beta m^f E_t \pi_{t+1} + \kappa_e y_t, & \text{if } C_t > X \ \&\ C_{t+1} > X \\ \beta m^f E_t \pi_{t+1} + \kappa_r y_t, & \text{if } C_t < X \ \&\ C_{t+1} < X, \end{cases} \tag{13}$$

where

$$m^f = m(\mu + \frac{1-\beta\mu}{1-\beta\mu m}(1-\mu)),\ \kappa = (\frac{1}{\theta} - 1)(1-\beta\mu)(\gamma+\phi),$$
$$\kappa_e = \frac{\kappa}{\gamma+\phi}(\phi+\gamma+\theta),\ \kappa_r = \frac{\kappa}{\gamma+\phi}(\phi+\gamma-\frac{\theta}{\lambda}).$$

- $\kappa_e > \kappa_r$:the slope of the NK Phillips Curve is flatter in the contraction.
- m^f increases with μ: when the price is more sticky, the firm will be closer to rational firm.
- Empirical Evidence:Daly, M. C. and Hobijn, B. (2014)

Results (1): Forward Guidance Puzzle

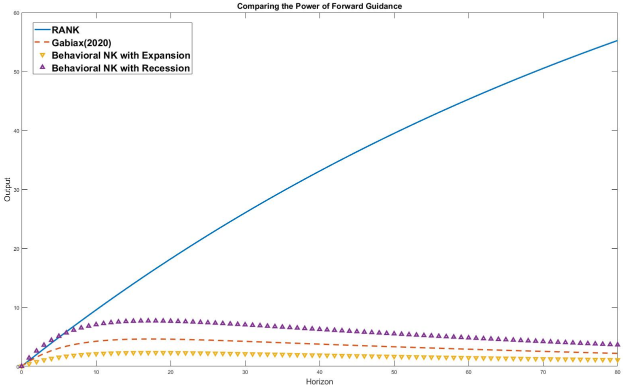
- The forward guidance puzzle is that the power of forward guidance is more powerful if the horizon of the interest rate is longer in the standard NK model.
- Following Gabaix (2020), we can rewrite Eq (12) and let $i_t - \pi_{t+1} = r_t$ with $r_T = -\delta = -1\%$ and $r_t = 0$ with $t \neq T$ to generate the following equation:

$$\pi_0 = \begin{cases} \sigma_e \kappa_e \frac{m^{T+1} - (\beta m^f)^T}{m - (\beta m^f)} \delta, & \text{if } C_t > X \text{ \& } C_{t+1} > X \\ \sigma_r \kappa_r \frac{m^{T+1} - (\beta m^f)^T}{m - (\beta m^f)} \delta, & \text{if } C_t < X \text{ \& } C_{t+1} < X, \end{cases}$$

with $r_T = -\delta = -1\%$.

Results (1): Forward Guidance Puzzle

- $\sigma_e \kappa_e < \sigma_r \kappa_r$: The power of forward guidance is smaller in the expansion than in the contraction.
- Empirical Evidence:Campbell, J. R., Evans, C. L., Fisher, J. D., Justiniano, A., Calomiris, C. W., and Woodford, M. (2012)



Results (2): Interest Rate Peg Stability

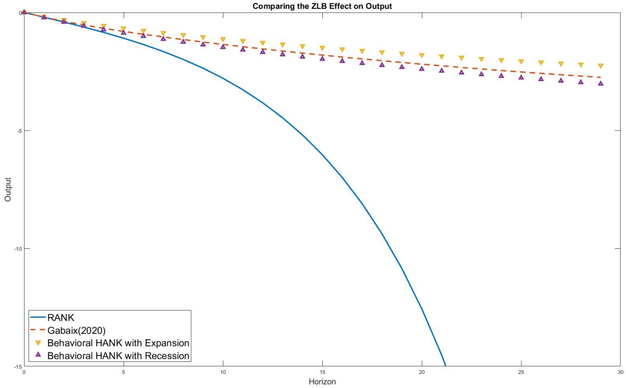
- Clarida et al. (2000) show that the the main reason for the volatile output in 1970s is due to passive interest rate, but the output is stable in the ZLB in the US and Japan, why?
- Gabaix(2020) uses the behavioral model to explain why interest rate is stable during the ZLB but how about the passive interest rate in 1970s?
- From the IS curve in Eq (12) and the standard NKPC in Eq (13), we rewrite the equations in the matrix form and the condition for the stable dynamic system is the following:

$$\phi_\pi + \frac{(1-m)(1-\beta m^f)}{\sigma_s \kappa_s} > 1,$$

  where $s \in \{e, r\}$
- Since $\sigma_e \kappa_e < \sigma_r \kappa_r$, it is harder to achieve the condition in contraction than in expansion: Both Gabaix (2020) and Clarida et al. (2000) could be right within the current model.

Results (2): Interest Rate Peg Stability

- Even if the ZLB is stable, output will becomes less stable in the contraction than in the expansion.



Fiscal Policy

- The government spending is financed by the debt in the future, which we denote as $B_{t+1} = B_{Bt} + Rd_t$.
- Let d_t be the deficit and G be the government spending, we can rewrite $d_t = G_t + \frac{r}{R}B_{t-1}$ with fiscal rule $d_t = -\delta_y y_t + \epsilon_t^g$
- Solving the problem, we can obtain the IS curve with debt such that:

$$\begin{cases} y_t = mE_t y_{t+1} + b_e d_t - \sigma_z(i_t - E_{t+1}\pi_{t+1}), & \text{if } C_t > X \ \& \ C_{t+1} > X \\ y_t = mE_t y_{t+1} + b_r d_t - \sigma_z(i_t - E_{t+1}\pi_{t+1}), & \text{if } C_t < X \ \& \ C_{t+1} < X \end{cases} \tag{14}$$

where $b_e = \frac{\phi r R(1-m)}{(\phi + \frac{1}{\sigma_e})(R-m)}$ and $b_r = \frac{\phi r R(1-m)}{(\phi + \frac{1}{\sigma_r})(R-m)}$ are the sensitivity of the consumption toward the deficit during the expansion and recession.

Results (3): Asymmetric Effects of Fiscal Policy

- Agent is non-Ricardian if $m < 1$ and Ricardian if $m = 1$.
- $b_e < b_r$: fiscal policy is more powerful in the contraction than in the expansion.
- This explains why some empirical literature shows the fiscal policy is powerful (i.e. Johnson et al. (2006), Parker et al. (2013)) and some works find little evidence on the power of fiscal policy (i.e. Taylor (2009), Fama (2021)).

Results (4): Fiscal Policy helps stabilize the ZLB

- Stable condition becomes:

$$\phi_\pi + \frac{(1-m)(1-\beta m^f)}{\kappa_z \sigma_z} + (1-\beta m^f)\frac{b_z \delta_y}{\sigma_z \kappa_z} > 1.$$

  where $s \in \{e, r\}$

- With fiscal policy, it is easier to stabilize the economy under the ZLB.
- This show that that our model allows for the analysis on the coordination of the monetary and fiscal policies.
- $(1-m)(1-\beta m^f) > \beta m^f b_s \delta_y$ and since $b_e < b_r$ the δ_y should be smaller to avoid explosion.
- Even in the active rule, it can be shown that the condition to avoid the explosion in output for Taylor's rule is more restricted in the contraction (ie ϕ_π should be larger in the contraction to avoid explosion).

Thanks!