Monetary Policy and Exchange Rate Dynamics in a Behavioral Open Economy Model[1]

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[1] The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Motivation

- Expectations are crucial for monetary transmission
  - Woodford: "... very little else matters"
- Even more relevant for Forward guidance (FG)
  - New-Keynesian (NK) models provides a clear FG mechanism
  - Forward guidance puzzle (FGP): FG actually too potent in NK models
- Deviating from rational expectations may help address FGP
  - Behavioral agents: Woodford (2019), Gabaix (2020)
- Little is known about the implications of behavioral assumptions in richer theoretical setups, including open economy models

This paper

Develop a behavioral open economy NK model:

1. Helps resolve UIP-related anomalies
   - Forward premium puzzle (Fama, 1984)
   - Predictability reversal puzzle (Bacchetta and van Wincoop, 2010)
   - Engel puzzle (Engel, 2016)
   - Forward guidance exchange rate puzzle (Galí, 2020)

2. Consistent with empirical evidence on UIP holding when measured expectations are used (Kalemli-Ozcan and Varela, 2021)

3. Significantly modifies macroeconomic dynamics (NFA and RER)

4. Lowers the efficacy of FG and 'low for longer' type policies, but to relatively lower degree than in closed economies

5. Modifies international monetary spillovers, making positive output comovement more likely

Literature

- Behavioral discounting
  - Woodford (2019), Gabaix (2020), Angeletos and Huo (2021), Gust, Herbst, and Lopez-Salido (2021)
- Learning
  - Brock and Hommes (1997), Evans and Honkapohja (2001), Bullard and Mitra (2002), Preston (2005), Branch and McGough (2009), De Grauwe (2011)
- Diagnostic expectations
  - Bordalo, Gennaioli, and Shleifer (2018), Bianchi, Ilut, and Saijo (2021)
- Bounded rationality in open economies
  - Du, Eusepi, and Preston (2021)
- Resolving UIP-related puzzles
  - Bacchetta and van Wincoop (2021), Valchev (2020), Itskhoki and Mukhin (2021)

Outline

1. Introduction
2. Theoretical Setup
3. Linearized Model
4. Exchange Rate Dynamics
5. Monetary Policy Transmission
6. International Spillovers
7. Conclusions

Theoretical Setup

Households

- Household h maximizes

$$U_t^h = \hat{\mathbb{E}}_t \sum_{T=t}^{\infty} \beta^{T-t} \left[\frac{\left(C_T^h\right)^{1-\sigma}}{1-\sigma} - \frac{\left(N_T^h\right)^{1+\varphi}}{1+\varphi}) \right]$$

where $\hat{\mathbb{E}}_t$ is subjective expectated value operator

- Consumption basket

$$C_t^h = \left[(1-\alpha)^{\frac{1}{\eta}} \left(C_{H,t}^h\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(C_{F,t}^h\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

- Real budget constraint

$$C_t^h + \frac{B_t^h}{1+i_t} + \frac{Q_t}{\Phi_t} \frac{B_t^{*,h}}{1+i_t^*} = \frac{B_{t-1}^h}{\Pi_t} + Q_t \frac{B_{t-1}^{*,h}}{\Pi_t^*} + W_t N_t^h + D_t$$

where $\Phi_t = \Phi(B_t^*)$ is a risk premium

Firms

- Monopolistically competitive firms
- Calvo-style price rigidity
- Producer currency pricing: $P_{H,t}^{f} = \varepsilon_t P_{H,t}^{*,f}$
- When allowed to reoptimize, firm f maximizes

$$V_t^f = \hat{\mathbb{E}}_t \sum_{T=t}^{\infty} \theta^{T-t} \Lambda_{t,T} \left[P_{H,t}^{f} (Y_{H,T}^{f} + Y_{H,T}^{*,f}) - W_T N_T^f \right]$$

Monetary Authority

Standard Taylor-like feedback rule

$$i_t = \rho i_{t-1} + (1-\rho)\left[i + \phi_\pi(\Pi_t - \Pi) + \phi_y \log(Y_t/Y)\right] + \nu_t$$

where ν_t is a monetary policy shock

Behavioral Discounting

- Agents are myopic as in Gabaix (2020)
  - Shrink their expectations about variables beyond their control towards a simple benchmark (steady state)
  - Possible microfoundation: agents receive noisy signals
- For any variable X_t, the perceived equilibrium law of motion is

$$X_{t+1} - X = m\mathbf{G}^X(\mathbf{X}_t - \mathbf{X}, \epsilon_{t+1}) \tag{1}$$

  with $0 \leq m \leq 1$ and $\mathbf{G}^X$ indicating the true policy function
- *Linear approximation*: behavioral k-period ahead expectations of X_t

$$\hat{\mathbb{E}}_t \{X_{t+k} - X\} = m^k \mathbb{E}_t \{X_{t+k} - X\} \tag{2}$$

Linearized Model

IS Curve

- *Individual* Euler equation:

$$\hat{C}_t^h = \hat{\mathbb{E}}_t \hat{C}_{t+1}^h - \frac{1}{\sigma} \hat{\mathbb{E}}_t \left\{ \hat{i}_t - \hat{\pi}_{t+1} \right\} \tag{3}$$

- *Individual* consumption function:

$$\left(1 + \frac{\sigma}{\mu\varphi}\right) \hat{C}_t^h = (1-\beta)\left(\hat{B}_{t-1}^{*,h} + \hat{B}_{t-1}^h\right)$$
$$+\hat{\mathbb{E}}_t \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta)\left(\frac{\varphi+1}{\mu\varphi}\hat{W}_T + \hat{D}_T\right) - \frac{\beta}{\sigma}\left(1 + \frac{\sigma}{\mu\varphi}\right)\left(\hat{i}_T - \hat{\pi}_{T+1}\right)\right]$$

- *Aggregate* IS Curve:

$$\hat{C}_t = m\mathbb{E}_{t+1}\hat{C}_{t+1} - \frac{1}{\sigma}\left(\hat{i}_t - m\mathbb{E}_t\hat{\pi}_{t+1}\right) + (1-m)\frac{1-\beta}{1+\frac{\sigma}{\mu\varphi}}\hat{B}_t^* \tag{4}$$

Uncovered Interest Rate Parity

- UIP condition

$$\hat{\mathbb{E}}_t \left\{ \hat{i}_t - \hat{\pi}_{t+1} \right\} = \hat{\mathbb{E}}_t \left\{ \hat{i}^*_t - \hat{\pi}^*_{t+1} + \hat{Q}_{t+1} - \hat{Q}_t - \phi \hat{B}^*_t \right\}$$

holds under subjective expectations

- But *fails* when combined with rational expectations

$$\hat{i}_t - m\mathbb{E}_t \left\{ \hat{\pi}_{t+1} \right\} = \hat{i}^*_t - m\mathbb{E}_t \left\{ \hat{\pi}^*_{t+1} - \hat{Q}_{t+1} \right\} - \hat{Q}_t - \phi \hat{B}^*_t$$

- Consistent with recent empirical evidence (Kalemli-Ozcan and Varela, 2021; Candian and De Leo, 2021)

Phillips Curve

PC of Gabaix (2020)

- Reoptimizing firms choose:

$$\hat{P}_{H,t}^{\diamond,f} = (1-\beta\theta)\sum_{T=t}^{\infty}(\beta\theta)^{T-t}\hat{\mathbb{E}}_t\left\{\hat{\pi}_{H,t+1}+\ldots+\hat{\pi}_{H,T}+\hat{MC}_T\right\}$$

- Phillips Curve

$$\hat{\pi}_{H,t} = m\beta\mathbb{E}_t\{\hat{\pi}_{H,t+1}\} + \frac{(1-\theta)(1-\beta\theta)}{\theta}\hat{MC}_t$$

Parameterization

- Closely follow Gali and Monacelli (2005)
  - Calvo probability $\theta = 0.85$
- Cognitive discounting $m = \{0.5, 0.75, 0.9, 1.0\}$
  - $m = 0.85$ (Gabaix, 2020)
  - $m = 0.65$ (Fuhrer and Rudebusch, 2004)
  - $m = 0.50$ (Gust, Herbst, and Lopez-Salido, 2021)
  - $m = 0.40 - 0.70$ (Ilabaca, Meggiorini, and Milani, 2020)
- Interest rate smoothing parameter $\rho = \{0.5, 0.75, 0.9, 0.95\}$
- Debt-elastic risk premium $\phi = 0.01$ Stationarity

Exchange Rate Dynamics

Forward Premium Puzzle

- Fama (1984) regression

$$\Delta\hat{\varepsilon}_{t+1} = a_0 + a_1\left(\hat{i}_t - \hat{i}_t^*\right) + \epsilon_t \tag{5}$$

  - Data: $\mathbb{E}a_1 \approx 0$
  - UIP + rational expectations: $\mathbb{E}a_1 = 1$
- Behavioral model

$$\mathbb{E}_t\left\{\Delta\hat{\varepsilon}_{t+1}\right\} = \frac{1}{m}\left(\hat{i}_t - \hat{i}_t^*\right) + \left(\frac{1}{m} - 1\right)\hat{Q}_t \tag{6}$$

- Fama coefficient

$$\mathbb{E}a_1 = \frac{1}{m} + \left(\frac{1}{m} - 1\right) Corr\left\{\hat{Q}_t, \hat{i}_t - \hat{i}_t^*\right\} \frac{Std\left\{\hat{Q}_t\right\}}{Std\left\{\hat{i}_t - \hat{i}_t^*\right\}} \tag{7}$$

Forward Premium

Table 1: Fama Regression Coefficients

PARAMETER	m =0.50	m =0.75	m =0.90	m =1.00
$\rho = 0.95$	-0.07	-0.04	0.37	1.00
$\rho = 0.90$	0.17	0.36	0.67	1.00
$\rho = 0.75$	0.51	0.70	0.86	1.00
$\rho = 0.50$	0.75	0.86	0.94	1.00

Predictability Sign Reversal

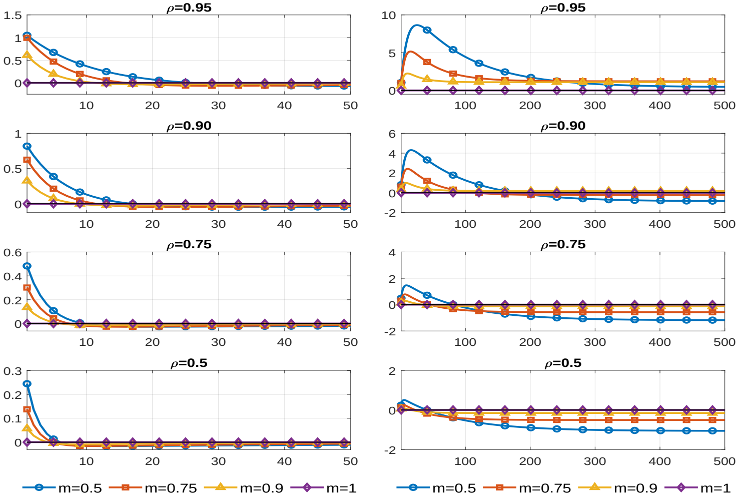
- Engel-style regression (for $s = 0, 1, \ldots$):

$$r^x_{t+1} \equiv \hat{i}_t - \hat{i}^*_t - \Delta\hat{\varepsilon}_{t+1} = b_{s,0} + b_{s,1}\left(\hat{i}_{t-s} - \hat{i}^*_{t-s}\right) + \epsilon_t,$$

  - Bacchetta and van Wincoop (2010): $\mathbb{E}b_{s,1}$ change sign from positive to negative for some $s > 0$
  - Engel (2016): $\sum_{s=1}^{\infty} \mathbb{E}b_{s,1} < 0$
  - UIP + rational expectations: $\mathbb{E}b_{s,1} = 0$

Predictability Sign Reversal

Exchange Rate FGP



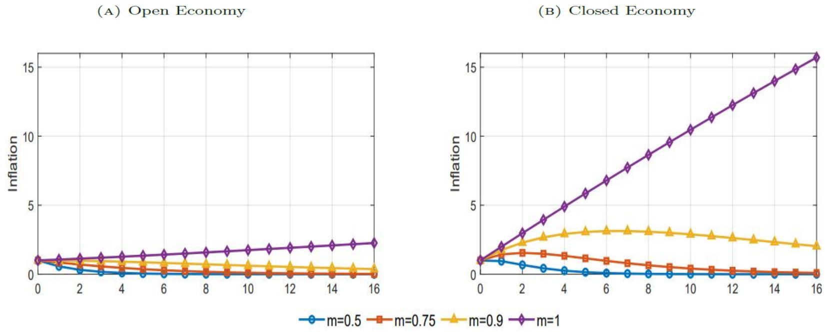
(a) Engel Coefficients **(b)** Cum. Sums of Engel Coeff.

Monetary Policy Transmission

Forward Guidance Puzzle

▸ Monetary Policy Shock ▸ Lower for Longer Policies

$$\hat{\pi}_t \approx \underbrace{-\kappa A \mathbb{E}_t \sum_{T=t}^{\infty} (T-t+1)\, m^{T-t} \hat{r}_T}_{\text{Domestic Marginal Cost}} \underbrace{- \frac{\alpha}{1-\alpha} \mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \hat{r}_T}_{\text{Import Prices}} - \frac{\alpha}{1-\alpha} \hat{Q}_{t-1}$$



International Spillovers

Home Output Decomposition

- Decomposing small open economy output

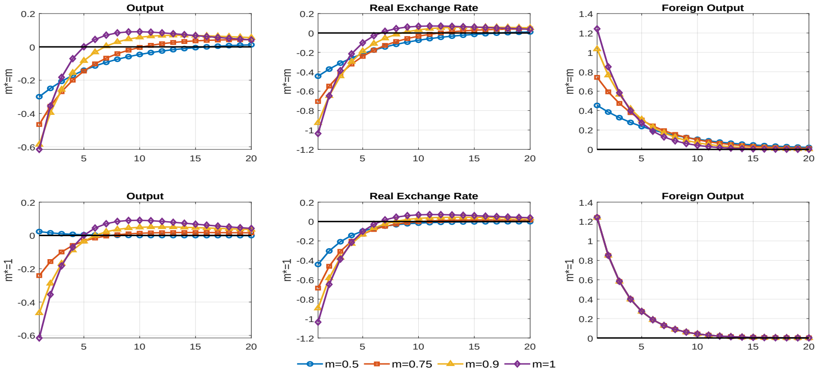
$$\hat{Y}_t = \underbrace{\alpha \hat{Y}_t^*}_{\text{Foreign Demand}} + \underbrace{\eta \frac{\alpha(2-\alpha)}{1-\alpha} \hat{Q}_t}_{\text{Expenditure Switching}}$$

$$\underbrace{-\frac{1-\alpha}{\sigma} \mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \hat{r}_T}_{\text{Home Policy Response}} + \underbrace{(1-m)(1-\alpha) \frac{1-\beta}{1+\frac{\sigma}{\mu\varphi}} \mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \hat{B}_T^*}_{\text{Myopia “Damper"}}$$

- Foreign Demand channel depends on foreign real interest rates
- Expenditure Switching channel depends on the interest rate differential

Keeping Home Real Interest Rate Constant

$$\hat{Y}_t \approx \underbrace{-\frac{\alpha}{\sigma}\mathbb{E}_t\sum_{T=t}^{\infty} {m^*}^{T-t}\hat{r}_T^*}_{\text{Foreign Demand}} + \underbrace{\eta\frac{\alpha(2-\alpha)}{1-\alpha}\mathbb{E}_t\sum_{T=t}^{\infty} m^{T-t}\hat{r}_T^*}_{\text{Expenditure Switching}}$$



Conclusions

Conclusions

- Extending standard open economy NK framework by adding behavioral agents

  1. Helps resolve several anomalies related to the UIP condition
  2. Decreases the efficacy of policies that rely on announcements of future actions, like “low for longer", thus mitigating the FGP
  3. Can better account for international output comovement

- Extension is not costless, but benefits are significant - true both for closed and open economy models, but particularly for the latter

Conclusion

Thank you!

Extra Slides

Phillips Curve of Gabaix (2020)

▸ Phillips Curve

- If firms are BR, firms resetting their price would choose on average price of:

$$p_t^* = p_t + (1 - \beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t^{BR} [\pi_{t+1} + \ldots + \pi_{t+k} - \mu_{t+k}] \tag{8}$$

- Applying cognitive discounting, so that

$$p_t^* = p_t + (1 - \beta\theta) \sum_{k=0}^{\infty} (M\beta\theta)^k \mathbb{E}_t [\pi_{t+1} + \ldots + \pi_{t+k} - \mu_{t+k}] \tag{9}$$

which gives

$$\pi_t = \beta M \left[\theta + (1 - \theta) \frac{1 - \beta\theta}{1 - M\beta\theta} \right] \mathbb{E}_t \pi_{t+1} + \kappa x_t \tag{10}$$

Stationarity

▸ Parameterization

- Recall IS curve

$$\hat{C}_t = m\mathbb{E}_t\hat{C}_{t+1} - \frac{1}{\sigma}\hat{r}_t + (1-m)\frac{1-\beta}{1+\frac{\sigma}{\mu\varphi}}\hat{B}_t^*$$

- Small open economy: absent risk premium ($\phi = 0$), home real interest rate $\hat{r}_t$ becomes tied to the (exogenous) foreign interest rate

- Rational expectations $m = 1$: unit root in consumption, need $\phi > 0$ to induce stationarity

- Myopia $m < 1$: stationarity issue aggrevated, need for risk premium even stronger

- Intuition: myopic agents are less sensitive to future risk premia, and so their consumption responds too little to income shocks

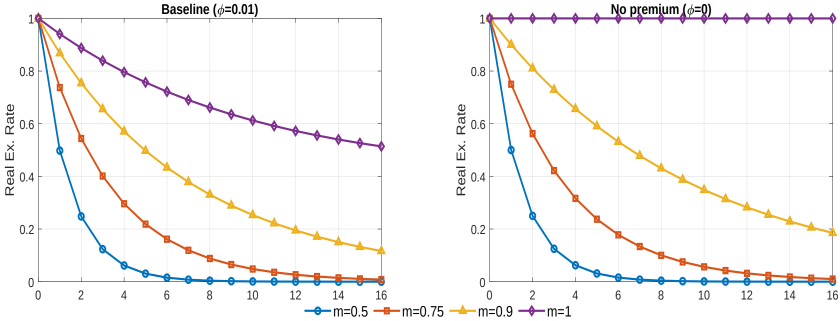
- $\phi = 0.01$ enough to induce stationarity for $m \geq 0.5$

Exchange Rate FGP

Engel's Puzzle

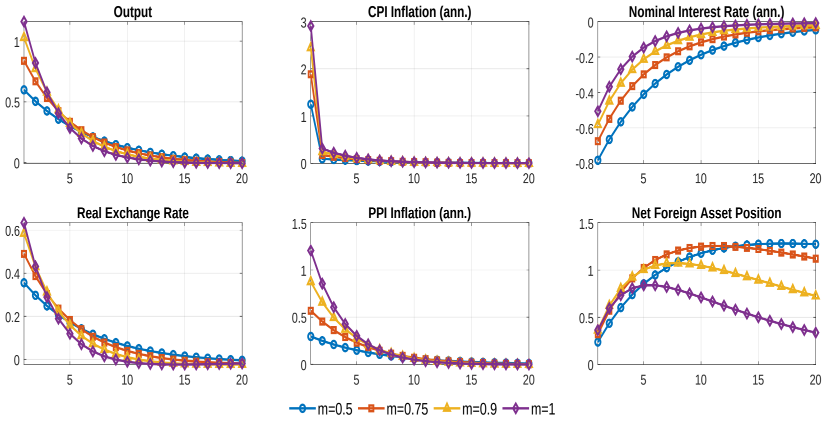
- RER response to real interest rate changes T periods into the future

$$\hat{Q}_t = -\mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \left(\hat{r}_T - \hat{r}^*_T + \phi \hat{B}^*_T \right)$$



Conventional Monetary Policy Shock

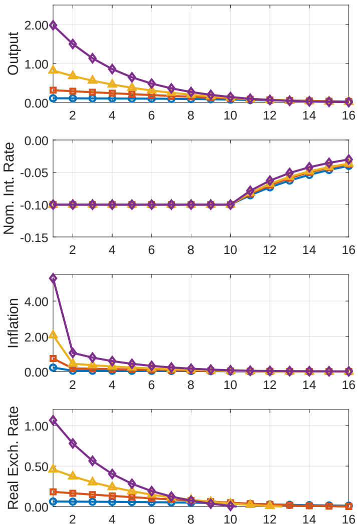
▸ FGP



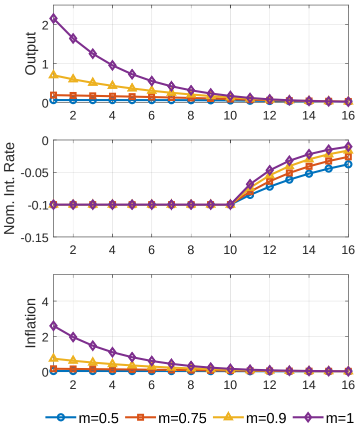
- Behavioral discounting dampens the effects of monetary policy shocks
- Increases persistence of RER and NFA

Lower for Longer Policies

▸ FGP



(c) Open Economy



(d) Closed Economy

Home Output Decomposition

Spillovers

- Decomposing small open economy output

$$\hat{Y}_t = \underbrace{\alpha \hat{Y}_t^*}_{\text{Foreign Demand}} + \underbrace{\eta \frac{\alpha(2-\alpha)}{1-\alpha} \hat{Q}_t}_{\text{Expenditure Switching}}$$

$$\underbrace{- \frac{1-\alpha}{\sigma} \mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \hat{r}_T}_{\text{Home Policy Response}} + \underbrace{(1-m)(1-\alpha) \frac{1-\beta}{1+\frac{\sigma}{\mu\varphi}} \mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t} \hat{B}_T^*}_{\text{Myopia “Damper"}}$$

- Foreign Demand channel depends on foreign real interest rates
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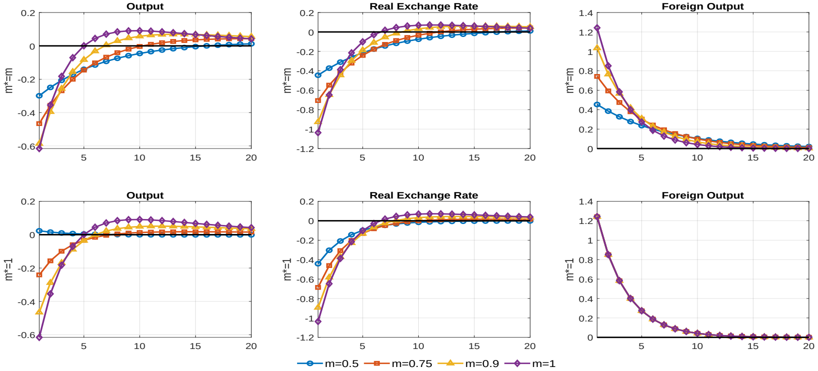
Keeping Home Real Interest Rate Constant

Decomposing output

$$\hat{Y}_t \approx \underbrace{-\frac{\alpha}{\sigma}\mathbb{E}_t \sum_{T=t}^{\infty} m^{*\,T-t}\hat{r}^*_T}_{\text{Foreign Demand}} + \underbrace{\eta\frac{\alpha(2-\alpha)}{1-\alpha}\mathbb{E}_t \sum_{T=t}^{\infty} m^{T-t}\hat{r}^*_T}_{\text{Expenditure Switching}}$$



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