Forward Guidance and the Exchange Rate

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Introduction

- ZLB $\Rightarrow$ need for unconventional monetary policies
- "Forward guidance"
- Optimal policy under the ZLB: high effectiveness of forward guidance (Eggertson-Woodford, Jung et al., Galí))
- The *forward guidance puzzle* (Del Negro et al., McKay et al.)

$$\widehat{y}_t = \mathbb{E}_t\{\widehat{y}_{t+1}\} - \frac{1}{\sigma}\mathbb{E}_t\{\widehat{i}_t - \mathbb{E}_t\{\pi_{t+1}\}\}$$

$$\Rightarrow \widehat{y}_t = -\frac{1}{\sigma}\sum_{k=0}^{\infty}\mathbb{E}_t\{\widehat{i}_{t+k} - \pi_{t+1+k}\}$$

Present Paper

- Forward guidance in the open economy
- Role of the exchange rate in the transmission of forward guidance:

  (i) theory: partial and general equilibrium
  (ii) empirical evidence

$\Rightarrow$ *a forward guidance exchange rate puzzle?*

Forward Guidance and the Exchange Rate

- Pricing of domestic and foreign bonds

$$1 = (1 + i_t)\mathbb{E}_t\{\Lambda_{t,t+1}(P_t/P_{t+1})\}$$

$$1 = (1 + i_t^*)\mathbb{E}_t\{\Lambda_{t,t+1}(\mathcal{E}_{t+1}/\mathcal{E}_t)(P_t/P_{t+1})\}$$

Up to a first-order approximation:

$$i_t = i_t^* + \mathbb{E}_t\{\Delta e_{t+1}\}$$

Letting $q_t \equiv p_t^* + e_t - p_t$ and $r_t \equiv i_t - \mathbb{E}_t\{\pi_{t+1}\}$:

$$q_t = r_t^* - r_t + \mathbb{E}_t\{q_{t+1}\}$$

$$\Rightarrow q_t = \sum_{k=0}^{\infty} \mathbb{E}_t\{r_{t+k}^* - r_{t+k}\} + \lim_{T\to\infty} \mathbb{E}_t\{q_{t+T}\}$$

FG and the Exchange Rate: A Partial Equilibrium Experiment

- *Assumption:* partial equilibrium (no change in inflation), small economy.
- Announcement at time t

$$\widehat{i}_{t+k} = \delta$$

for $k = T, T+1, ..., T+D-1$

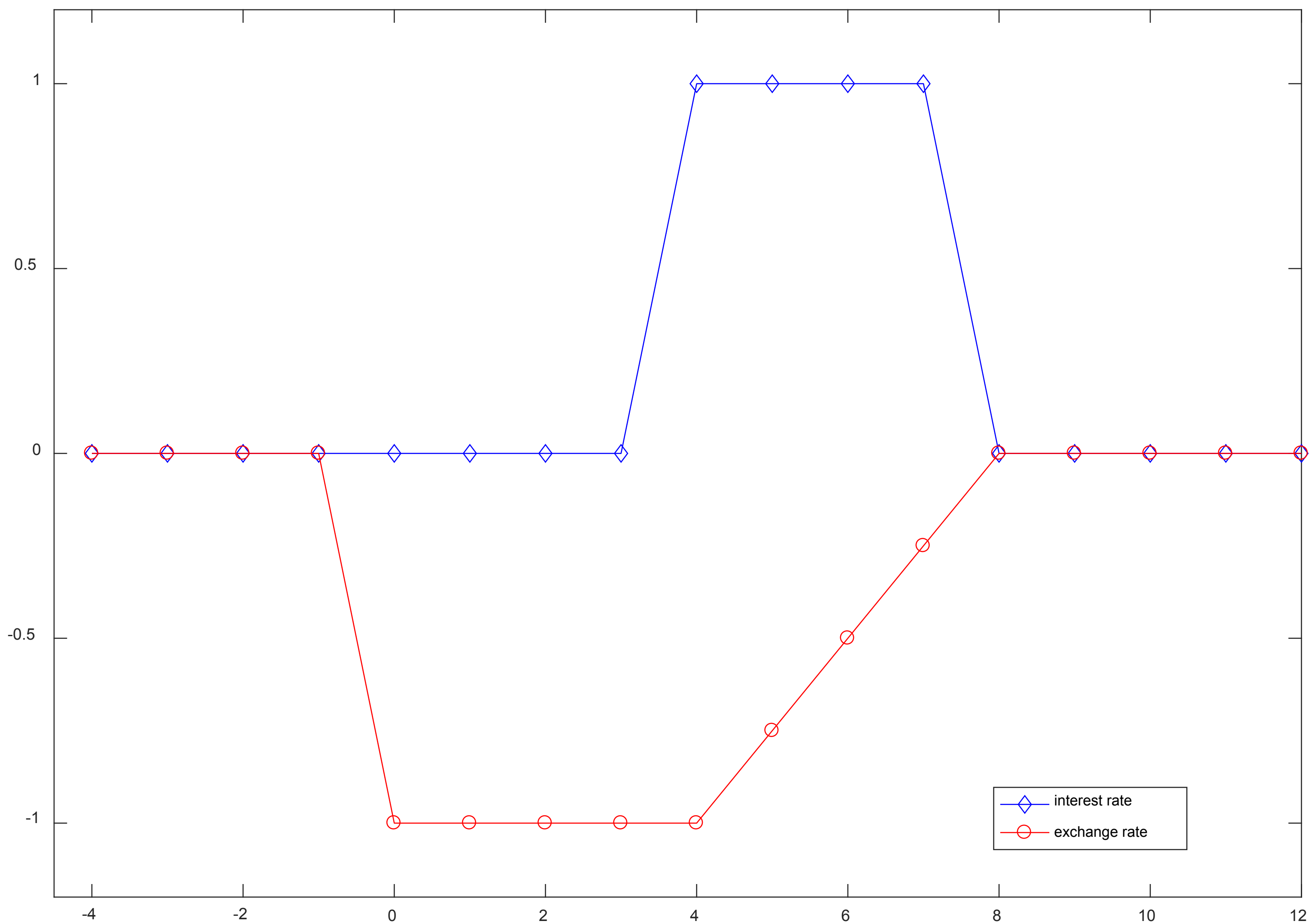
- Real exchange rate response at t:

$$\widehat{q}_t = -D\delta$$

$\Rightarrow$ *invariance to implementation horizon*

- Adjustment over time (fig.)

Forward Guidance and the Exchange Rate: Partial Equilibrium



FG and the Exchange Rate: General Equilibrium

- A small open economy NK model (Galí-Monacelli):

$$y_t = (1-\upsilon)c_t + \vartheta q_t$$

$$c_t = \mathbb{E}_t\{c_{t+1}\} - \frac{1}{\sigma}(i_t - \mathbb{E}_t\{\pi_{t+1}\})$$

$$c_t = \frac{1}{\sigma} q_t$$

$$\pi_{H,t} = \beta \mathbb{E}_t\{\pi_{H,t+1}\} + \kappa y_t - \omega q_t$$

$$i_t = \phi_\pi \pi_{H,t}$$

$$\pi_{H,t} \equiv p_{H,t} - p_{H,t-1} \quad ; \quad \pi_t \equiv p_t - p_{t-1}$$

$$q_t \equiv e_t - p_t \quad ; \quad p_t = (1-\upsilon)p_{H,t} + \upsilon e_t$$

$$\Rightarrow \quad q_t = -(i_t - \mathbb{E}_t\{\pi_{t+1}\}) + \mathbb{E}_t\{q_{t+1}\}$$

FG and the Exchange Rate: General Equilibrium

- Announcement at time t:

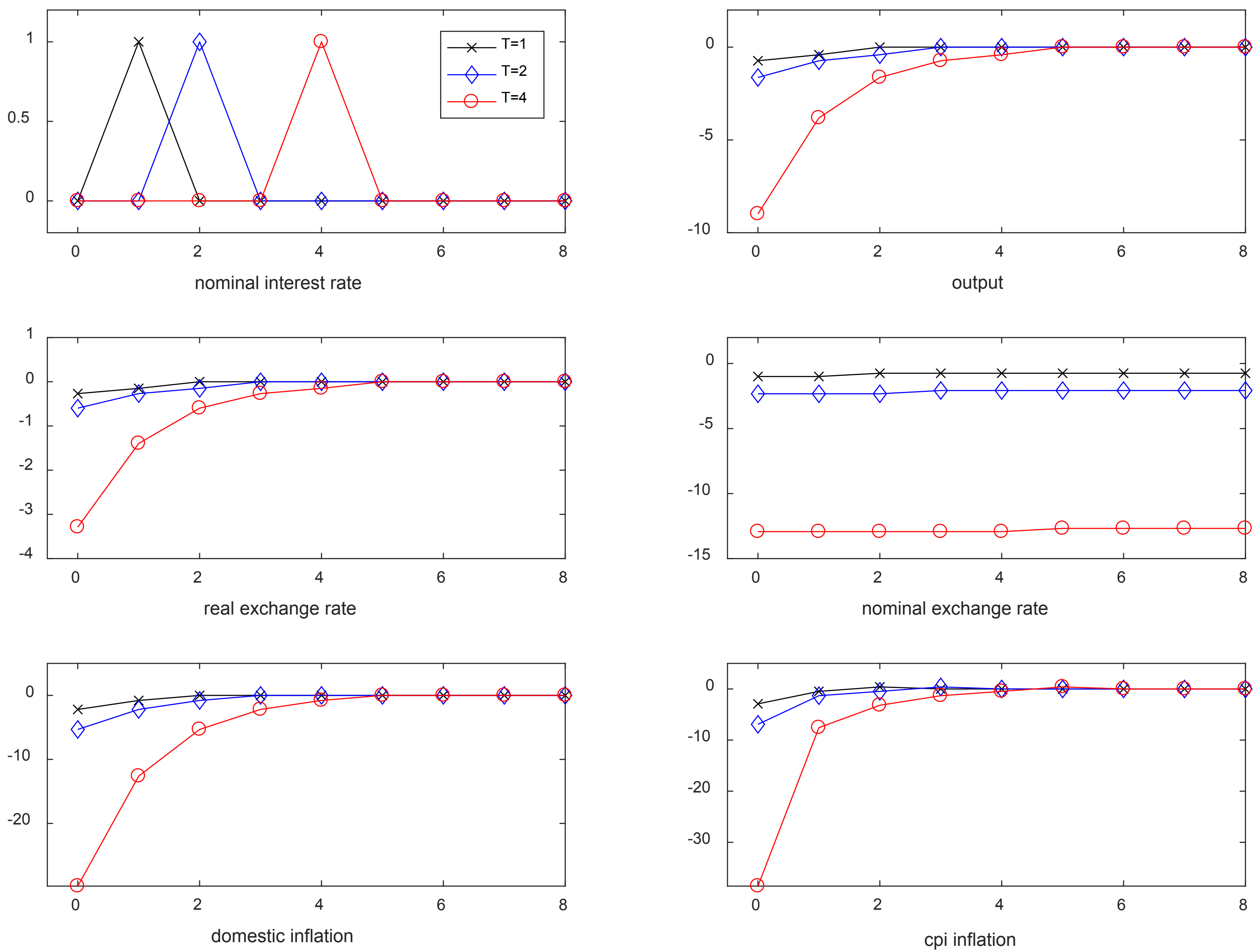
  (i) $\widehat{i}_{t+k} = 0$ for $k = 0, 1, ..., T-1$
  (ii) $\widehat{i}_{t+k} = \delta$ for $k = T, T+1, ..., T+D-1$
  (iii) $\widehat{i}_{t+k} = \phi_{\pi}\pi_{H,t+k}$ for $k = T+D, T+D+1, ...$

- Calibration

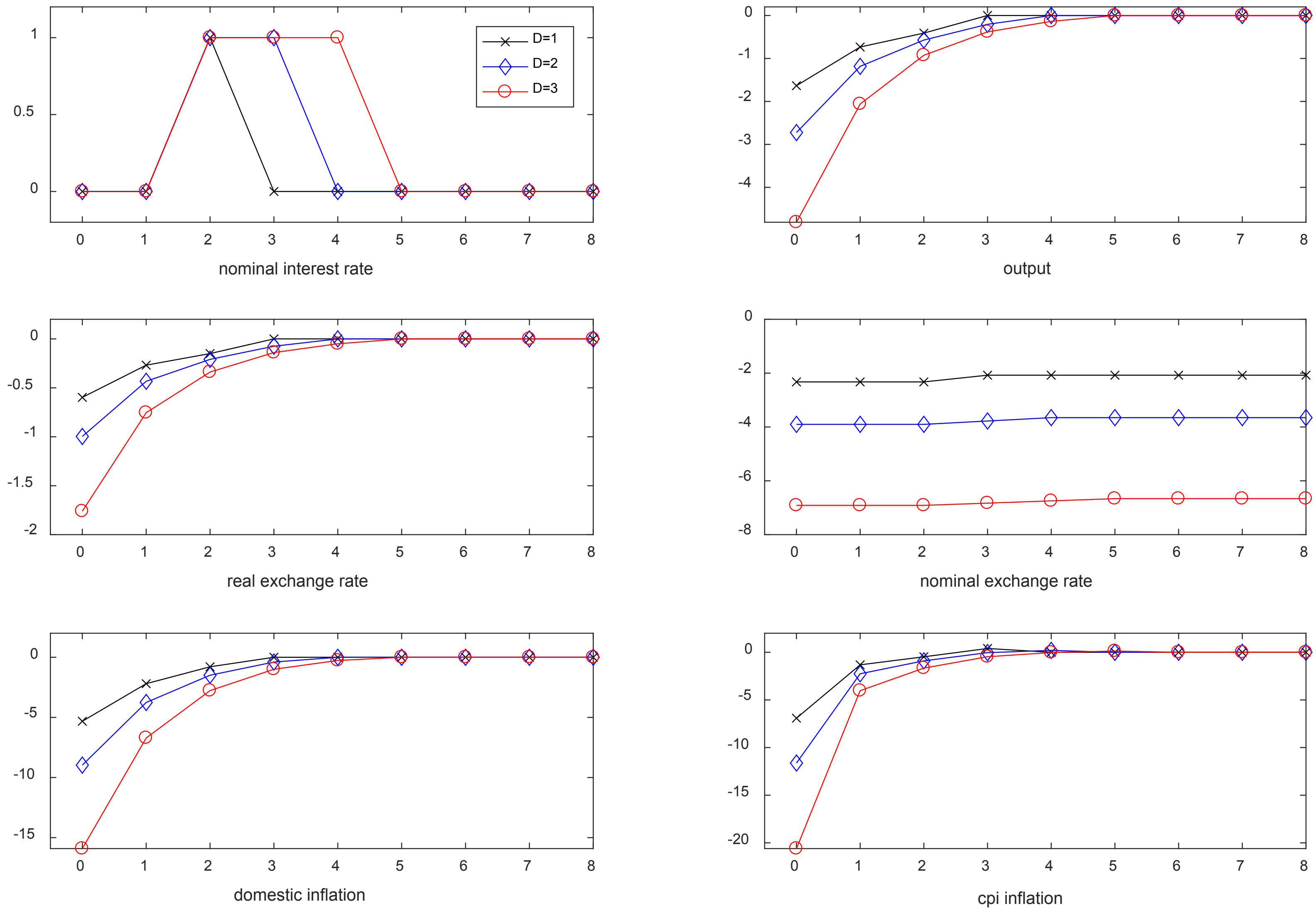
  (i) preferences: $\beta = 0.99$, $\upsilon = 0.4$, $\sigma = 1$, $\eta = 2$, $\varphi = 5$
  (ii) price stickiness: $\theta = 0.75$

- Dynamic responses: the role of the horizon
- Dynamic responses: the role of duration

Forward Guidance in the Open Economy: The Role of the Horizon



Forward Guidance in the Open Economy: The Role of Duration



FG and the Exchange Rate: Empirical Evidence

- Decomposition (for any $M > 0$).

$$
\begin{aligned}
q_t &= \sum_{k=0}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\} + \lim_{T\to\infty} \mathbb{E}_t\{q_{t+T}\} \\
&= q_t^S(M) + q_t^L(M) + \lim_{T\to\infty} \mathbb{E}_t\{q_{t+T}\}
\end{aligned}
$$

where

$$
\begin{aligned}
q_t^S(M) &\equiv \sum_{k=0}^{M-1} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\} \\
q_t^L(M) &\equiv \sum_{k=M}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\}
\end{aligned}
$$

FG and the Exchange Rate: Empirical Evidence

- Yield on an M-period bond (expectations hypothesis):

$$r_t(M) = \frac{J}{M}\sum_{k=0}^{M-1} \mathbb{E}_t\{r_{t+k}\}$$

$$r_t^*(M) = \frac{J}{M}\sum_{k=0}^{M-1} \mathbb{E}_t\{r_{t+k}^*\}$$

$$\Rightarrow q_t^S(M) = \frac{M}{J}[r_t^*(M) - r_t(M)]$$

FG and the Exchange Rate: Empirical Evidence

- *Assumption #1*: $\sum_{k=M_L}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\} \simeq 0$ for "large" M_L:

$$
\begin{aligned}
q_t^L(M) &\simeq \sum_{k=M}^{M_L-1} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\} \\
&= q_t^S(M_L) - q_t^S(M)
\end{aligned}
$$

- *Assumption #2:*

$$
\lim_{T\to\infty} \mathbb{E}_t\{q_{t+T}\} \simeq \alpha_0 + \alpha_1 t + \ldots + \alpha_q t^q
$$

FG and the Exchange Rate: Empirical Evidence

- Data

  - monthly, 2004:1-2016:12
  - euro-dollar real exchange rate
  - German and U.S. government bond yields with 2, 5, 10 and 30 year maturity
  - market-based inflation forecasts for 2, 5, 10 and 30 year horizons.

- Estimated equation:

$$q_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \gamma_S q_t^S(M) + \gamma_L q_t^L(M) + \varepsilon_t$$

  for $M \in \{24, 60, 120\}$ and $M_L = 360$

- Theoretical prediction:

$$H_0 : \gamma_S = \gamma_L = 1$$

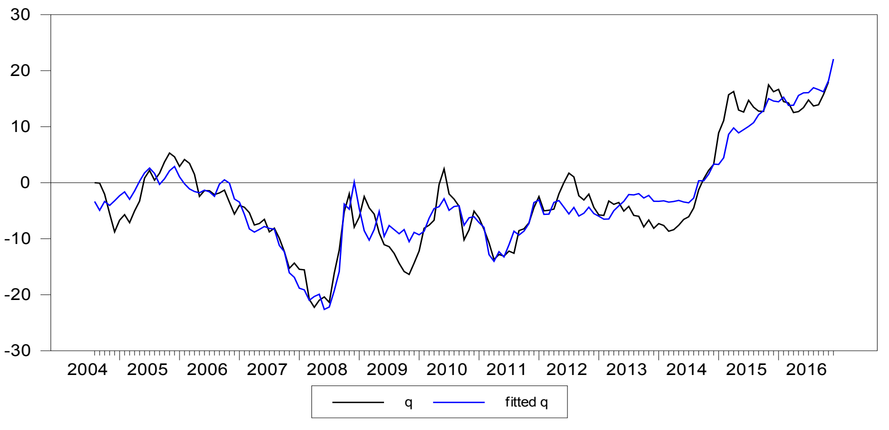
Table 1. Expected Interest Differentials and the Real Exchange Rate

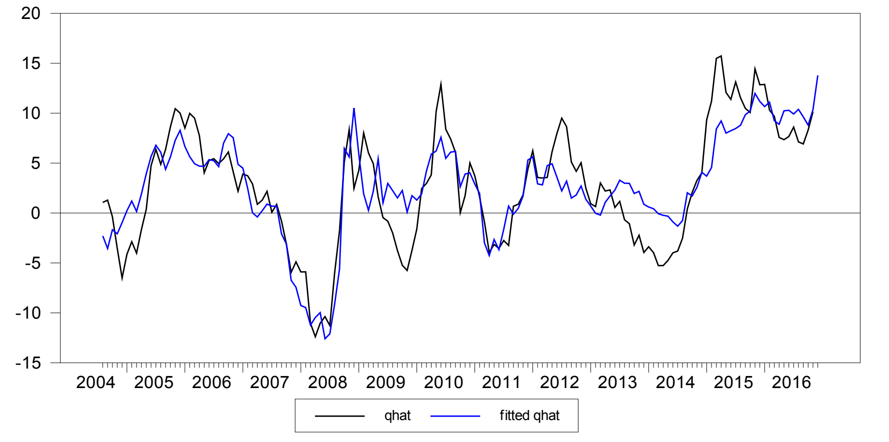
Levels, Euro-dollar, *2004:8-2016:12*

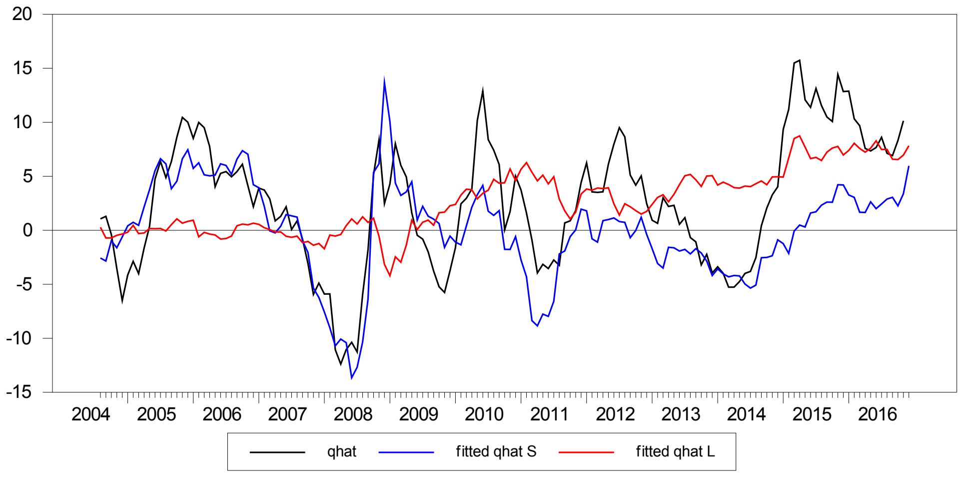
(A)	$q_t^S(M)$	$q_t^L(M)$			p	R^2
M=*24*	3.11^{**} (0.19)	0.16^{**} (0.02)			0.00	0.88
M=*60*	1.66^{**} (0.15)	0.11^{**} (0.03)			0.00	0.81
M=*120*	0.87^{**} (0.13)	0.06 (0.04)			0.00	0.74

(B)	$q_t^S(24)$	$q_t^B(24, 60)$	$q_t^B(60, 120)$	$q_t^L(120)$		R^2
	3.26^{**} (0.22)	-0.29 (0.32)	0.36 (0.25)	0.15^{**} (0.03)	0.00	0.88

Expected Real Interest Rate Differentials and the Real Exchange Rate (M=24)





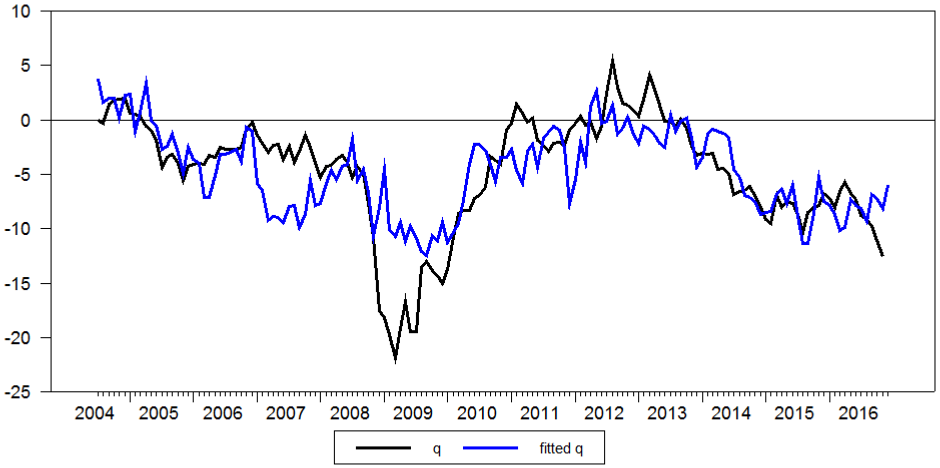


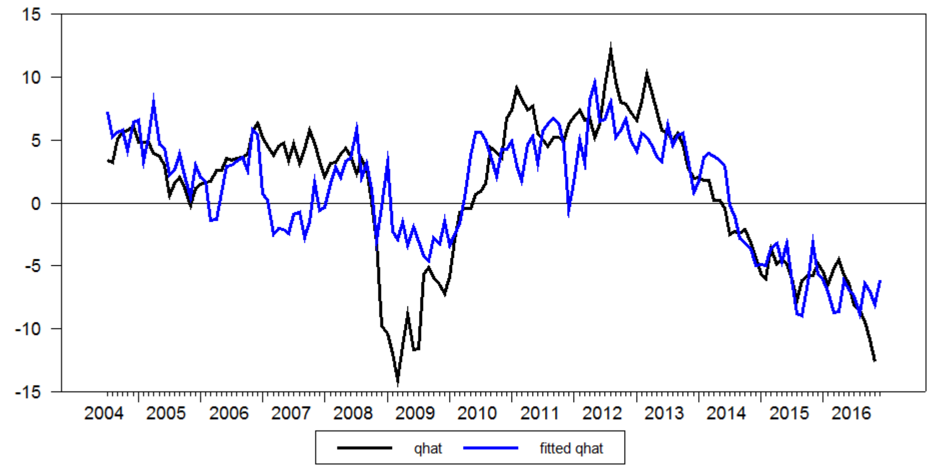
Expected Interest Differentials and the Real Exchange Rate

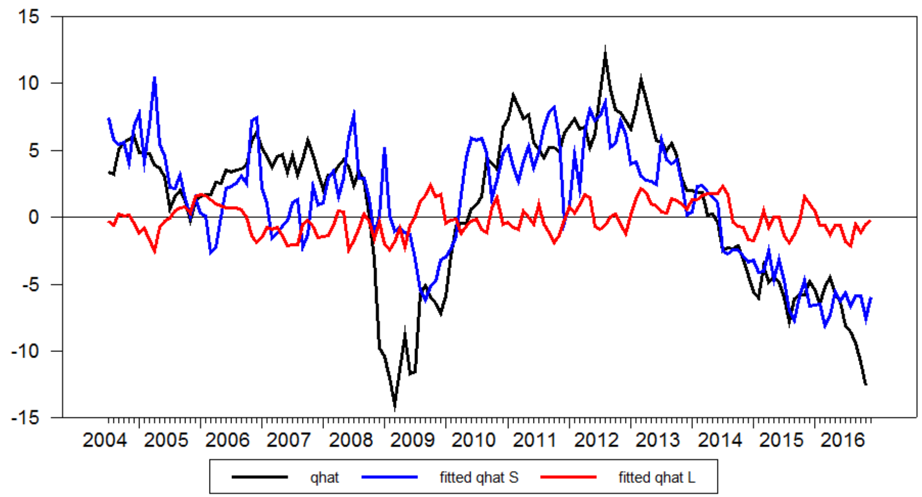
Levels, **Euro-SEK**, *2004:7-2016:12*

(A)	$q_t^S(M)$	$q_t^L(M)$		p	R^2
M=*24*	3.60^{**} (0.29)	0.64^{**} (0.16)		0.00	0.53
M=*60*	1.84^{**} (0.16)	-0.35 (0.26)		0.00	0.50
(B)	$q_t^S(24)$	$q_t^B(24,60)$	$q_t^L(60)$		R^2
	3.21^{**} (0.29)	1.16^{**} (0.19)	-0.13 (0.24)	0.00	0.58

Expected Real Interest Rate Differentials and the Real Exchange Rate: SWEDEN (M=24)







FG and the Exchange Rate: Empirical Evidence

- Baseline real exchange equation

$$q_t = q_t^S(M) + q_t^L(M) + \lim_{T \to \infty} \mathbb{E}_t\{q_{t+T}\}$$

- First-Difference specification

$$\Delta q_t = \Delta q_t^S(M) + \Delta q_t^L(M) + \xi_t$$

where $\xi_t \equiv \lim_{T\to\infty}(\mathbb{E}_t\{q_{t+T}\} - \mathbb{E}_{t-1}\{q_{t+T}\})$.

- Estimated equation:

$$q_t = \alpha + \gamma_S \Delta q_t^S(M) + \gamma_L \Delta q_t^L(M) + \xi_t$$

for $M \in \{24, 60, 120\}$ and $M_L = 360$

- Theoretical prediction:

$$H_0 : \gamma_S = \gamma_L = 1$$

Table 2. Expected Interest Differentials and the Real Exchange Rate

First-differences, Euro-dollar, *2004:9-2016:12*

(A)	$\Delta q_t^S(M)$	$\Delta q_t^L(M)$	p	R^2
M=*24*	1.43^{**} (0.29)	0.09^{*} (0.03)	0.00	0.16
M=*60*	0.83^{**} (0.19)	0.08^{*} (0.03)	0.00	0.16
M=*120*	0.64^{**} (0.14)	-0.005 (0.04)	0.00	0.13

(B)	$\Delta q_t^S(24)$	$\Delta q_t^B(24,60)$	$\Delta q_t^B(60,120)$	$\Delta q_t^L(120)$		R^2
	1.42^{**} (0.29)	0.07 (0.30)	0.63^{*} (0.27)	0.01 (0.04)	0.00	0.17

FG and the Exchange Rate: Empirical Evidence

- First-Difference specification

$$\Delta q_t = \Delta q_t^S(M) + \Delta q_t^L(M) + \xi_t$$

where $\xi_t \equiv \lim_{T\to\infty}(\mathbb{E}_t\{q_{t+T}\} - \mathbb{E}_{t-1}\{q_{t+T}\})$.

- Estimated equation:

$$q_t = \alpha + \gamma_S \Delta q_t^S(M) + \gamma_L \Delta q_t^L(M) + \xi_t$$

for $M \in \{24, 60, 120\}$ and $M_L = 360$

- Theoretical prediction:

$$H_0 : \gamma_S = \gamma_L = 1$$

- Potential endogeneity $\Rightarrow$ IV estimation using *lags* of Δq_t and $q_t^S(M)$

Table 3. Expected Interest Differentials and the Real Exchange Rate

First-differences + IV, Euro-dollar, *2004:9-2016:12*

(A)	$\Delta q_t^S(M)$	$\Delta q_t^L(M)$	p
M=24	1.83* (0.89)	−0.25 (0.14)	0.00
M=60	1.64 (0.80)	−0.16 (0.14)	0.00
M=120	0.89 (0.59)	−0.42** (0.14)	0.00

(B)	$\Delta q_t^S(24)$	$\Delta q_t^B(24,60)$	$\Delta q_t^B(60,120)$	$\Delta q_t^L(120)$	p
	1.84* (0.90)	−0.15 (2.13)	0.37 (0.89)	−0.36 (0.26)	0.00

Possible Explanations?

- Proposed solutions for the closed economy FG puzzle

1. Finite lives (Del Negro et al.)
2. Idiosyncratic labor income risk + borrowing constraints (McKay et al.)
3. Lack of common knowledge (Angeletos-Lian)
4. "Behavioral discounting" (Gabaix)

$$\Rightarrow \widehat{y}_t = \alpha \mathbb{E}_t\{\widehat{y}_{t+1}\} - \frac{1}{\sigma}\mathbb{E}_t\{\widehat{i}_t - \mathbb{E}_t\{\pi_{t+1}\}\}$$

- (1) and (2) do not apply to exchange rate equation
- (3) and (4) cannot account for overreaction to near-term expectations

Concluding comments

- Effectiveness of forward guidance policies in open economies; exchange rate role.
- Partial equilibrium: invariance to implementation horizon
- General equilibrium: stronger effects the more distant the implementation horizon
- Empirical evidence: expectations of interest rate differentials in the near (distant) future have much larger (smaller) effects than predicted by the theory

$\Rightarrow$ a *forward guidance exchange rate puzzle?*

FG and the Exchange Rate: General Equilibrium

- Dynamic responses: the role of openness

$$\pi_{H,t} = \beta \mathbb{E}_t\{\pi_{H,t+1}\} + \kappa_v y_t$$

$$y_t = \mathbb{E}_t\{y_{t+1}\} - \frac{1}{\sigma_\upsilon}(i_t - \mathbb{E}_t\{\pi_{H,t+1}\})$$

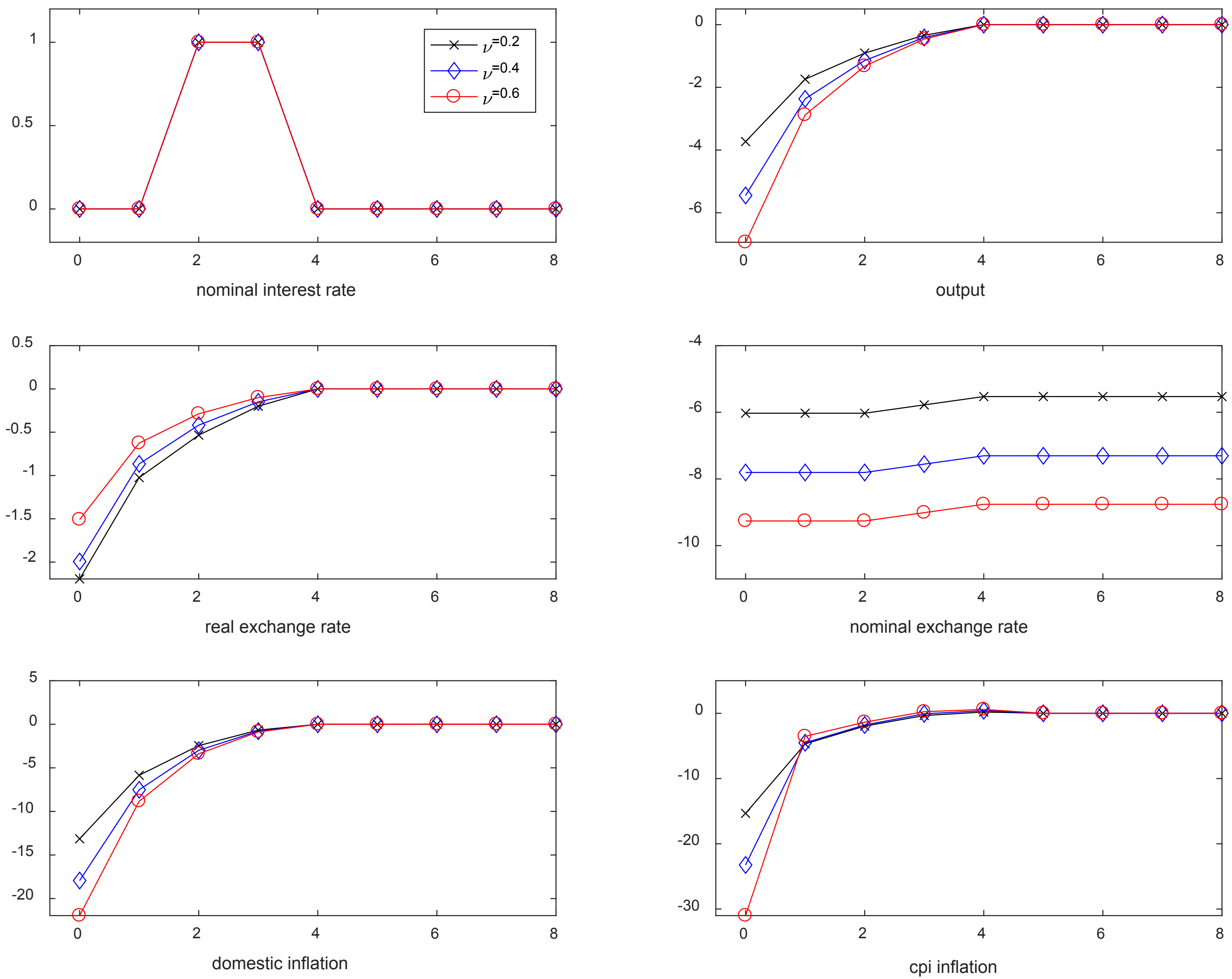
$$q_t = \sigma_\upsilon(1-\upsilon)y_t$$

where $\sigma_\upsilon \equiv \frac{\sigma}{1+(\sigma\eta-1)\upsilon(2-\upsilon)}$ and $\kappa_v \equiv \lambda\left(\sigma_\upsilon + \varphi\right)$.

Benchmark case: $\sigma\eta = 1 \quad \Rightarrow (\pi_{H,t}, y_t)$ invariant to openness

Baseline calibration: $\sigma\eta > 1 \quad \Rightarrow \frac{\partial \sigma_\upsilon}{\partial \upsilon} < 0$, ambiguous impact

Forward Guidance in the Open Economy: The Role of Openness



Expected Interest Differentials and the Real Exchange Rate

First-differences, **Euro-SEK**, *2004:8-2016:12*

(A)	$\Delta q_t^S(M)$	$\Delta q_t^L(M)$		p	R^2
M=24	0.31 (0.23)	0.07 (0.09)		0.00	0.01
M=60	0.51^{**} (0.16)	-0.08 (0.10)		0.00	0.06

(B)	$\Delta q_t^S(24)$	$\Delta q_t^B(24,60)$	$\Delta q_t^B(60)$		R^2
	0.52^{**} (0.23)	0.51^{**} (0.18)	-0.05 (0.10)	0.00	0.06

Expected Interest Differentials and the Real Exchange Rate				
First-differences + IV, **Euro-SEK**, *2004:8-2016:12*				
(A)	$\Delta q_t^S(M)$	$\Delta q_t^L(M)$		p
M=24	0.14^* (0.63)	-0.07 (0.28)		0.00
M=60	0.63 (0.61)	-0.21 (0.30)		0.00
(B)	$\Delta q_t^S(24)$	$\Delta q_t^B(24, 60)$	$\Delta q_t^B(60)$	p
	0.43 (0.72)	1.31 (1.02)	-0.35 (0.37)	0.00

Expected Real Interest Rate Differentials and the Real Exchange Rate (multiple horizons)