Uncovered Interest Parity, Forward Guidance and the Exchange Rate

Jordi Galí

CREI, UPF, Barcelona GSE

October 2019

Present Paper

- Forward guidance in the open economy, role of the exchange rate.
- Forward guidance in a SOE-NK model

  ⇒ high exchange rate sensitivity to anticipated interest rate changes
  ⇒ source: *horizon-invariance* property for the real exchange rate under UIP

- Empirical evidence on the horizon-invariance property

  (i) strong rejection of horizon-invariance
  (ii) *deviations* from horizon-invariance: excess sensitivity (smoothness) of the exchange rate to anticipated interest rate differentials in the near (distant) future.

  ⇒ *"forward guidance exchange rate puzzle"*

- Possible explanations

Forward Guidance in a SOE-NK Model

- Model based on Galí-Monacelli (2005)
- Continuum of monopolistically competitive firms producing differentiated goods, sold to domestic and foreign markets
- Staggered price setting à la Calvo
- Producer currency pricing, law of one price.
- Imperfect substitutability between domestic and foreign goods bundles
- Complete financial markets $\Rightarrow$ UIP
- Taylor-like interest rate rule

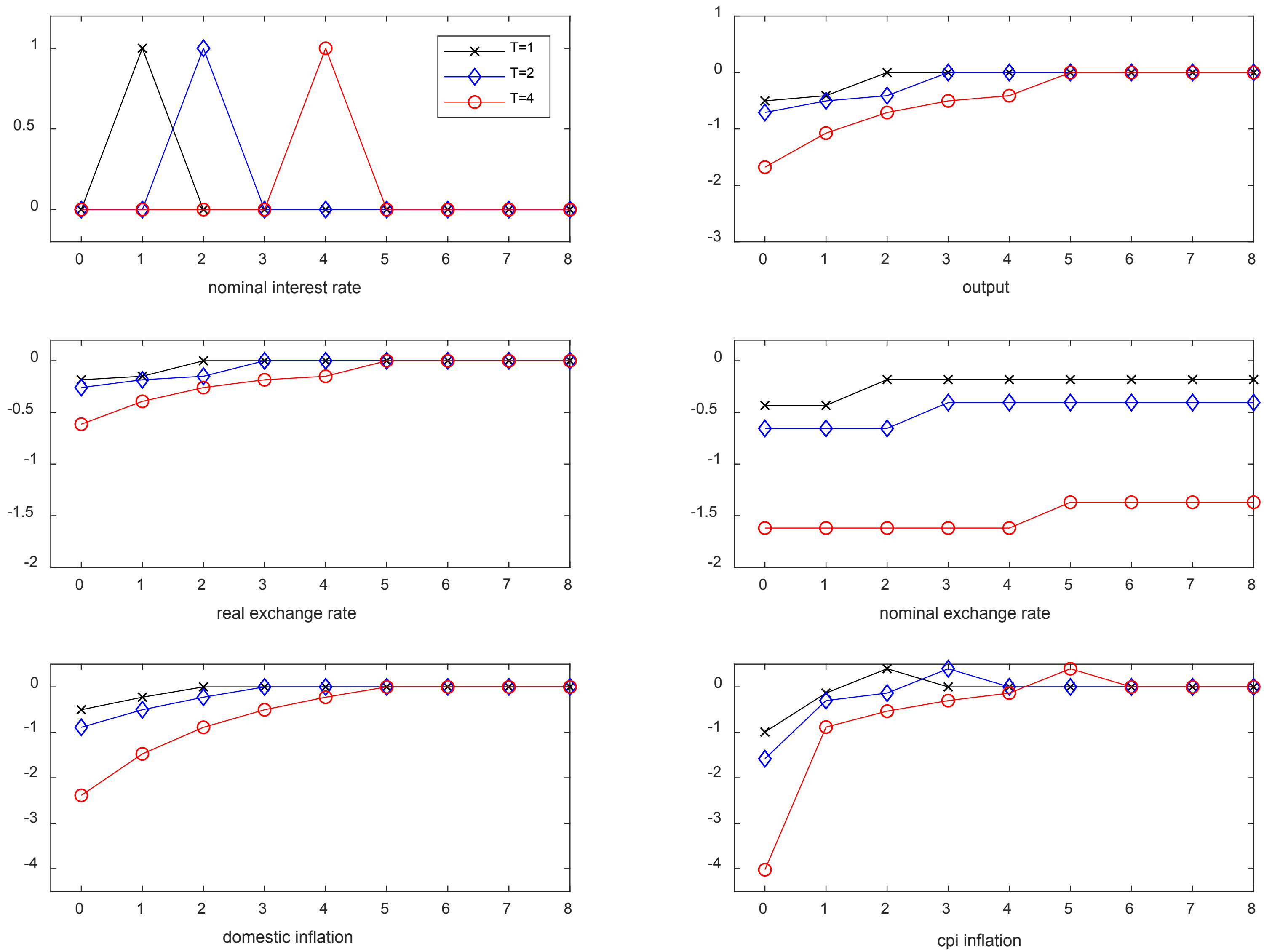
A Forward Guidance Experiment

- Announcement at $t = 0$

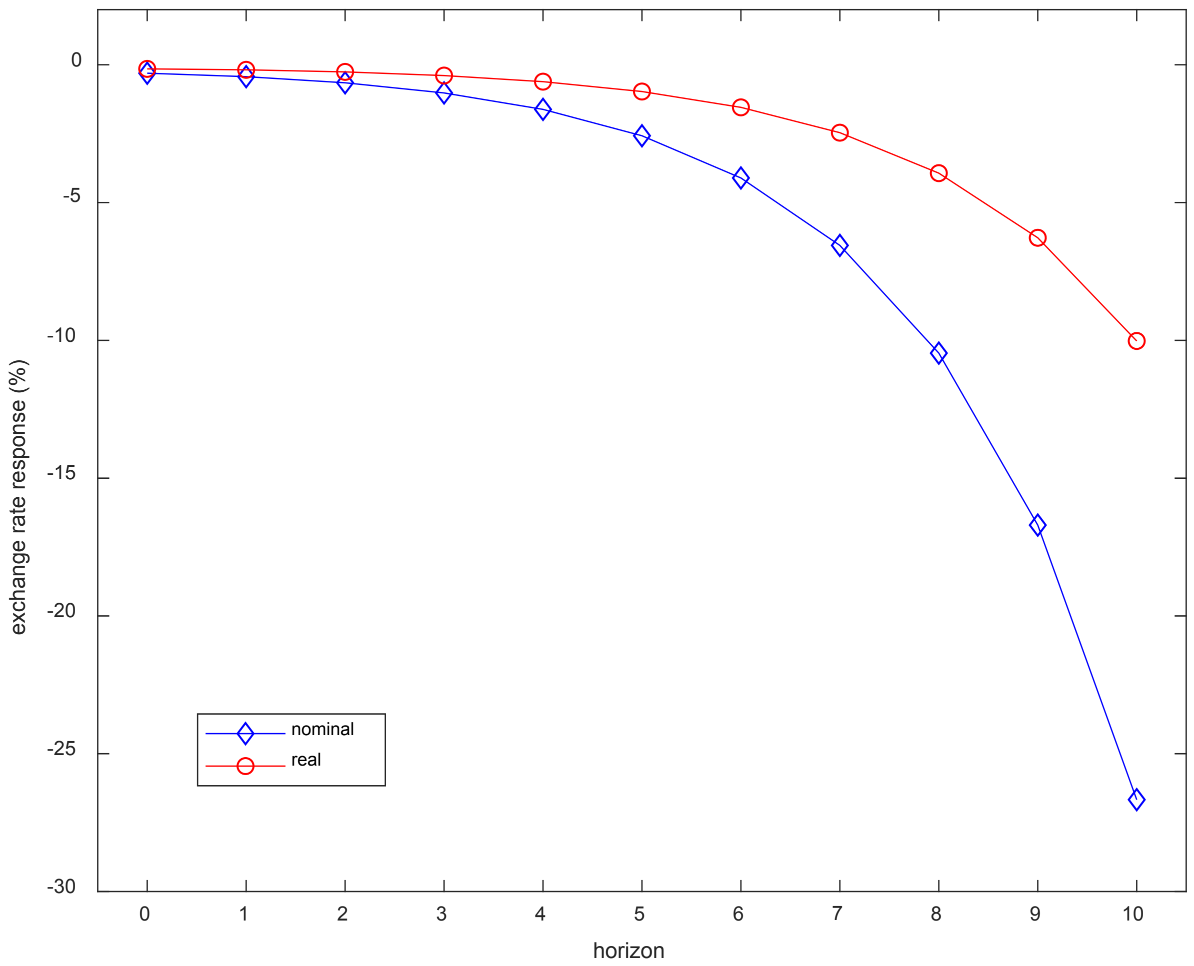
  (i) $i_t = i$ for $t = 0, 1, ..., T - 1$
  (ii) $i_t = i + 0.25$ at $t = T$
  (iii) $i_t = i + \phi_\pi \pi_t$ for $t = T + 1, T + 2, ...$

- Impulse responses for alternative implementation horizons T

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



Forward Guidance and the Exchange Rate



A Horizon-Invariance Result under UIP

- 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 $r_t \equiv i_t - \mathbb{E}_t\{\pi_{t+1}\}$:

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

Assuming $\lim_{T\to\infty} \mathbb{E}_t\{q_T\}$ is well defined and bounded

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

$\Rightarrow$ *horizon-invariance*

A Horizon-Invariance Result under UIP

- Real exchange rate equation under UIP

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

$$\Rightarrow \textit{horizon-invariance}$$

- Forces behind amplification in the model: endogenous inflation response

- *Question:* Does the horizon of expected real interest rate differentials matter?

Empirical Models (I): Baseline Specification

- *Assumption #1*: $\lim_{T\to\infty} \mathbb{E}_t\{q_T\} = q$

$$q_t = q + \sum_{k=0}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\}$$

- *Assumption #2*: for a sufficiently long horizon m:

$$\sum_{k=m}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\} \simeq 0$$

- *Decomposition*: for any "short" horizon $n \in \{1, 2, 3, ..., m-1\}$

$$q_t \simeq \; q + \underbrace{\sum_{k=0}^{n-1} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\}}_{\equiv D^S_t(n)} + \underbrace{\sum_{k=n}^{m-1} \mathbb{E}_t\{r^*_{t+k} - r_{t+k}\}}_{\equiv D^L_t(n)}$$

- *Empirical equation*

$$q_t = \alpha + \gamma_S D^S_t(n) + \gamma_L D^L_t(n)$$

Empirical Models (II): Time Trend Specification

- *Assumption #1*: $\lim_{T\to\infty} \mathbb{E}_t\{\widehat{q}_T\} = 0$, where $\widehat{q}_t \equiv q_t - (\alpha + \delta t)$

$$\Rightarrow q_t = \alpha + \delta t + \sum_{k=0}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k} - \delta\}$$

- *Assumption #2*: for a sufficiently long horizon m:

$$\sum_{k=m}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k} - \delta\} \simeq 0$$

- *Decomposition*

$$q_t \simeq \alpha + \delta(t-m) + D^S_t(n) + D^L_t(n)$$

- *Empirical equation*

$$q_t = \alpha_0 + \delta t + \gamma_S D^S_t(n) + \gamma_L D^L_t(n)$$

Empirical Models (III): Unit Root Specification

- Assumption #1: $\{q_t\} \sim I(1)$ with drift δ

$$\Rightarrow \widehat{q}_t = \sum_{k=0}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k} - \delta\} + \lim_{T\to\infty} \mathbb{E}_t\{\widehat{q}_T\}$$

- *Assumption #2*: for a sufficiently long horizon m:

$$\sum_{k=m}^{\infty} \mathbb{E}_t\{r^*_{t+k} - r_{t+k} - \delta\} \simeq 0$$

- *Decomposition*

$$q_t \simeq \alpha + \delta(t-m) + D_t^S(n) + D_t^L(n) + \lim_{T\to\infty} \mathbb{E}_t\{\widehat{q}_T\}$$

- *Empirical equation*

$$\Delta q_t = \delta + \gamma_S \Delta D_t^S(n) + \gamma_L \Delta D_t^L(n) + \varepsilon_t$$

where $\varepsilon_t \equiv \lim_{T\to\infty}(\mathbb{E}_t - \mathbb{E}_{t-1})\{q_T\}$

Empirical Implementation

- *Assumption #1*: $\sum_{k=0}^{n-1} \mathbb{E}_t\{i_{t+k}\} \simeq \frac{n}{12}\, i_t(n)$, where $i_t(n)$ is the (annualized) zero coupon yield on an n-month bond
- *Assumption #2*: $\sum_{k=1}^{n} \mathbb{E}_t\{\pi_{t+k}\} \simeq \frac{n}{12}\, \pi_t^e(n)$, where $\pi_t^e(n)$ is (annualized) expected inflation over the next n months from inflation swap contracts.
- Short-run component:

$$D_t^S(n) \simeq \frac{n}{12}[(i_t^*(n) - \pi_t^{*e}(n)) - (i_t(n) - \pi_t^e(n))]$$

- Long-run component

$$D_t^L(n) = D_t^S(m) - D_t^S(n)$$

Data

- Monthly data; 2004:8-2018:12 ; US, EA and UK
- Zero coupon yields on government bonds with 1, 2, 5, 10 and 30 year maturities
- Expected inflation over 1, 2, 5, 10 and 30 year horizons derived from inflation swap contracts.
- Asuumed "long horizon" $m = 360$

  $\Rightarrow$ time series for $D_t^S(n)$ for $n = 12, 24, 60, 120, 360.$
  $\Rightarrow$ time series for $D_t^L(n)$ for $n = 12, 24, 60, 120.$

- Real exchange rates:

  - euro-dollar, pound-dollar, and pound-euro nominal exchange rates
  - CPI indexes for the US, EA and UK economies.

Empirical Evidence

- *Empirical equations*

$$q_t = \alpha + \gamma_S D_t^S(n) + \gamma_L D_t^L(n)$$

$$q_t = \alpha_0 + \delta t + \gamma_S D_t^S(n) + \gamma_L D_t^L(n)$$

$$\Delta q_t = \delta + \gamma_S \Delta D_t^S(n) + \gamma_L \Delta D_t^L(n) + \varepsilon_t$$

- UIP benchmark:

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

Table 1A

U.S. - Euro Area Evidence

	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	2.91** (0.92)	0.36** (0.05)	0.77
$n = 24$	1.90** (0.60)	0.33** (0.05)	0.77
$n = 60$	1.27** (0.31)	0.25** (0.06)	0.77
$n = 120$	0.95** (0.22)	0.19** (0.08)	0.75
$n = 360$	0.41** (0.04)	–	0.50
Time trend			
$n = 12$	2.76** (0.85)	0.53** (0.07)	0.80
$n = 24$	1.83** (0.53)	0.50** (0.08)	0.80
$n = 60$	1.26** (0.27)	0.43** (0.10)	0.80
$n = 120$	0.94** (0.20)	0.41** (0.14)	0.78
$n = 360$	0.61** (0.07)	–	0.76
First differences			
$n = 12$	2.20** (0.41)	0.17** (0.04)	0.18
$n = 24$	1.07** (0.48)	0.16** (0.05)	0.16
$n = 60$	0.51* (0.27)	0.16** (0.06)	0.14
$n = 120$	0.41** (0.13)	0.12 (0.05)	0.13
$n = 360$	0.19** (0.04)	–	0.12

Robustness (I): Time-Varying Term Premia

- Assumption:

$$\sum_{k=0}^{n-1} \mathbb{E}_t\{i_{t+k}\} = \frac{n}{12}[i_t(n) - v_t(n)]$$

where $v_t(n)$ is the (annualized) term-premium on an n-month bond estimated by Adrian et al. (2019)

- Implementation

$$D_t^S(n) \simeq \frac{n}{12}[(i_t^*(n) - v_t^*(n) - \pi_t^{*e}(n)) - (i_t(n) - v_t(n) - \pi_t^e(n))]$$

$$D_t^L(n) \equiv D_t^S(m) - D_t^S(n)$$

- Empirical equation

$$q_t = \alpha + \gamma_S D_t^S(n) + \gamma_L D_t^L(n)$$

Table 2A			
U.S.-Euro Area Evidence: Term Premium Adjustment			
	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	1.77^{**} (0.78)	0.37^{**} (0.04)	0.80
$n = 24$	1.12^{**} (0.48)	0.36^{**} (0.05)	0.79
$n = 60$	0.86^{**} (0.28)	0.33^{**} (0.06)	0.80
$n = 120$	0.78^{**} (0.20)	0.27^{**} (0.07)	0.75
$n = 360$	0.41^{**} (0.03)	–	0.78
Time trend			
$n = 12$	1.37^{**} (0.67)	0.51^{**} (0.05)	0.83
$n = 24$	0.91^{**} (0.39)	0.51^{**} (0.06)	0.82
$n = 60$	0.75^{**} (0.22)	0.49^{**} (0.08)	0.82
$n = 120$	0.71^{**} (0.16)	0.06^{**} (0.02)	0.82
$n = 360$	0.55^{**} (0.03)	–	0.82
First differences			
$n = 12$	1.65^{**} (0.40)	0.11 (0.08)	0.11
$n = 24$	0.77 (0.43)	0.11 (0.07)	0.09
$n = 60$	0.39 (0.27)	0.11 (0.07)	0.08
$n = 120$	0.36^{**} (0.17)	0.09 (0.07)	0.08
$n = 360$	0.14 (0.08)	–	0.07

Robustness (II): Alternative Inflation Expectations

- Assumption: $\{\pi_t^* - \pi_t\} \sim AR(1)$

  Decomposition:

$$
\begin{aligned}
q_t &= q + \sum_{k=0}^{\infty} \mathbb{E}_t\{i_{t+k}^* - i_{t+k}\} - \sum_{k=0}^{\infty} \mathbb{E}_t\{\pi_{t+1+k}^* - \pi_{t+1+k}\} \\
&= q + \widetilde{D}_t^S(n) + \widetilde{D}_t^L(n) - \psi(\pi_t^* - \pi_t)
\end{aligned}
$$

  where $\widetilde{D}_t^S(n) \equiv \sum_{k=0}^{n-1} \mathbb{E}_t\{i_{t+k}^* - i_{t+k}\}$ and $\widetilde{D}_t^L(n) = \widetilde{D}_t^S(m) - \widetilde{D}_t^S(n)$

- Empirical equation:

$$
q_t = q + \gamma_S \widetilde{D}_t^S(n) + \gamma_L \widetilde{D}_t^L(n) - \psi(\pi_t^* - \pi_t)
$$

Table 3A

U.S.-Euro Area Evidence: Nominal Specification

	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	2.61^{**} (1.09)	0.33^{**} (0.09)	0.72
$n = 24$	1.74^{**} (0.58)	0.29^{**} (0.09)	0.73
$n = 60$	0.87^{**} (0.24)	0.21^{**} (0.05)	0.79
$n = 120$	0.58^{**} (0.18)	0.24^{**} (0.07)	0.75
$n = 360$	0.43^{**} (0.05)	–	0.68
Time trend			
$n = 12$	2.80^{**} (1.33)	0.29^{**} (0.14)	0.72
$n = 24$	1.82^{**} (0.68)	0.25^{**} (0.14)	0.73
$n = 60$	0.74^{**} (0.17)	0.41^{**} (0.06)	0.83
$n = 120$	0.52^{**} (0.14)	0.07^{**} (0.02)	0.81
$n = 360$	0.46^{**} (0.08)	–	0.69
First differences			
$n = 12$	6.28^{**} (1.43)	0.12^{**} (0.04)	0.27
$n = 24$	3.10^{**} (0.65)	0.11^{*} (0.06)	0.27
$n = 60$	1.17^{**} (0.30)	0.13^{**} (0.06)	0.26
$n = 120$	0.54^{**} (0.18)	0.13^{**} (0.05)	0.18
$n = 360$	0.20^{**} (0.06)	–	0.14

Possible Explanations

- Time-varying foreign exchange risk premium

$$\zeta_t \equiv r_t^* - r_t + \mathbb{E}_t\{\Delta q_{t+1}\}$$

- Implied exchange rate equation

$$q_t = \alpha + \gamma_S D_t^S(n) + \gamma_L D_t^L(n) + \varepsilon_t$$

where $\varepsilon_t \equiv - \sum_{k=0}^{\infty} \mathbb{E}_t\{\zeta_{t+k}\}$

- Previous evidence $\Rightarrow$ rejection of orthogonal risk premium
- What model generates a pattern for the risk premium consistent with the evidence?

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)

$$\Rightarrow c_t = \alpha \mathbb{E}_t\{c_{t+1}\} - \frac{1}{\sigma}\widehat{r}_t$$

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

Possible Explanations

- Convex portfolio adjustment costs (Bacchetta-van Wincoop 2019)

$$q_t = \varphi q_{t-1} + \sum_{k=0}^{\infty} \alpha^k \mathbb{E}_t \{ r_{t+k}^* - r_{t+k} \}$$

where $\alpha \in [0, 1)$ and $\varphi \in [0, 1)$

Possible Explanations

- A simple behavioral model

$$r_t = r_t^* + \varkappa \widetilde{\mathbb{E}}_t\{\Delta q_{t+1}\}$$

where $\varkappa \geq 0$: weight on expected exchange rate change

Assumption: $\widetilde{\mathbb{E}}_t\{\widehat{q}_{t+1}\} = \alpha \mathbb{E}_t\{\widehat{q}_{t+1}\}$ with $\alpha \in [0, 1)$

$$\widehat{q}_t = \frac{1}{\varkappa} \sum_{k=0}^{\infty} \alpha^k \mathbb{E}_t\{r_{t+k}^* - r_{t+k}\}$$

$\varkappa < 1 \Rightarrow$ "short-run overreaction"

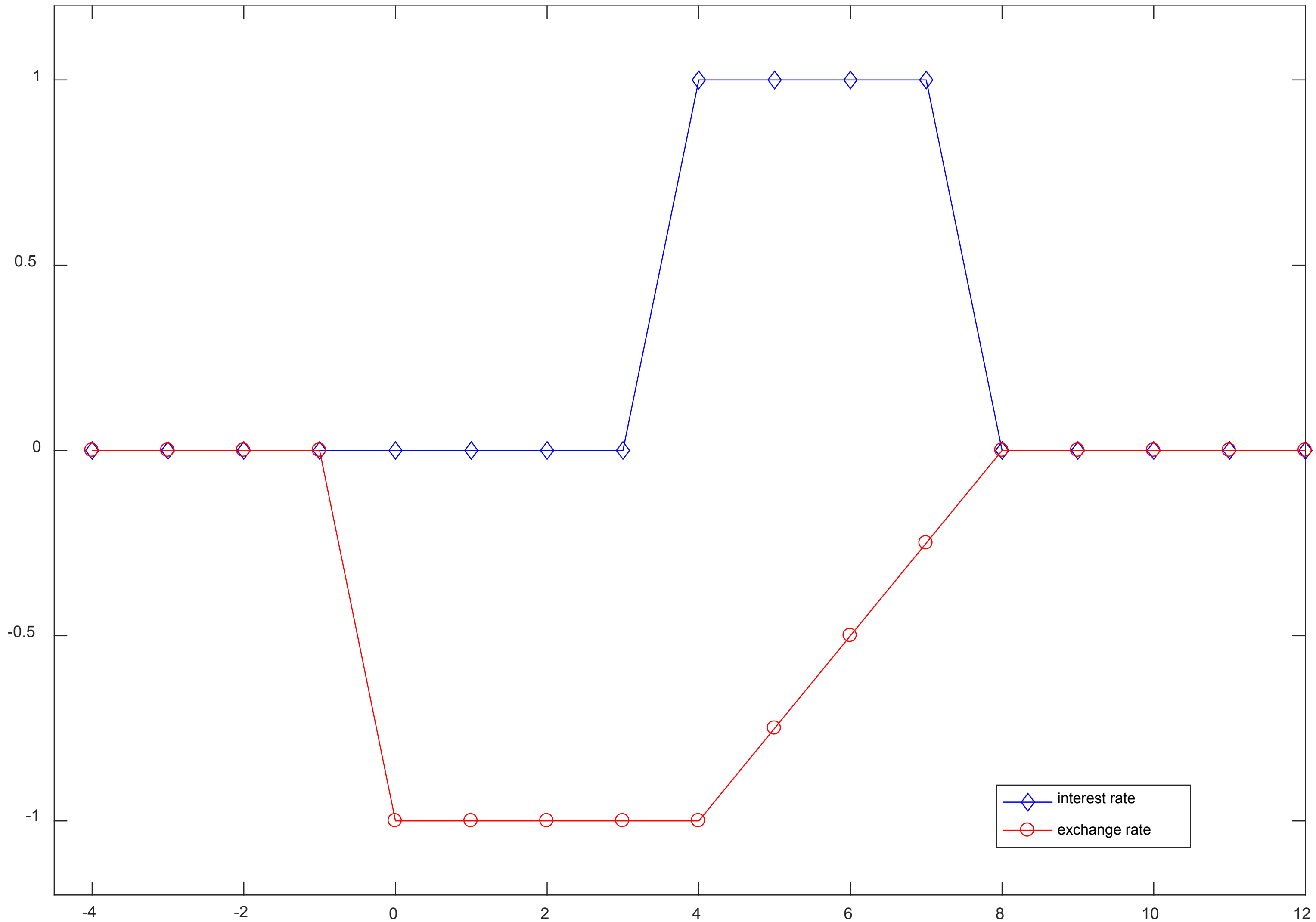
$\alpha < 1 \Rightarrow$ "horizon discounting"

Concluding Comments

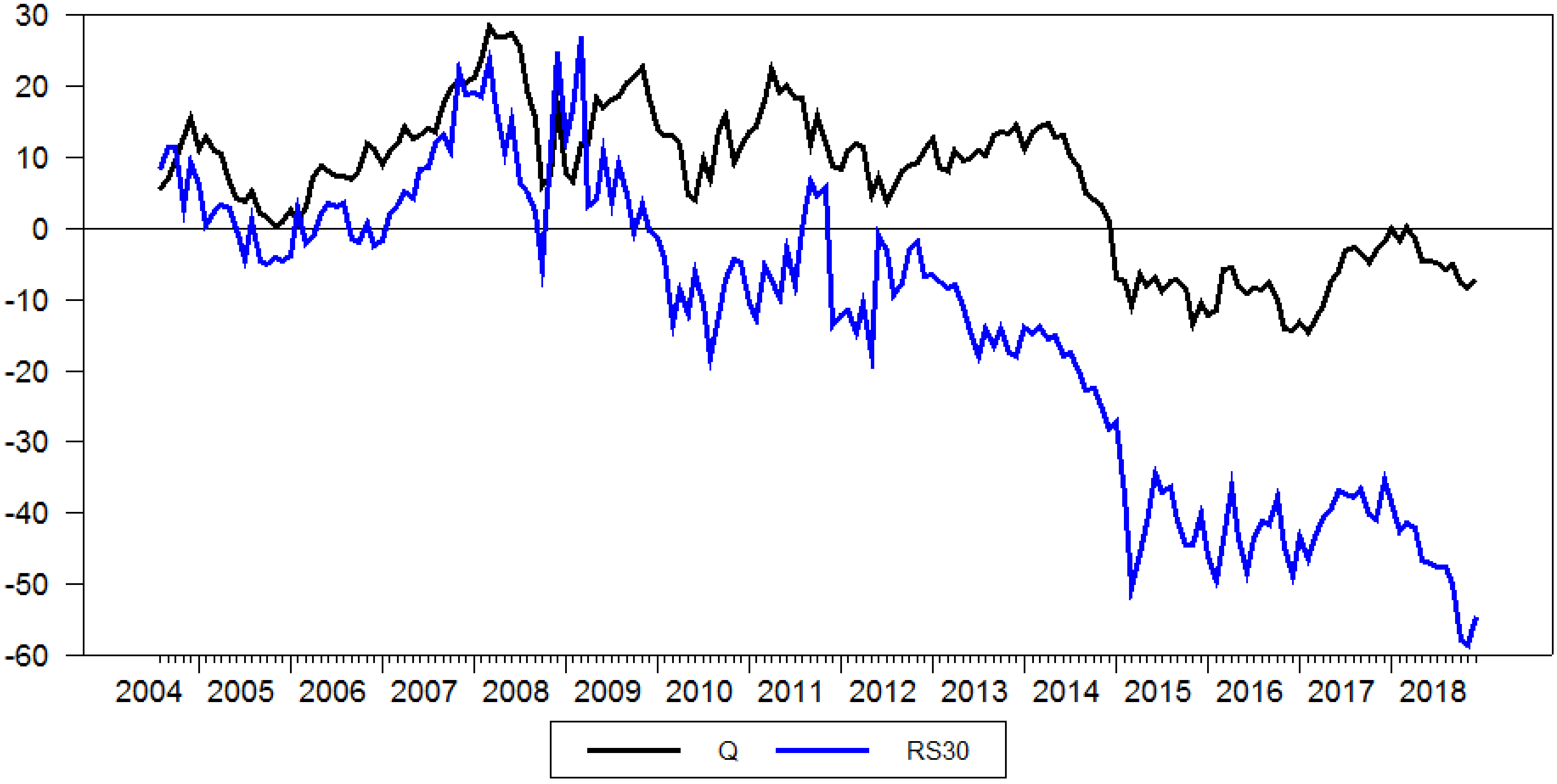
- Role of the exchange rate in the transmission of forward guidance in open economies
- UIP benchmark: real exchange rate response to expected real interest rate differentials should be invariant to the horizon
- Evidence: expectations of interest rate differentials in the near (distant) future have much larger (smaller) effects than predicted by the theory

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

Forward Guidance and the Exchange Rate: Partial Equilibrium

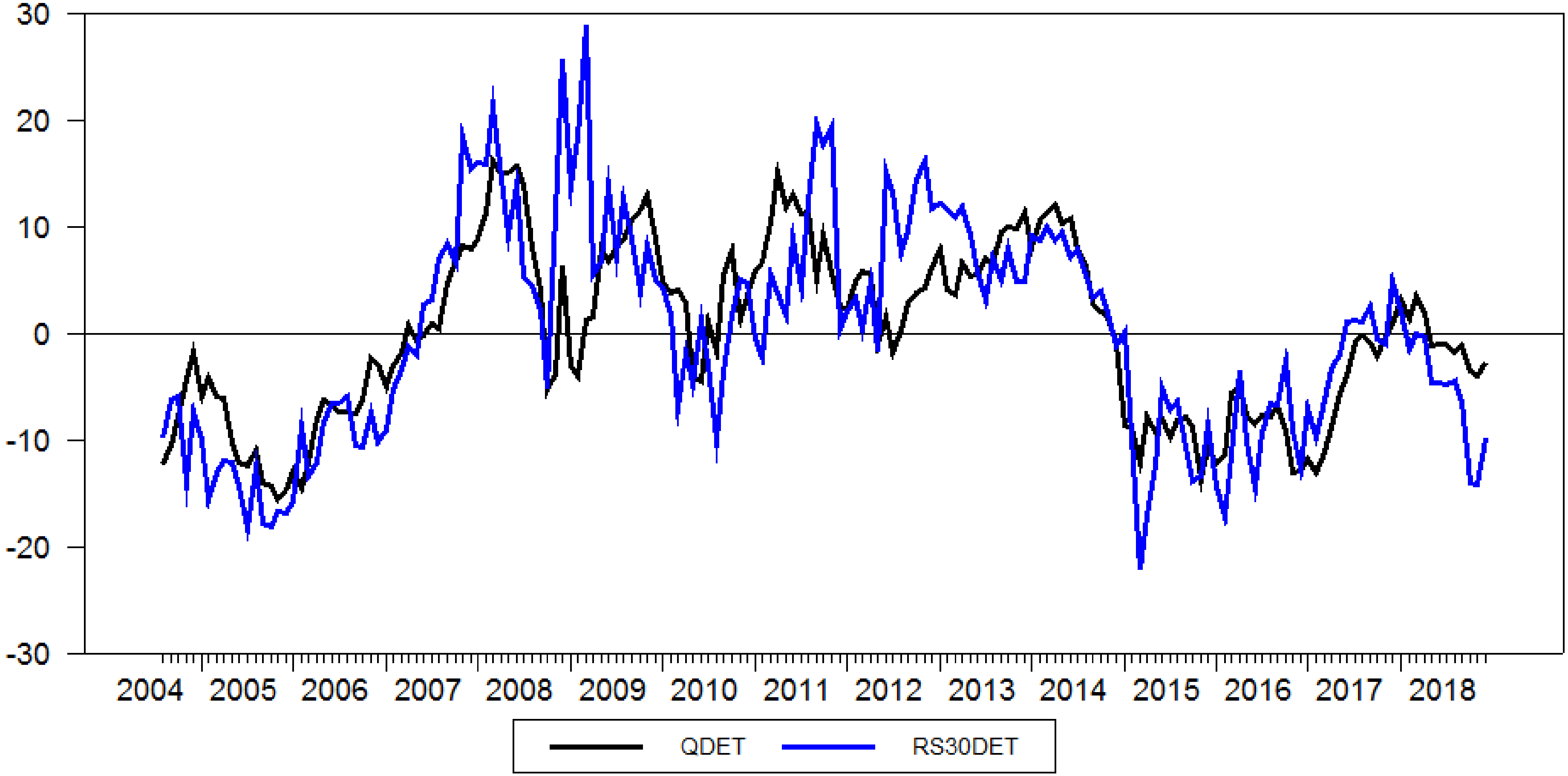


Actual and Fundamental Real Exchange Rate



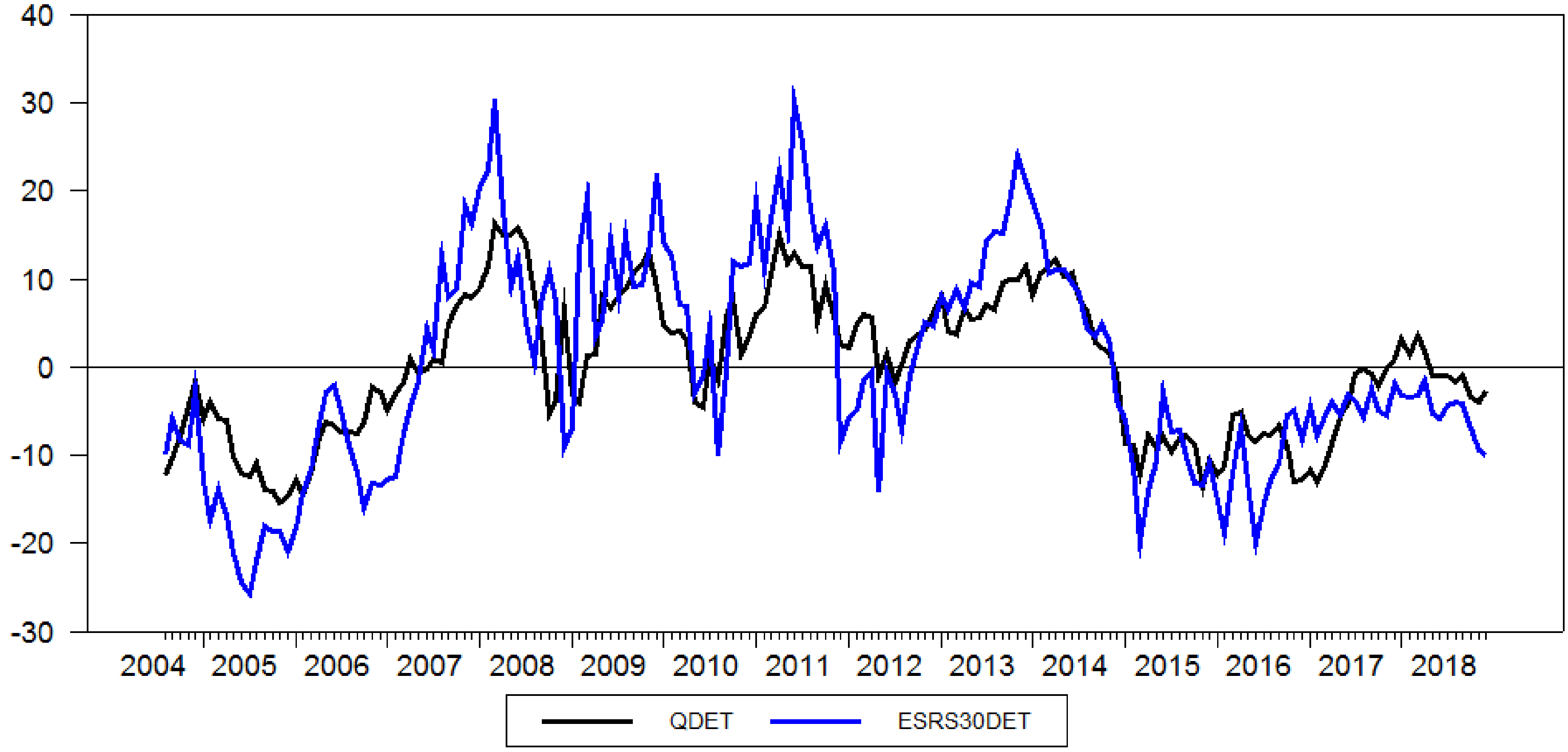
Actual and Fundamental Real Exchange Rate

Detrended



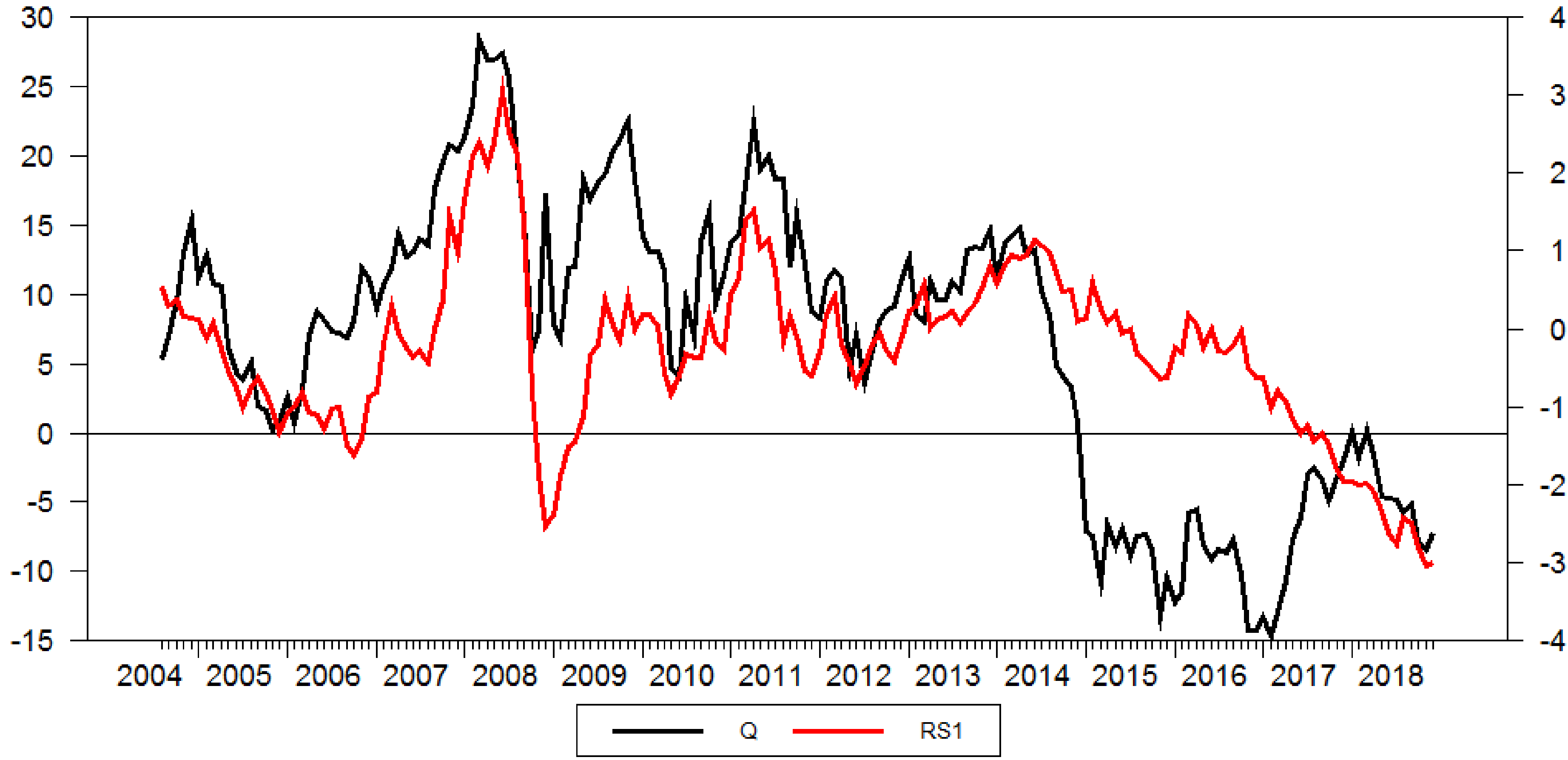
Actual and Fundamental Real Exchange Rate

Detrended, TP adjusted



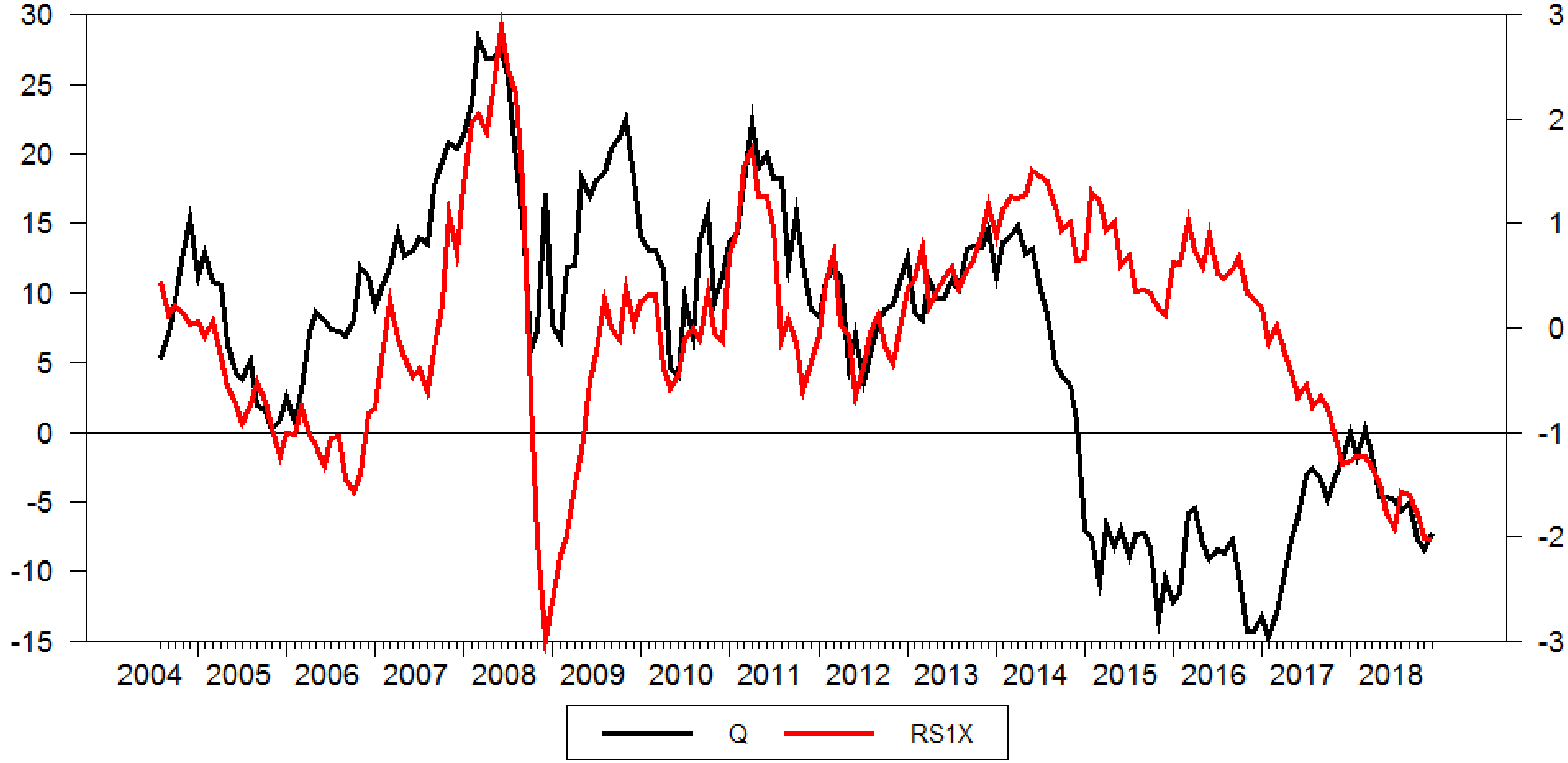
Actual and Fundamental Real Exchange Rate

Short Term Component



Actual and Fundamental Real Exchange Rate

Orthogonal Short Term Component



Actual and Fundamental Real Exchange Rate

Orthogonal Short Term Component, Single Scale

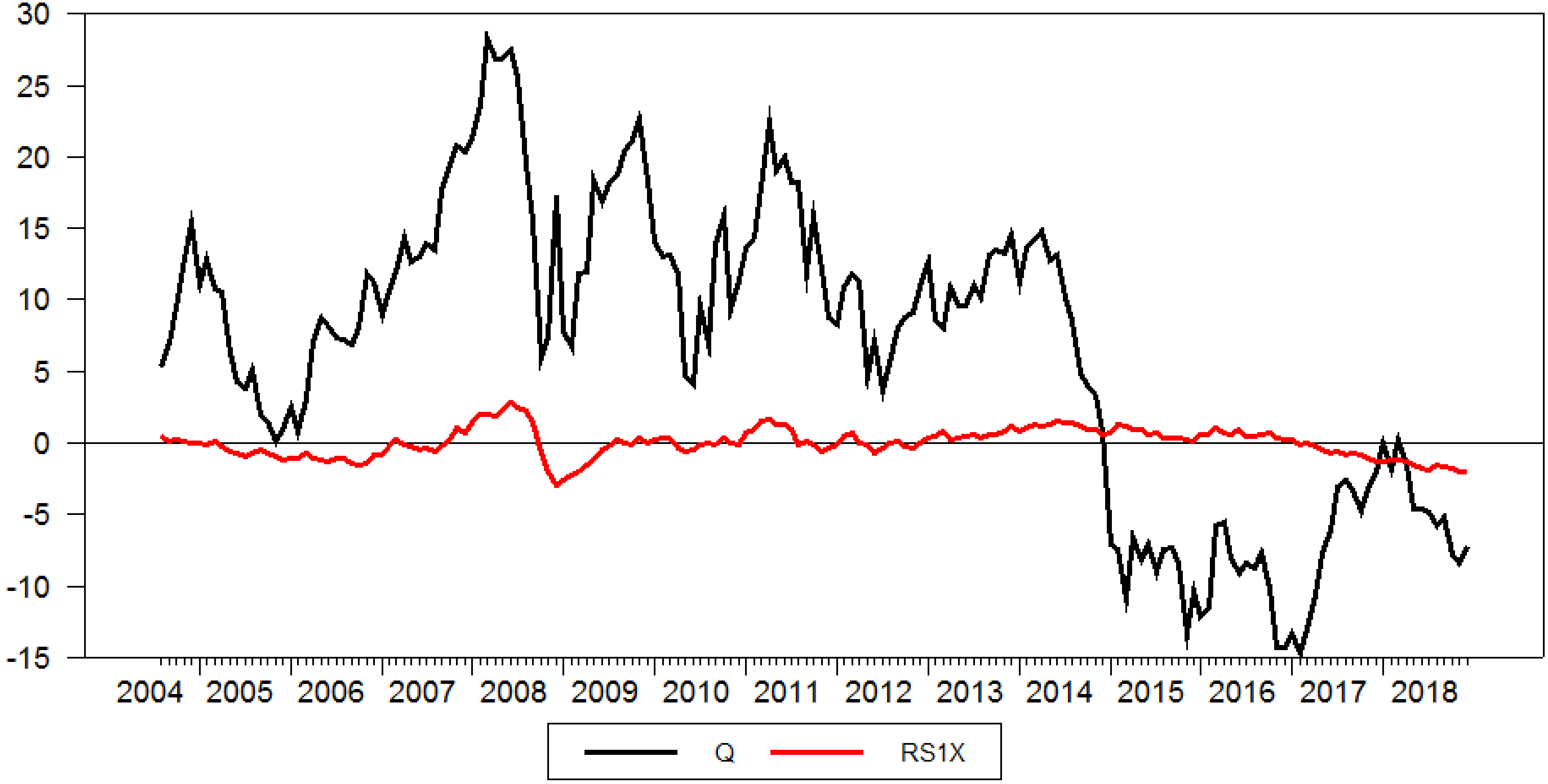


Table 1B			
U.S.- U.K. Evidence			
	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	4.34^{**} (0.58)	0.23^{**} (0.06)	0.72
$n = 24$	3.09^{**} (0.27)	0.11^{**} (0.05)	0.77
$n = 60$	1.85^{**} (0.21)	-0.04 (0.05)	0.75
$n = 120$	1.22^{**} (0.16)	-0.14 (0.08)	0.67
$n = 360$	0.39^{**} (0.06)	–	0.55
Time trend			
$n = 12$	3.80^{**} (0.74)	0.18^{*} (0.06)	0.73
$n = 24$	3.05^{**} (0.40)	0.13^{**} (0.05)	0.77
$n = 60$	1.86^{**} (0.34)	-0.04 (0.05)	0.75
$n = 120$	0.93^{**} (0.25)	-0.13^{*} (0.07)	0.68
$n = 360$	0.17^{*} (0.09)	–	0.63
First differences			
$n = 12$	1.45^{**} (0.56)	0.00 (0.04)	0.04
$n = 24$	1.13^{**} (0.25)	-0.02 (0.05)	0.07
$n = 60$	0.55^{**} (0.19)	-0.04 (0.04)	0.05
$n = 120$	0.28^{**} (0.14)	-0.07 (0.05)	0.03
$n = 360$	0.01 (0.05)	–	0.01

Table 1C			
Euro Area - U.K. Evidence			
	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	3.91** (0.92)	0.30** (0.10)	0.41
$n = 24$	2.51** (0.46)	0.30** (0.09)	0.44
$n = 60$	1.57** (0.28)	0.25** (0.10)	0.44
$n = 120$	1.21** (0.20)	0.14 (0.11)	0.40
$n = 360$	0.30 (0.11)	–	0.15
Time trend			
$n = 12$	4.02** (1.09)	0.30** (0.09)	0.41
$n = 24$	2.92** (0.62)	0.30** (0.09)	0.45
$n = 60$	2.10** (0.43)	0.24** (0.09)	0.47
$n = 120$	1.68** (0.31)	0.05 (0.10)	0.44
$n = 360$	0.30 (0.10)	–	0.24
First differences			
$n = 12$	0.42 (0.66)	0.16** (0.03)	0.10
$n = 24$	0.53** (0.11)	0.15** (0.03)	0.11
$n = 60$	0.38 (0.31)	0.15 (0.04)	0.11
$n = 120$	0.14 (0.21)	0.17** (0.06)	0.10
$n = 360$	0.16 (0.02)	–	0.10

Table 2B

U.S.- U.K. Evidence: Term Premium Adjustment

	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	4.34** (0.72)	0.22** (0.08)	0.70
$n = 24$	3.25** (0.32)	0.11 (0.06)	0.78
$n = 60$	1.71** (0.14)	0.09 (0.05)	0.81
$n = 120$	1.07** (0.11)	0.11 (0.07)	0.77
$n = 360$	0.43** (0.07)	–	0.57
Time trend			
$n = 12$	3.68** (0.88)	0.12* (0.06)	0.72
$n = 24$	3.10** (0.50)	0.09 (0.05)	0.78
$n = 60$	2.19** (0.24)	0.16** (0.04)	0.82
$n = 120$	1.46** (0.18)	0.16* (0.06)	0.79
$n = 360$	0.21* (0.06)	–	0.63
First differences			
$n = 12$	1.56** (0.58)	0.07** (0.03)	0.09
$n = 24$	1.07** (0.25)	0.05 (0.03)	0.10
$n = 60$	0.66** (0.15)	0.05 (0.04)	0.11
$n = 120$	0.56** (0.12)	0.01 (0.04)	0.13
$n = 360$	0.07 (0.03)	–	0.04

Table 2C

Euro Area - U.K. Evidence: Term Premium Adjustment

	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	2.12 (1.33)	0.20** (0.08)	0.36
$n = 24$	1.49** (0.62)	0.19** (0.07)	0.38
$n = 60$	1.02** (0.29)	0.20** (0.06)	0.40
$n = 120$	0.82** (0.18)	0.18** (0.17)	0.42
$n = 360$	0.27** (0.05)	–	0.31
Time trend			
$n = 12$	−0.11 (1.47)	0.30** (0.07)	0.42
$n = 24$	0.23 (0.83)	0.29** (0.06)	0.42
$n = 60$	0.45 (0.53)	0.27** (0.06)	0.42
$n = 120$	0.54 (0.41)	0.24** (0.07)	0.42
$n = 360$	0.28** (0.04)	–	0.42
First differences			
$n = 12$	0.50 (0.53)	0.01 (0.07)	0.01
$n = 24$	0.55 (0.31)	0.01 (0.07)	0.01
$n = 60$	0.38 (0.23)	0.00 (0.07)	0.02
$n = 120$	0.02 (0.07)	0.00 (0.06)	0.01
$n = 360$	0.02 (0.07)	–	0.01

Table 3B

U.S.- U.K. Evidence: Nominal Specification

	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	9.41^{**} (1.33)	-0.06 (0.12)	0.56
$n = 24$	5.17^{**} (0.76)	-0.13 (0.13)	0.62
$n = 60$	2.09^{**} (0.32)	0.00 (0.09)	0.59
$n = 120$	0.98^{**} (0.30)	0.12 (0.13)	0.46
$n = 360$	0.29^{*} (0.16)	–	0.16
Time trend			
$n = 12$	5.33^{**} (1.42)	-0.07 (0.12)	0.69
$n = 24$	3.15^{**} (0.70)	-0.10 (0.12)	0.71
$n = 60$	1.25^{**} (0.28)	-0.04 (0.09)	0.68
$n = 120$	0.34 (0.24)	0.04 (0.11)	0.63
$n = 360$	0.21^{*} (0.06)	–	0.61
First differences			
$n = 12$	3.98^{**} (1.33)	-0.08 (0.03)	0.08
$n = 24$	2.75^{**} (0.74)	-0.13 (0.04)	0.14
$n = 60$	0.86^{**} (0.29)	-0.07 (0.05)	0.17
$n = 120$	0.23 (0.16)	-0.05 (0.05)	0.01
$n = 360$	-0.06 (0.04)	–	0.01

Table 3C			
Euro Area - U.K. Evidence: Nominal Specification			
	$\widehat{\gamma}_S$	$\widehat{\gamma}_L$	R^2
Baseline			
$n = 12$	8.84^{**} (1.48)	0.11 (0.10)	0.50
$n = 24$	4.92^{**} (0.88)	0.08 (0.09)	0.51
$n = 60$	2.49^{**} (0.45)	−0.01 (0.11)	0.48
$n = 120$	1.38^{**} (0.42)	−0.19 (0.15)	0.30
$n = 360$	−0.00 (0.14)	–	0.01
Time trend			
$n = 12$	8.67^{**} (1.68)	0.28^{**} (0.11)	0.60
$n = 24$	4.99^{**} (0.93)	0.27^{**} (0.10)	0.63
$n = 60$	2.72^{**} (0.48)	0.10 (0.08)	0.60
$n = 120$	1.78^{**} (0.41)	−0.04 (0.12)	0.49
$n = 360$	0.20^{*} (0.12)	–	0.15
First differences			
$n = 12$	7.18^{**} (1.53)	0.09^{**} (0.02)	0.33
$n = 24$	3.38^{**} (0.87)	0.10^{**} (0.03)	0.29
$n = 60$	1.35^{**} (0.23)	0.11^{**} (0.05)	0.29
$n = 120$	0.69^{**} (0.23)	0.08^{*} (0.04)	0.23
$n = 360$	0.15^{**} (0.04)	–	0.13