Exchange Rate Disconnect Redux

Ryan Chahrour[1] Vito Cormun[2] Pierre De Leo[3]
Pablo Guerrón Quintana[1] Rosen Valchev[1]

[1]Boston College

[2]Santa Clara University

[3]University of Maryland

Exchange Rates and Fundamentals

Study of exchange rates suffused with **puzzles**

$\hookrightarrow$ weak relationship between real exchange rate (q) and many macro fundamentals (f)

1. Determination Puzzle (Meese & Rogoff 83)
2. Risk-sharing Puzzle (Backus & Smith 93)
3. Uncovered Interest Parity (UIP) Puzzle (Fama 84)
4. Excess Comovement Puzzle (Engel 16)
5. Excess Volatility Puzzle

Exchange Rates and Fundamentals

Study of exchange rates suffused with **puzzles**

↪ weak relationship between real exchange rate (q) and many macro fundamentals (f)

1. Determination Puzzle (Meese & Rogoff 83)
2. Risk-sharing Puzzle (Backus & Smith 93)
3. Uncovered Interest Parity (UIP) Puzzle (Fama 84)
4. Excess Comovement Puzzle (Engel 16)
5. Excess Volatility Puzzle

Prevalent interpretation: **exchange rate disconnect**

- q and f are driven by different (set of) shocks

Exchange Rates and Fundamentals

Study of exchange rates suffused with **puzzles**

↪ weak relationship between real exchange rate (q) and many macro fundamentals (f)

1. Determination Puzzle (Meese & Rogoff 83)
2. Risk-sharing Puzzle (Backus & Smith 93)
3. Uncovered Interest Parity (UIP) Puzzle (Fama 84)
4. Excess Comovement Puzzle (Engel 16)
5. Excess Volatility Puzzle

Prevalent interpretation: **exchange rate disconnect**

- q and f are driven by different (set of) shocks

This paper: identify drivers of q using minimal structure

Exchange Rate Disconnect Revisited

1. Real exchange rates are **connected** with macro fundamentals

   - link between current q and future f

Exchange Rate Disconnect Revisited

1. Real exchange rates are **connected** with macro fundamentals

    - link between current q and future f

2. Disturbances to TFP & TFP expectations explain $\approx 60\%$ of q and f

    - significant role for fluctuations in noisy expectations of TFP
        - anticipation vs realization characterizes dynamics of q
        - noise in TFP expectations accounts for excess volatility of q rel. to f

    - responses of q and f generate all q puzzles

    - noise is why relationship between q and f appears weak

Literature

Empirical: Meese & Rogoff 83, Fama 84, Backus & Smith 93, Eichenbaum & Evans 95, Chari, Kehoe & McGrattan 02, Cheung, Ching & Pascual 02, Engel & West 05, Gourinchas & Rey 07, Engel, Mark & West 08, Chen, Rogoff & Rossi 10, Sarno & Schmelling 14, Nam & Wang 15, Siena 17, Stavrakeva & Tang 20, Alessandria & Choi 21, Miyamoto et al. 21

Theoretical:

1. **Currency Excess returns:**
   - **Consumption Risk:** Verdelhan 10, Bansal & Shaliastovich 12, Colacito & Croce 13, Farhi & Gabaix 16
   - **Segmented Markets Risk:** Alvarez, Atkeson & Kehoe 09, Adrian, Etula & Shin 15, Camacho, Hau & Rey 18
   - **Behavioral biases:** Gourinchas & Tornell 04, Bachetta & van Wincoop 06, Burnside et. al 11, Candian & De Leo 21
   - **Liquidity premia:** Engel 16, Valchev 20, Engel & Wu 20, Bianchi, Bigio & Engel 21
2. **Disconnect:** Engel & West 05, Bacchetta & Van Wincoop 06, Obstfeld & Rogoff 00, Itskhoki & Mukhin 21
3. **Backus-Smith Puzzle:** Kocherlakota & Pistaferri 07, Corsetti, Dedola & Leduc 08, Benigno & Thoenissen 08, Colacito & Croce 13, Karabarbounis 14, Itskhoki & Mukhin 21
4. **Specific FX shocks:** Devereux & Engel 02, Jeanne & Rose 02, Kollmann 05, Bacchetta & Van Wincoop 06, Eichenbaum, Johannsen & Rebelo 19, Itskhoki & Mukhin 21
5. **International News:** Beaudry & Portier 11, Kamber, Theodoridis & Thoenissen 17, Lambrias 19

Empirical Approach

Baseline Data

United States & G6 aggregates from 1976:Q1 to 2008:Q2

Baseline Data

United States & G6 aggregates from 1976:Q1 to 2008:Q2

Main variables:

1. Real exchange rate $\ln(q_t)$
2. US consumption $\ln(C_t)$
3. G6 consumption $\ln(C_t^\star)$
4. US investment $\ln(I_t)$
5. G6 investment $\ln(I_t^\star)$
6. Nominal interest rate differential $\ln(i_t/i_t^\star)$
7. Relative price $\ln(CPI_t/CPI_t^*)$
8. US utilization-adj. TFP $\ln(TFP_t)$

Overview

Two semi-structural techniques

↪ from fewer assumptions to more assumptions

1. VAR identification, based on "max-share"

   ↪ isolate comovement associated with main driver of surprise changes in q

2. VAR identification, based on "technology/exp. noise" distinction

   ↪ isolate role of TFP and TFP expectations in driving comovement

VAR – Max Share Approach

Objective: isolate comovement associated with main driver of surprise changes in q

Max Share: Extract shock that drives most of q

- Estimate a VAR

$$Y_t = B(L)Y_{t-1} + u_t$$

[Bayesian, 4 lags]

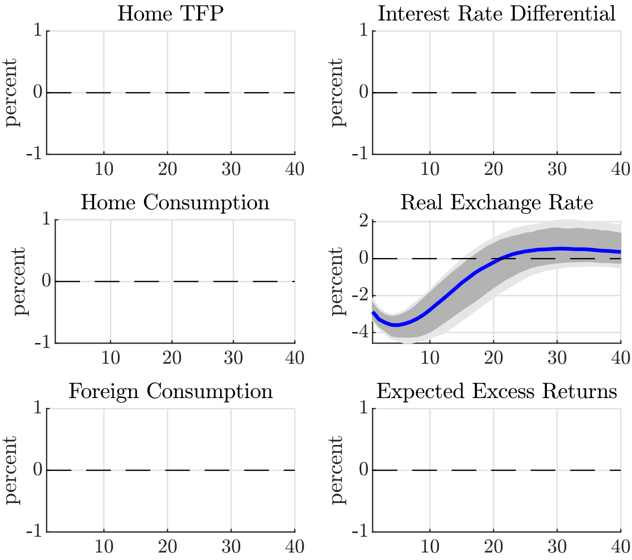
- Let

$$u_t = A\varepsilon_t, \qquad cov(\varepsilon_t) = I$$

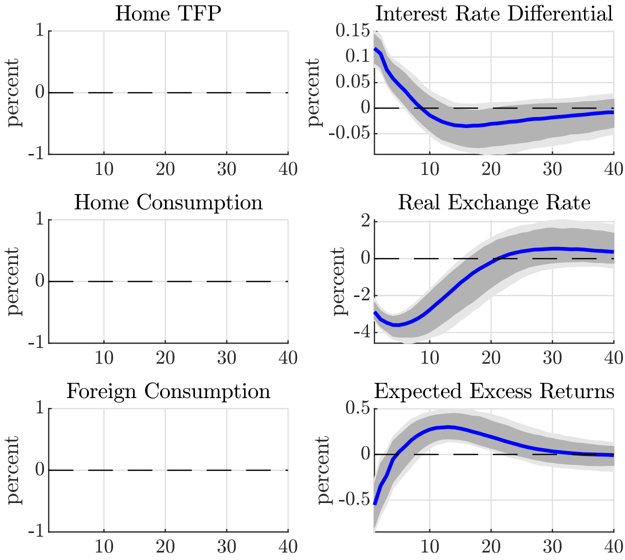
- Find A such that $\varepsilon_{1,t}$ explains most of $\leq$ 100Q forecast errors of q

$\hookrightarrow$ akin to 1^{st} principal component of VAR IRF (Uhlig 03, Angeletos et al. 20)

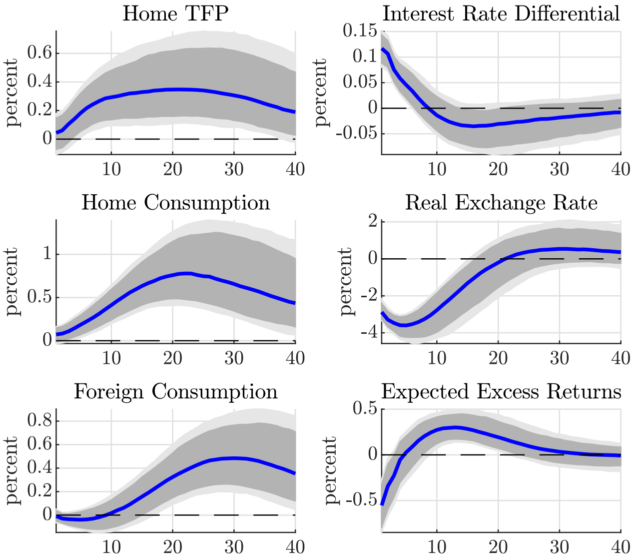
Conditional Dynamics – Max Share Approach (ε_1)



Conditional Dynamics – Max Share Approach (ε_1)



Conditional Dynamics – Max Share Approach (ε_1)



A Link Between Current RER and Future Fundamentals

Variance Decomposition

	Q1 Δ	Q4 Δ	Q12 Δ	Q24 Δ	Q40 Δ	Q100 Δ
Home TFP	0.03	0.06	0.20	0.37	0.45	0.43
Home Consumption	**0.02**	**0.04**	**0.21**	**0.47**	**0.51**	**0.40**
Foreign Consumption	**0.01**	**0.04**	**0.06**	**0.21**	**0.36**	**0.30**
Interest Rate Differential	0.40	0.39	0.30	0.34	0.35	0.39
Real Exchange Rate	**0.50**	**0.69**	**0.82**	**0.73**	**0.70**	**0.68**
Expected Excess Returns	0.47	0.33	0.34	0.44	0.45	0.47

- There *could be* a single source driving the bulk of q variation
- ... a link between current q and future f
- ... and a common origin of key q puzzles

A Link Between Current RER and Future Fundamentals

Variance Decomposition

	Q1 Δ	Q4 Δ	Q12 Δ	Q24 Δ	Q40 Δ	Q100 Δ
Home TFP	0.03	0.06	0.20	0.37	0.45	0.43
Home Consumption	**0.02**	**0.04**	**0.21**	**0.47**	**0.51**	**0.40**
Foreign Consumption	**0.01**	**0.04**	**0.06**	**0.21**	**0.36**	**0.30**
Interest Rate Differential	0.40	0.39	0.30	0.34	0.35	0.39
Real Exchange Rate	**0.50**	**0.69**	**0.82**	**0.73**	**0.70**	**0.68**
Expected Excess Returns	0.47	0.33	0.34	0.44	0.45	0.47

- There *could be* a single source driving the bulk of q variation
- ... a link between current q and future f
- ... and a common origin of key q puzzles

Next: directly identify disturbances to TFP and TFP expectations

1. Characterize comovement implied by these fundamental disturbances
2. Quantify the importance of future information about TFP

Identifying Expectations

Identifying Expectations

Objective: Identify technological & expectational disturbances

Basic idea: Agents observe a_t & noisy signal about future a:

$$a_t = \sum_{k=0}^{\infty} \alpha_k \varepsilon^a_{t-k} \qquad \eta_t = \sum_{k=1}^{\infty} \zeta_k a_{t+k} + v_t \qquad v_t = \sum_{k=0}^{\infty} \nu_k \varepsilon^v_{t-k}$$

Goal: separately identify ε^a_t and ε^v_t

Identifying Expectations

Assumptions: (Chahrour & Jurado 21)

0. Variables in the VAR span agents' information
1. Technological disturbances (ε_t^a) explain 100% of TFP
2. Expectational disturbances (ε_t^v) orthogonal to TFP at all leads & lags

On Recoverability

No more (or less) restrictive than traditional VAR

MA Representation

Identifying Expectations

Do not need to observe agents' actual signals η_t or beliefs

Macro variables & asset prices forward looking:

$$y_t = \chi E_t(a_{t+1}) + \dots$$

$\Rightarrow$ VAR captures agents' expectations of future TFP, $E_t(a_{t+k})$

Identifying Expectations

Do not need to observe agents' actual signals η_t or beliefs

Macro variables & asset prices forward looking:

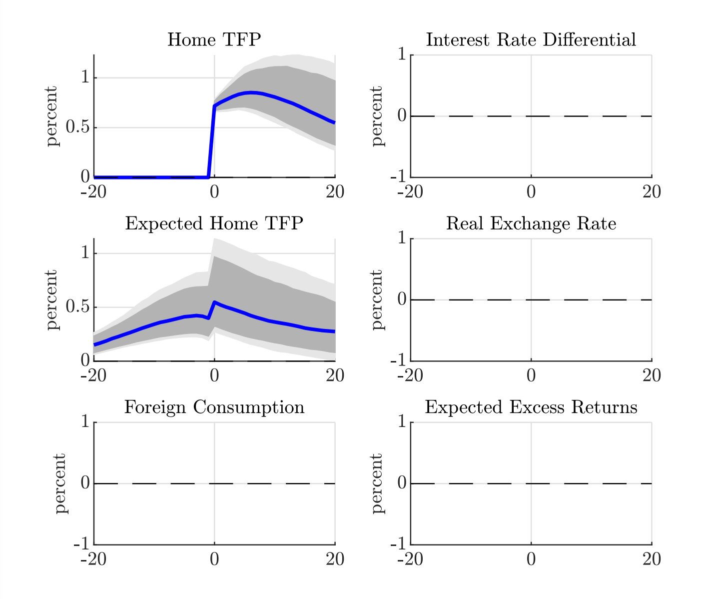
$$y_t = \chi E_t(a_{t+1}) + \dots$$

$\Rightarrow$ VAR captures agents' expectations of future TFP, $E_t(a_{t+k})$

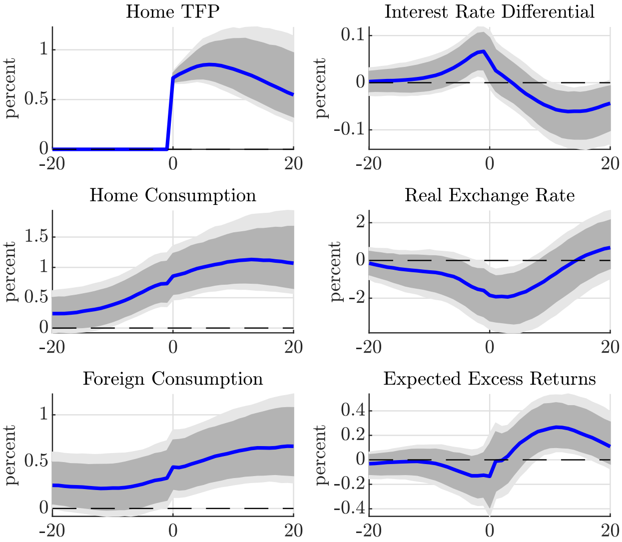
Decompose expectation into

a. Component that realizes $\rightarrow$ portion of $E_t(a_{t+k})$ related to ε^a_{t+k}
b. Component that doesn't $\rightarrow$ portion of $E_t(a_{t+k})$ driven by ε^v_{t+k}

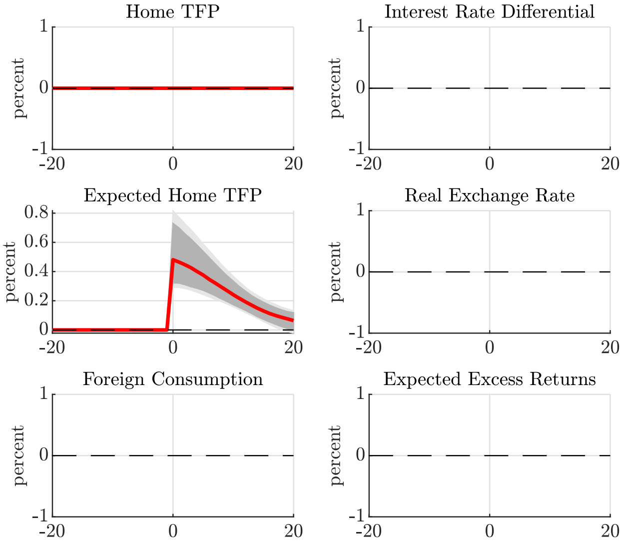
Conditional Dynamics – Technology (ε^a)



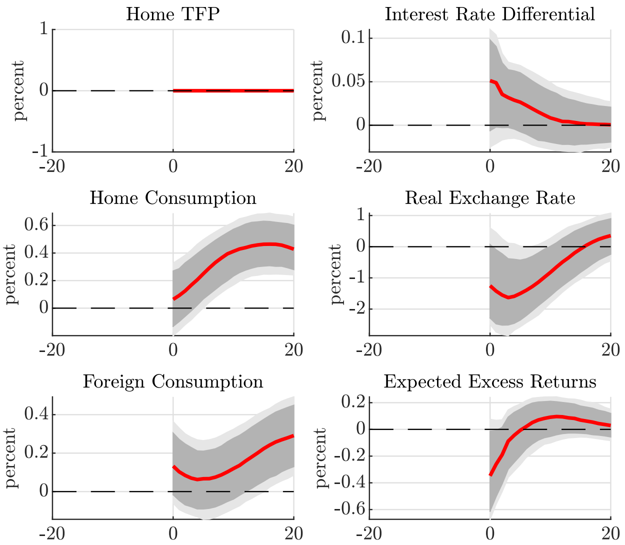
Conditional Dynamics – Technology (ε^a)



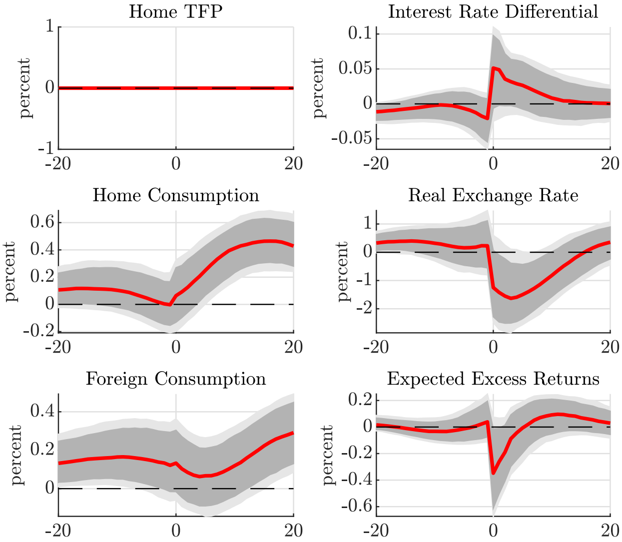
Conditional Dynamics – Expectational noise (ε^v)



Conditional Dynamics – Expectational noise (ε^v)



Conditional Dynamics – Expectational noise (ε^v)



Fundamental Disturbances Drive Both q and f ($\approx 60\%$)

Variance Decomposition (2-100Q frequency)

	Both	Technology	Exp. Noise
Home TFP	1.00		
Home Consumption	**0.70**		
Foreign Consumption	**0.63**		
Home Investment	0.62		
Foreign Investment	0.68		
Interest Rate Differential	0.57		
Real Exchange Rate	**0.64**		
Expected Excess Returns	0.50		

More on Role of Expectations

Important Role for Noise about Future TFP

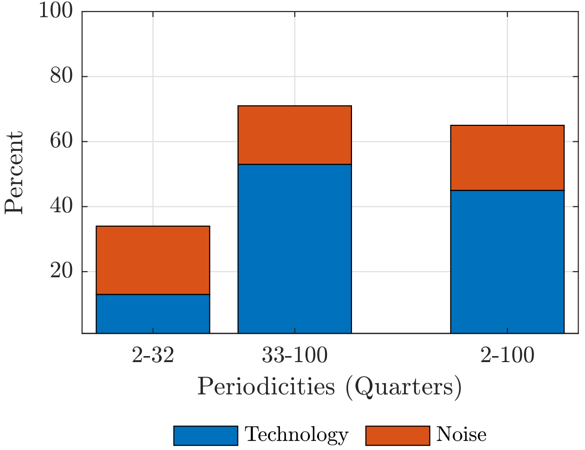
Variance Decomposition (2-100Q frequency)

	Both	Technology	Exp. Noise
Home TFP	1.00	1.00	0.00
Home Consumption	**0.70**	**0.54**	**0.16**
Foreign Consumption	**0.63**	**0.49**	**0.14**
Home Investment	0.62	0.46	0.15
Foreign Investment	0.68	0.43	0.25
Interest Rate Differential	0.57	0.46	0.11
Real Exchange Rate	**0.64**	**0.45**	**0.20**
Expected Excess Returns	0.50	0.35	0.15

More on Role of Expectations

Noise Dominates at Higher Frequencies for q

Variance Decomposition of Real Exchange Rate



All Puzzles Emerge in Response to Fundamental Disturbances

	Unconditional	Both	Technology	Exp. Noise
Fama β_{UIP}	-2.46	-2.20		
Engel β_{Λ}	2.53	2.62		
$\sigma(r_t - r_t^\star)/\sigma(\Delta q_t)$	0.17	0.25		
$autocorr(r_t - r_t^\star)$	0.95	0.98		
$corr(\Delta q_t, \Delta(c_t - c_t^\star))$	-0.27	-0.35		
$autocorr(\Delta q_t)$	0.29	0.58		
$autocorr(q_t)$	0.98	0.99		
$\sigma(\Delta q_t)/\sigma(\Delta c_t)$	6.05	5.65		

- Exchange rate puzzles have a common, fundamental origin

Noise Generates Excess Volatility in q relative to f

	Unconditional	Both	Technology	Exp. Noise
Fama β_{UIP}	-2.46	-2.20	-2.08	-2.96
Engel β_{Λ}	2.53	2.62	2.33	1.72
$\sigma(r_t - r_t^{\star})/\sigma(\Delta q_t)$	0.17	0.25	0.37	0.13
$autocorr(r_t - r_t^{\star})$	0.95	0.98	0.99	0.93
$corr(\Delta q_t, \Delta(c_t - c_t^{\star}))$	-0.27	-0.35	-0.31	-0.38
$autocorr(\Delta q_t)$	0.29	0.58	0.90	0.33
$autocorr(q_t)$	0.98	0.99	0.99	0.97
$\boldsymbol{\sigma(\Delta q_t)/\sigma(\Delta c_t)}$	**6.05**	**5.65**	**3.99**	**8.14**

- Noise in information structure needed to understand dynamics of q
  - ... especially excess volatility in q relative to f

Robustness

- Results in extended sample (1976-2018) Extended Sample
- Results across G7 countries
  - Canada Canada
  - France France
  - Germany Germany
  - Italy Italy
  - Japan Japan
  - United Kingdom United Kingdom
- Results using VECM (assumes q and $r - r^{\star}$ are stationary) VECM
- Responses of other variables Trade Balance

Why Were Previous Findings Mixed?

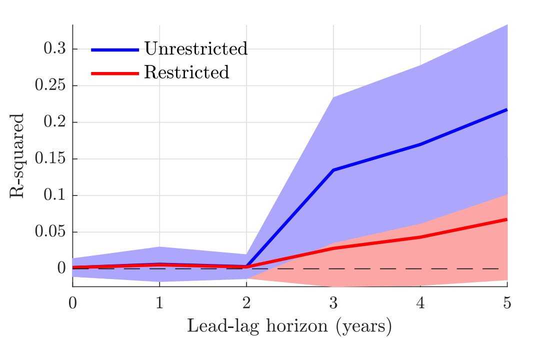
1. Most studies looked for a relationship between q_t and f_{t-k}

   $\hookrightarrow$ but anticipation is important

Why Were Previous Findings Mixed?

1. Most studies looked for a relationship between q_t and f_{t-k}

   $\hookrightarrow$ but anticipation is important



$$\Delta q_t = \alpha + \beta_0 \Delta TFP_t + \sum_{k=1}^{h} \beta_{-k}^{lag} (\Delta TFP_{t-k}) + \sum_{k=1}^{h} \beta_{k}^{lead} (\Delta TFP_{t+k}) + \varepsilon_t$$

Why Were Previous Findings Mixed?

2 Some studies looked for a relationship between q_t and f_{t+k}

Why Were Previous Findings Mixed?

2 Some studies looked for a relationship between q_t and f_{t+k}

- some focused on near-term ($k = 1$ year)

$\hookrightarrow$ we find that what matters most for q are news up to 4-5 years

Why Were Previous Findings Mixed?

2 Some studies looked for a relationship between q_t and f_{t+k}

- some focused on near-term ($k = 1$ year)

$\hookrightarrow$ we find that what matters most for q are news up to 4-5 years

- others test if q_t Granger-causes f_{t+k} (e.g. Engel & West 05)

$$f_t = \alpha + A(L) f_{t-1} + B(L) q_t$$

$\hookrightarrow$ Expectational noise acts as measurement error in q_t
(biasing $B(L)$ towards 0)

Factor Structure of Currency Excess Returns

$\approx 50\%$ of exp. currency returns due to two fundamental disturbances

Currency returns have a factor structure (Lustig & Verdelhan 11)

- e.g. Dollar, HML

Factors, however, appear generally unrelated to fundamentals

- studies looked for contemporaneous corr between factors and f
- ... or short-horizon shifts in time $(-/+1$ year)

Factor structure likely has a fundamental origin

$\hookrightarrow$ but need to look for relatively longer-run, *noisy* news!

Equity v. Currency Premia

Conclusions

1. Exchange rates are connected to traditional macro fundamentals
2. Both f and q are driven by TFP and expectations thereof
3. Exchange rate puzzles have a common, fundamental origin
4. Noise in expectations play a key role in dynamics of q relative to f

Appendix Slides

Variance Decomposition (Reduced-form Approach)

	Q1 Δ	Q4 Δ	Q12 Δ	Q24 Δ	Q40 Δ	Q100 Δ
Home TFP	0.03	0.06	0.20	0.37	0.45	0.43
Home Consumption	0.02	0.04	0.21	0.47	0.51	0.40
Foreign Consumption	0.01	0.04	0.06	0.21	0.36	0.30
Home Investment	0.29	0.34	0.32	0.40	0.42	0.41
Foreign Investment	0.06	0.08	0.15	0.22	0.34	0.33
Interest Rate Differential	0.40	0.39	0.30	0.34	0.35	0.39
Real Exchange Rate	0.50	0.69	0.82	0.73	0.70	0.68
Expected Excess Returns	0.47	0.33	0.34	0.44	0.45	0.47
Real Exchange Rate Changes	0.50	0.49	0.47	0.49	0.49	0.51

Share of forecast error variance explained by the Main FX shock (ε_1)

Return

FX Decomposition

Using the definition of expected excess returns:

$$E_t \lambda_{t+1} = E_t(q_{t+1}) - q_t - (r_t - r_t^\star)$$

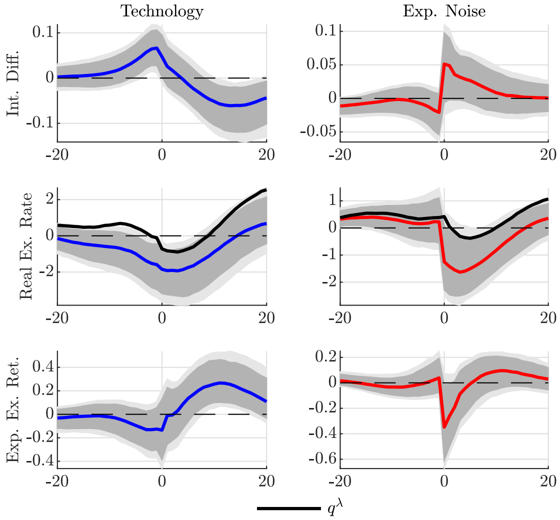
We can rearrange:

$$q_t = E(q_{t+1}) - (r_t - r_t^\star) - E_t \lambda_{t+1}$$

And solve forward:

$$q_t = \underbrace{-\sum_{k=0}^{\infty} E_t(r_{t+k} - r_{t+k}^\star)}_{=q_t^{UIP}} \underbrace{-\sum_{k=0}^{\infty} E_t \lambda_{t+k+1}}_{=q_t^{\lambda}}$$

Technology & Exp. Noise: FX Decomposition



Return

Anticipated vs surprise in fundamentals

Simulate tech+expectational shocks economy, compute $1 - R^2$ after regressing the change in exchange rate on present and past tech shocks.

	$1 - R^2$
Germany	0.69
Italy	0.72
France	0.68
Canada	0.47
Japan	0.65
United Kingdom	0.66
G6	0.65

Return

Identifying Expectations

Problem:

- Noise information structures are generically non-causal and non-invertible
- Common view: "VAR methods not applicable"
- Barsky & Sims 2012; Blanchard et al, 2013; etc.

Solution: Chahrour & Jurado (RESTUD, 21)

- Relax these assumptions
  - Past and future symmetric to econometrician
- Focus on "recoverability"
- Expand the scope of VAR methods to...exactly cases like this

Return

MA Representation

MA representation:

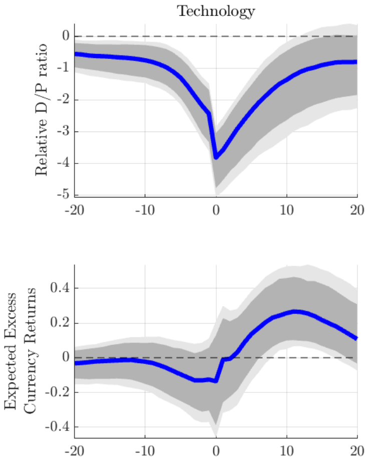
$$\begin{bmatrix} a_t \\ \eta_t \end{bmatrix} = \cdots + \begin{bmatrix} 0 & 0 \\ * & 0 \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t+1} \\ \varepsilon^v_{t+1} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t} \\ \varepsilon^v_{t} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t-1} \\ \varepsilon^v_{t-1} \end{bmatrix} + \cdots$$

Compare to Cholesky:

$$\begin{bmatrix} a_t \\ \eta_t \end{bmatrix} = \cdots + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t+1} \\ \varepsilon^v_{t+1} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t} \\ \varepsilon^v_{t} \end{bmatrix} + \begin{bmatrix} * & * \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t-1} \\ \varepsilon^v_{t-1} \end{bmatrix} + \cdots$$

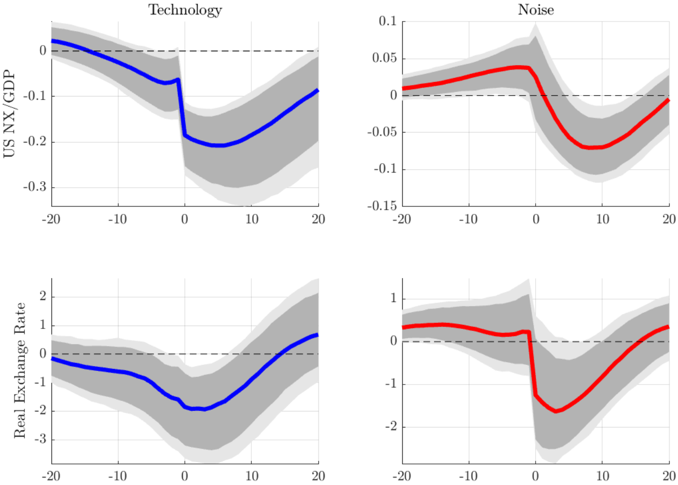
Return

Equity and Currency Premia



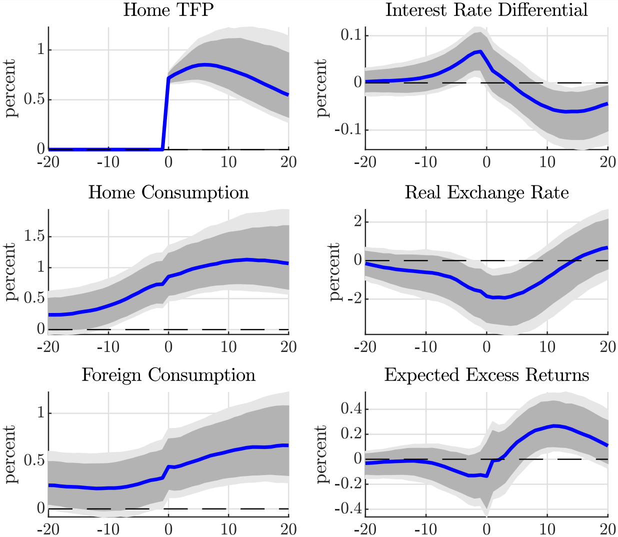
Return

Trade Balance and Exchange Rate

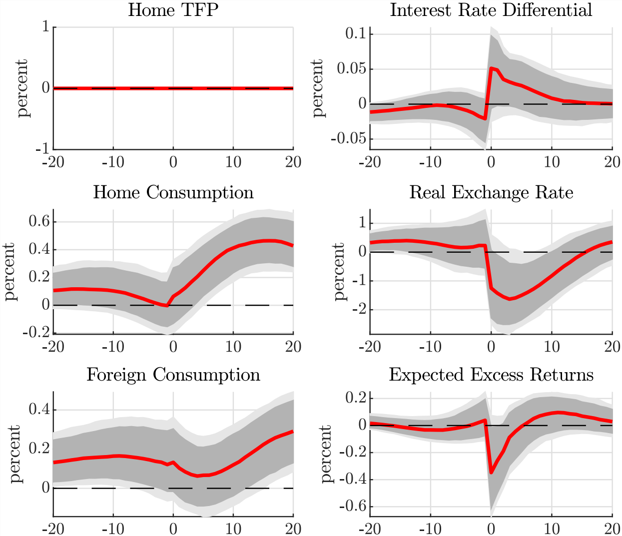


Return

Conditional Dynamics – Technology (ε^a) – Extended Sample

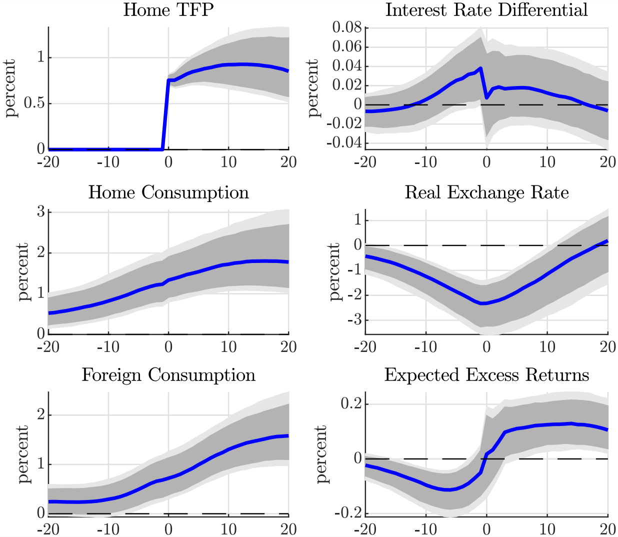


Conditional Dynamics – Expectational noise (ε^v)– Extended Sample

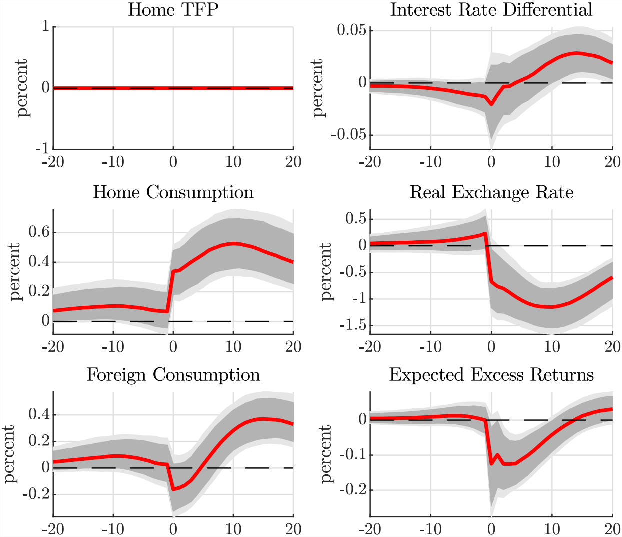


Return

Conditional Dynamics – Technology (ε^a) – Canada

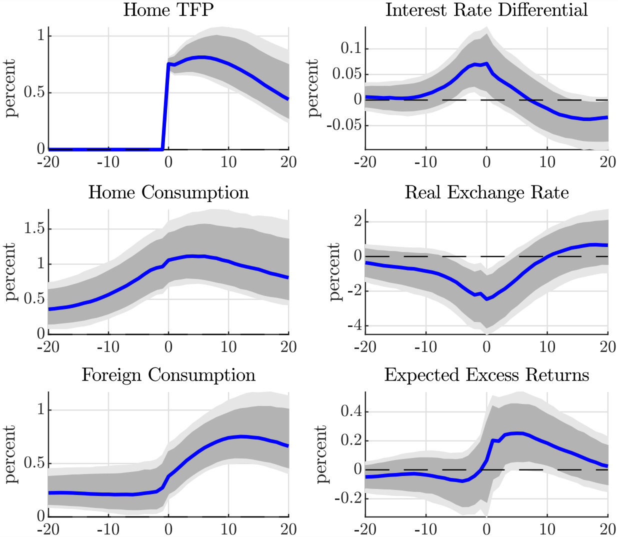


Conditional Dynamics – Expectational noise (ε^v)– Canada

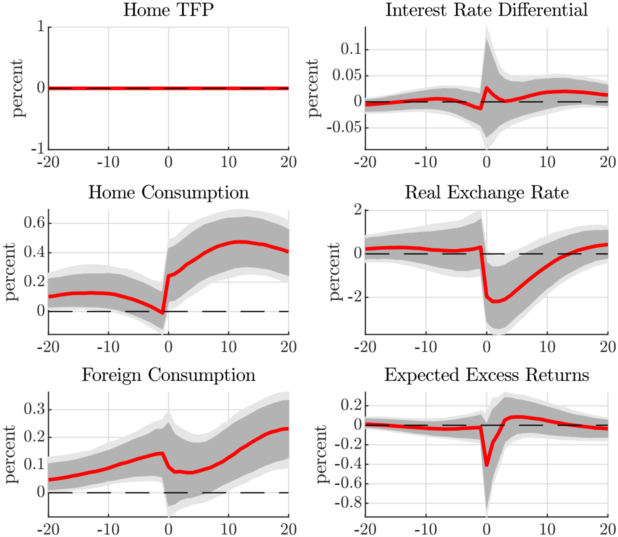


Return

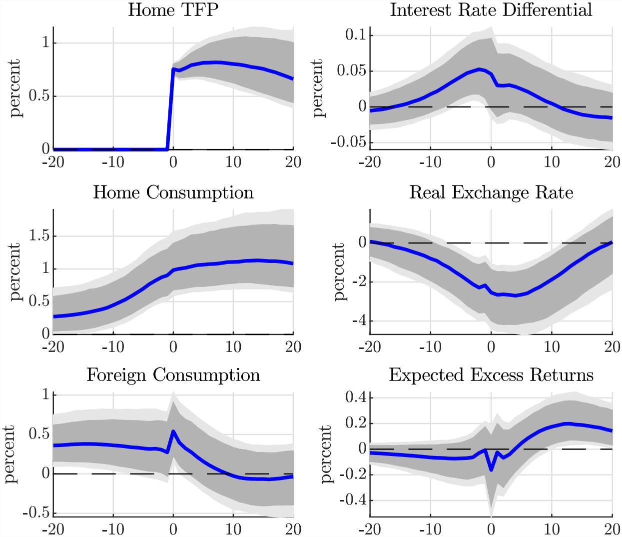
Conditional Dynamics – Technology (ε^a) – France



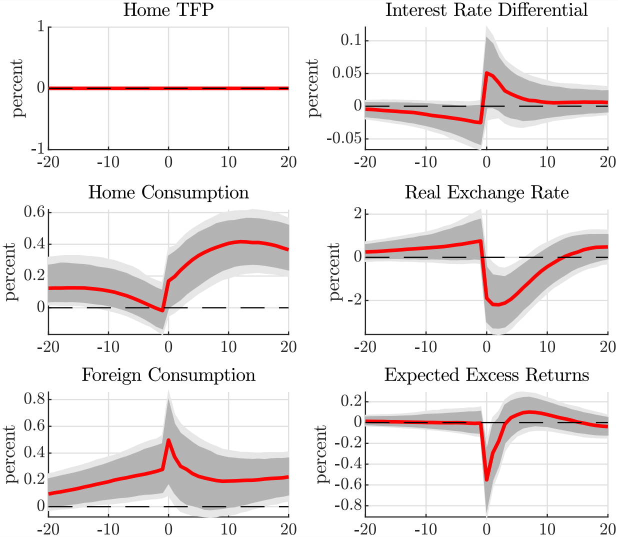
Conditional Dynamics – Expectational noise (ε^v)– France



Conditional Dynamics – Technology (ε^a) – Germany

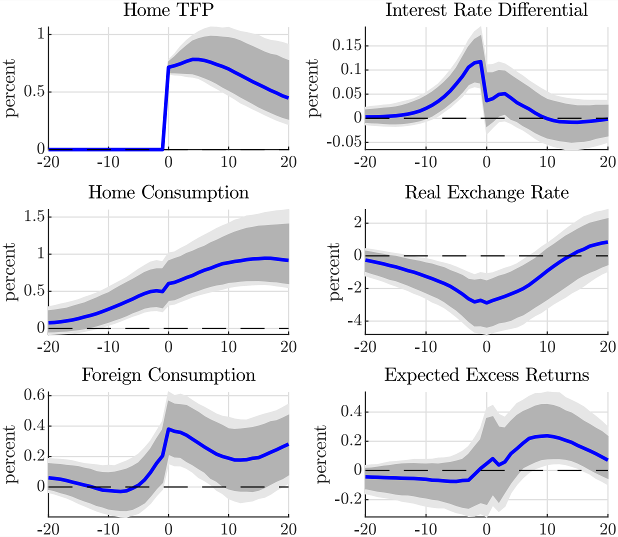


Conditional Dynamics – Expectational noise (ε^v)– Germany

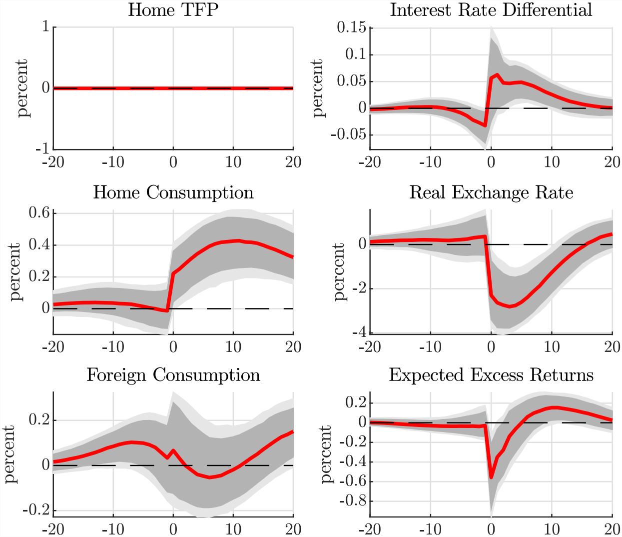


Return

Conditional Dynamics – Technology (ε^a) – Italy

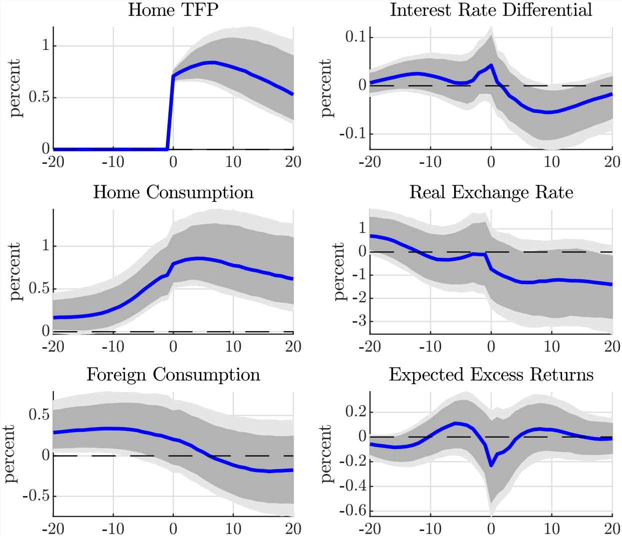


Conditional Dynamics – Expectational noise (ε^v)– Italy

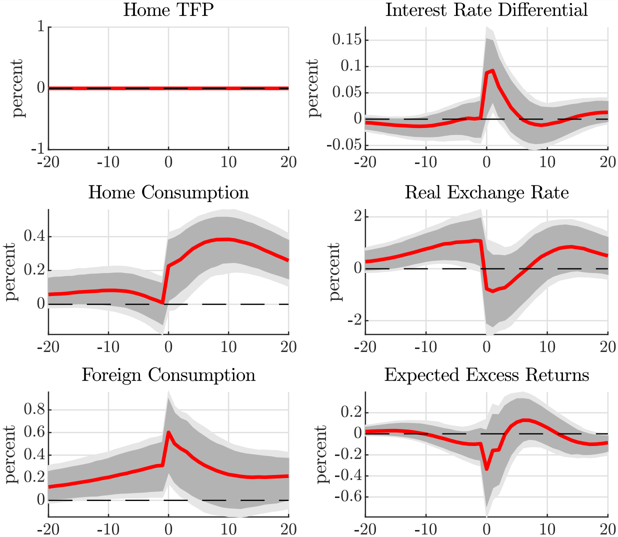


Return

Conditional Dynamics – Technology (ε^a) – Japan

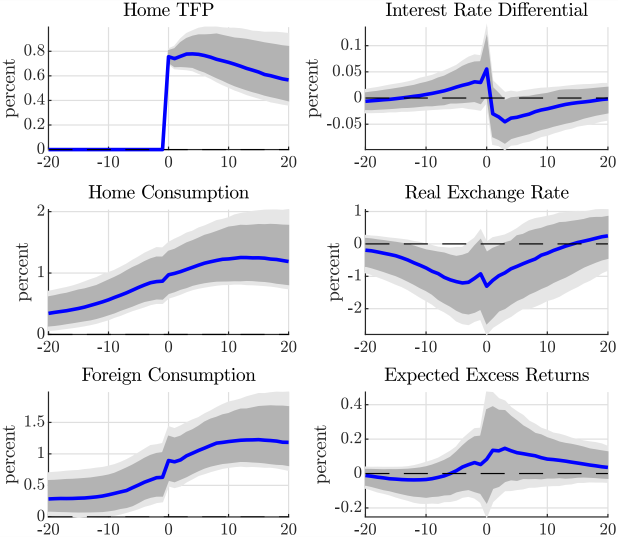


Conditional Dynamics – Expectational noise (ε^v)– Japan

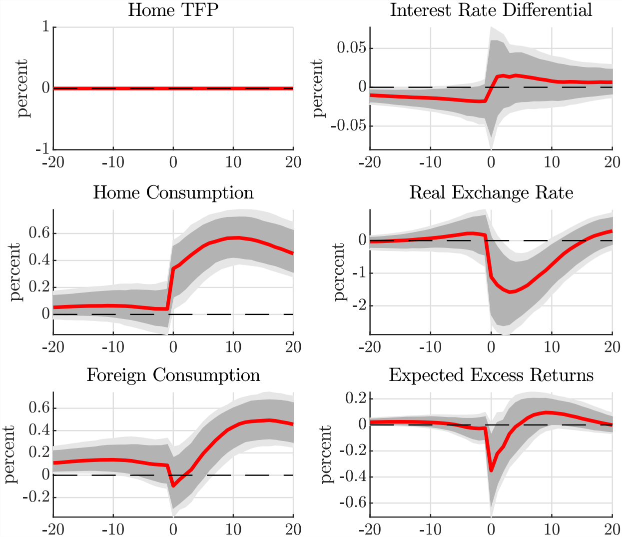


Return

Conditional Dynamics – Technology (ε^a) – United Kingdom

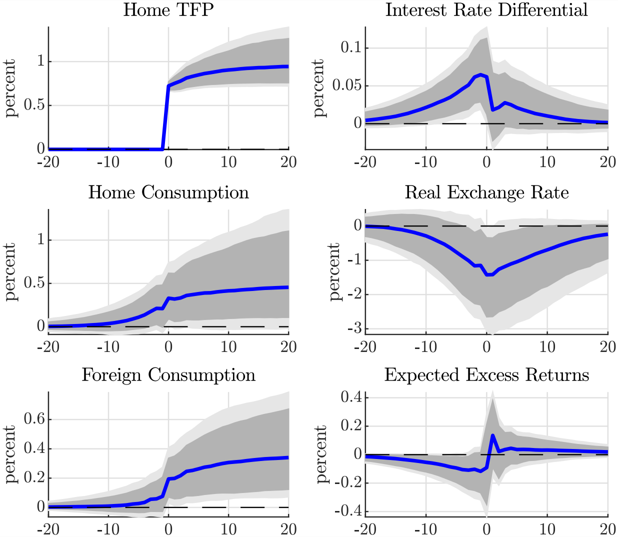


Conditional Dynamics – Expectational noise (ε^v)– United Kingdom

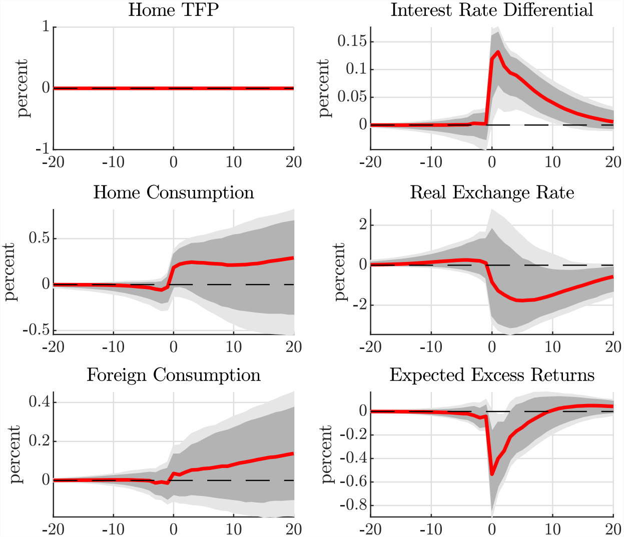


Return

Conditional Dynamics – Technology (ε^a) – VECM



Conditional Dynamics – Expectational noise (ε^v)– VECM



Return