Exchange Rate Disconnect Revisited

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Exchange Rate Disconnect

- In models, real exchange rate q_t tightly linked to macro fundamentals
  - As relative price of consumption, it plays crucial role in clearing markets
- In the data, however, q_t is largely "disconnected" from macro fundamentals, and also an order of magnitude more volatile
  - Empirical dynamics of q_t are roughly a random walk
  - Giving rise to numerous puzzles: Backus-Smith, Fama, Meese-Rogoff, ...
- Tremendous amount of work on resolving these puzzles, but ...
  - Many papers address puzzles piecemeal, one at a time
  - Previous focus on theory, but relatively little direct empirical evidence
    - ⋆ Wedge decomposition finds an important role for exogenous "FX-shocks"
- **This paper:** identify empirical drivers of q_t using minimal structure

Main Results

1. Real exchange rates are connected with macro fundamentals
    - however, the link runs between current q_t and future f_{t+k}

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1. Real exchange rates are connected with macro fundamentals
   - however, the link runs between current q_t and future f_{t+k}
2. Noisy news about future TFP explain $\approx 64\%$ of q_t (30% of Δq_t)
   - little role for pure "surprise" TFP shocks
   - significant role for fluctuations in noisy expectations of TFP
     - ★ decompose into actual, anticipated TFP changes and expectational noise
     - ★ Noise $\Rightarrow$ high frequency excess volatility
     - ★ Anticipated TFP shifts $\Rightarrow$ low-frequency, non-monotonic q_t dynamics
   - Transmission mechanism: endogenous, volatile deviations from UIP
   - conditional responses of q_t exhibit many, otherwise disparate, famous exchange rate puzzles

     $\Rightarrow$ puzzles share a common, fundamental, origin in *noisy* expectations of TFP

Literature

Empirical: Meese & Rogoff 83, Fama 84, Backus & Smith 93, Eichenbaum & Evans 95, Rogoff 96, Obstfeld and Rogoff (2000), 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

Theoretica Puzzle ''Solutions'':

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, Gabaix and Maggiori 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, Eichenbaum et. al. 20, 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 Business Cycles and TFP News:** Beaudry & Portier 11, Kamber, Theodoridis & Thoenissen 17, Lambrias 19

Overview

Two semi-structural techniques

↪ from fewer assumptions to more assumptions

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

   ↪ isolate main comovement patterns associated with surprise Δq

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

   ↪ isolate role of TFP and TFP expectations in driving comovement

Data

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

- results remain virtually unchanged if we extend to 2018:Q4

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Main variables:

1. Nominal exchange rate $\ln(s_t)$
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 $\ln(TFP_t)$

$$Y_t' \equiv \left[\ln\left(S_t\right), \ln\left(TFP_t\right), \ln\left(C_t\right), \ln\left(C_t^\star\right), \ln\left(I_t\right), \ln\left(I_t^\star\right), \ln\left(\frac{1+i_t}{1+i_t^\star}\right), \ln\left(\frac{CPI_t}{CPI_t^\star}\right)\right].$$

VAR – Max Share Approach

- Estimate a VAR

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

[Bayesian, 4 lags]

- Let

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

VAR – Max Share Approach

- Estimate a VAR

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

[Bayesian, 4 lags]

- Let

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

$$\varepsilon_t = A^{-1}u_t$$

- Following max-share procedure of Uhlig(2003), Angeletos et.al.(2020):
  - Pick A to maximize the share of variation in real exchange rate q_t explained by $\varepsilon_{1,t}$

Objective: isolate dominant factor behind fluctuations in q_t

VAR – Max Share Approach

- The real exchange rate is defined as usual (in logs)

$$q_t = s_t + p_t^* - p_t$$

- Simply a linear combination of VAR variables:

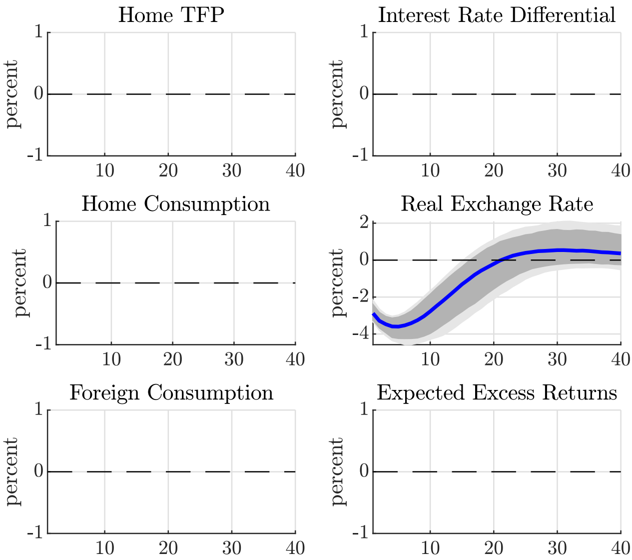
$$\begin{aligned} q_t = \phi_q Y_t &= \phi_q (I - B(L))^{-1} u_t \\ &= \phi_q (I - B(L))^{-1} A \underbrace{\varepsilon_t}_{=A^{-1}u_t} \end{aligned}$$

- Variance of q_t can then be decomposed in contributions of each $\varepsilon_{i,t}$

$$Var(q_{t+100} - \mathbb{E}_t(q_{t+100})) = \sum_i Var(q_{t+100} - \mathbb{E}_t(q_{t+100}) | \varepsilon_k = 0 \ , \forall k \neq i)$$

- Pick A to maximize $Var(q_{t+k} - \mathbb{E}_t(q_{t+k}) | \varepsilon_k = 0 \ , \forall k \neq 1)$
- Intuition: $\varepsilon_{1,t}$ gives us the dominant factor behind q_t fluctuations

Conditional Dynamics – Max-Share (ε_1)



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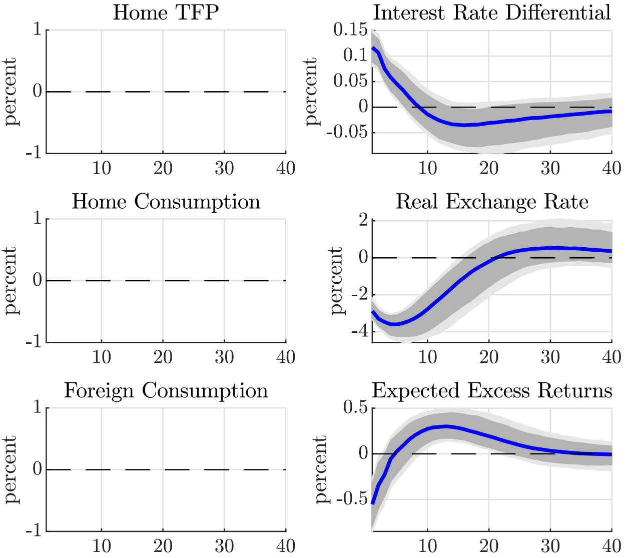

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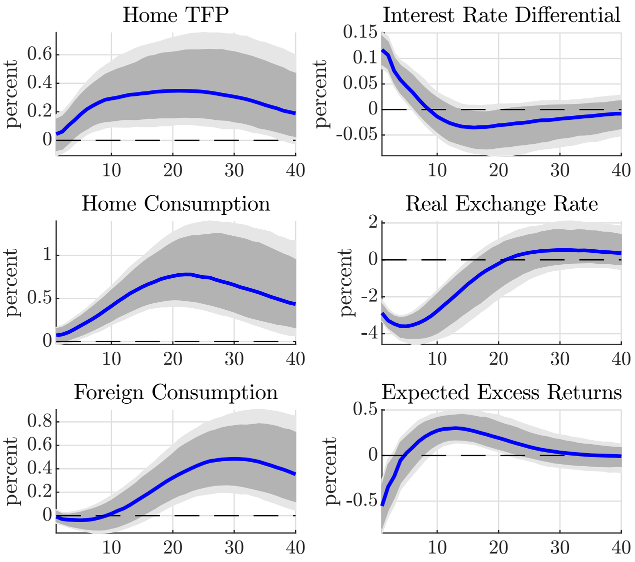

First Conclusions

- Strong link between current q and future f

Forecast Error 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**
Home Output	0.10	0.14	0.22	0.42	0.51	0.43
Foreign Output	0.10	0.07	0.08	0.19	0.34	0.33
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

- Where we define the expected currency return as standard:

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

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- Specifically, we see a link with future TFP

⇒ **Next:** directly identify disturbances to TFP and TFP expectations

Shocks to TFP and its expectations

Allow for general time series process for TFP a_t:

$$a_t = \sum_{k=0}^{\infty} \alpha_k \varepsilon^a_{t-k}$$

Basic idea: Agents have noisy information about future TFP innovations:

$$\mathbb{E}_t(\varepsilon^a_{t+k}) \neq 0$$

WLOG represent information as an arbitrary signal η_t of future ε^a_{t+k}

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

where $\varepsilon^a_t \perp \varepsilon^v_t$

Goal: separately identify disturbances to TFP ε^a_t and expectations ε^v_t

Shocks to TFP and its expectations

We follow the method of Chahrour and Jurado (2021). Some intuition:

- Imagine we have data on both a_t and η_t.
- Then we could represent their time series dynamics as

$$\begin{bmatrix} a_t \\ \eta_t \end{bmatrix} = A(L) \begin{bmatrix} \varepsilon_t^a \\ \varepsilon_t^v \end{bmatrix}$$

  where $A(L) = \sum_{-\infty}^{\infty} A_k L^k$ is a *two-sided* lag polynomial

- Under our null hypothesis we can impose following zero restrictions

$$\begin{bmatrix} a_t \\ \eta_t \end{bmatrix} = \cdots + \begin{bmatrix} 0 & 0 \\ * & 0 \end{bmatrix} \begin{bmatrix} \varepsilon_{t+1}^a \\ \varepsilon_{t+1}^v \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon_t^a \\ \varepsilon_t^v \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon_{t-1}^a \\ \varepsilon_{t-1}^v \end{bmatrix} + \cdots$$

  to separately identify ε_t^a and ε_t^v.

Shocks to TFP and its expectations

- In practice we do not have direct observations of η_t.
- This is where we can use the broader information set of our VAR
- Assuming information is reflected in agent decisions, then endogenous variables y_t are a function of future expected TFP innovations

$$y_t = \sum_{k=0}^{\infty} \gamma_k \varepsilon^a_{t-k} + \sum_{k=1}^{\infty} \chi_k \mathbb{E}_t(\varepsilon^a_{t+k})$$

- So the VAR, by including sufficient endogenous forward looking variables, will give us an estimate of the agent's forecast of future TFP innovations $\mathbb{E}_t(\varepsilon^a_{t+k})$
- We can then basically identify ε^a_t and ε^v_t from

$$\begin{bmatrix} a_t \\ \widehat{\mathbb{E}}_t(\varepsilon^a_{t+k}) \end{bmatrix} = \cdots + \begin{bmatrix} 0 & 0 \\ * & 0 \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t+1} \\ \varepsilon^v_{t+1} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t} \\ \varepsilon^v_{t} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t-1} \\ \varepsilon^v_{t-1} \end{bmatrix} + \cdots$$

Shocks to TFP and its expectations

In a nutshell

1. We use the estimated VAR to recover the Wold representation of TFP

$$a_t = \sum_{k=0}^{\infty} \alpha_k \varepsilon^a_{t-k}$$

this gives us an estimate of the TFP shocks ε^a_t

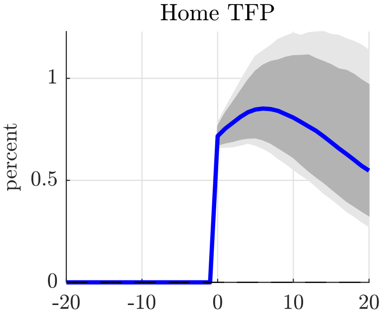
2. Given $\{\varepsilon^a_t\}$ we use the VAR-implied $\widehat{\mathbb{E}}_t(\varepsilon^a_{t+k})$ to extract $\{\varepsilon^v_t\}$

$$\{\varepsilon^v_t\} \equiv \{\widehat{\mathbb{E}}_t(\varepsilon^a_{t+k})\}_{t=0}^{T-k} \perp \{\varepsilon^a_t\}_{t=0}^{T}$$

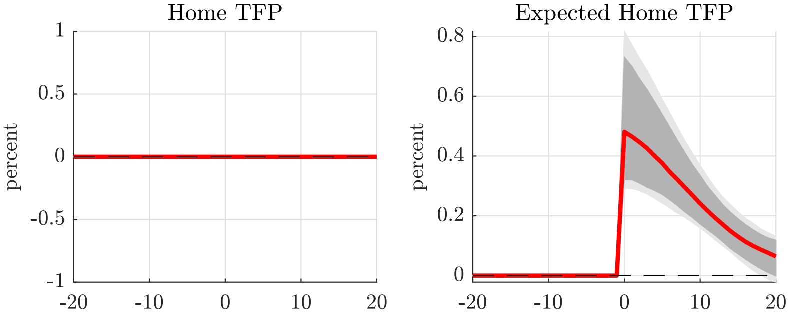
- Essentially, ε^v_t represents fluctuations in $\mathbb{E}_t(\varepsilon^a_{t+k})$ unrelated to any actual innovations to TFP past, current or future.
- For implementation, we choose $k = 20$ but results robust to choice of k

MA representation

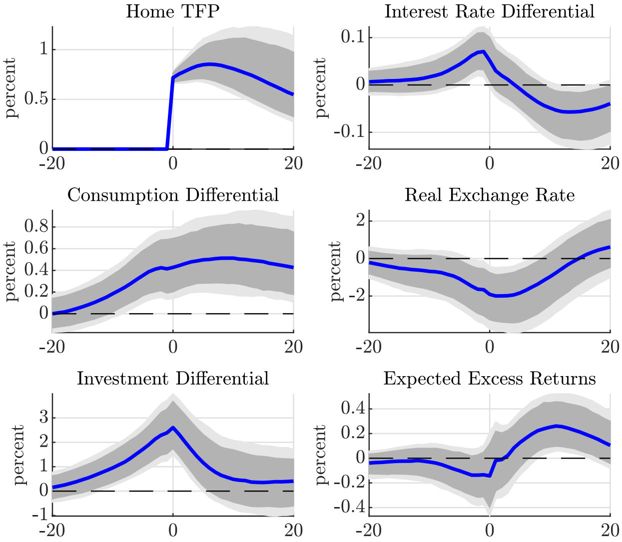
Conditional Dynamics – Technology (ε^a)



Conditional Dynamics – Expectation noise (ε^V)



Broader Impact– Technology (ε^a)



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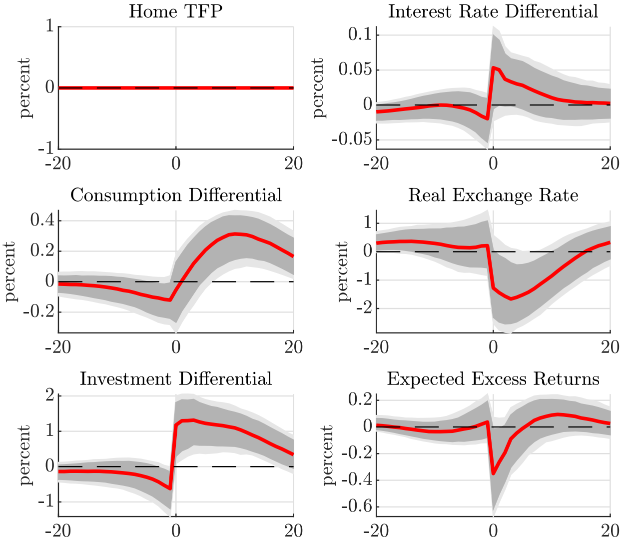


Variance Decomposition

- The rare shocks that drive *both* FX and international business cycles
  - A fundamental link between the exchange rate and the macroeconomy

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		
Quarterly Δq_t	0.30		

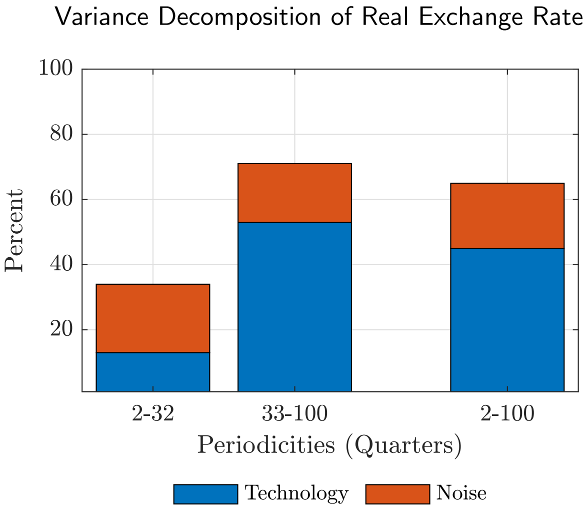
Variance Decomposition

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
Quarterly Δq_t	0.30	0.11	0.18

More on Role of Expectations

Noise Dominates at Higher Frequencies



Transmission Mechanism

- A natural hypothesis is that the news transmit to exchange rate through current and expected future interest rate differentials.
- Denote the excess currency return as

$$\lambda_{t+1} \equiv q_{t+1} - q_t + r_t^* - r_t$$

- Then, a standard decomposition of the real exchange rate gives us:

$$q_t = \underbrace{-\sum_{k=0}^{\infty} \mathbb{E}_t(r_{t+k} - r_{t+k}^*)}_{\equiv q_t^{UIP}} \underbrace{- \sum_{k=0}^{\infty} \mathbb{E}_t(\lambda_{t+k+1})}_{\equiv q_t^{\lambda}}$$

Transmission Mechanism

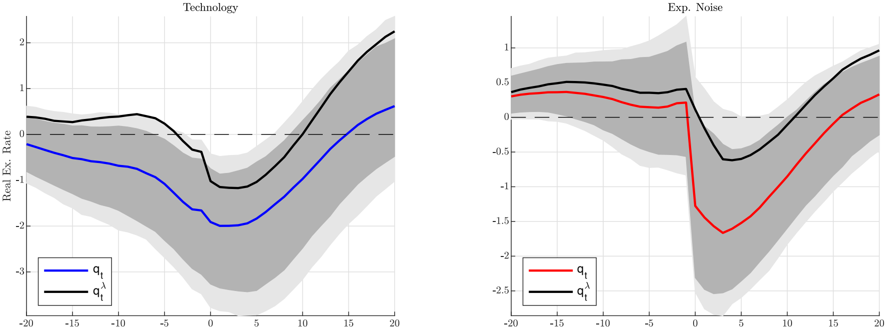
$$q_t = q_t^{UIP} + q_t^{\lambda}$$

- We want to know whether q_t^{λ} plays an important role in the transmission of the noisy news shocks we have identified
  - This would be informative about underlying equilibrium model
- This is not an orthogonal decomposition, but still

$$Var(q_t) = Cov(q_t, q_t^{UIP}) + Cov(q_t, q_t^{\lambda})$$

	Both shocks		Tech shocks		Noise shocks	
	q_t^{UIP}	q_t^{λ}	q_t^{UIP}	q_t^{λ}	q_t^{UIP}	q_t^{λ}
$\frac{Cov(q_t, q^i)}{Var(q_t)}$	-0.02	1.02	-0.02	1.02	0.05	0.95
$\frac{Cov(\Delta q_t, \Delta q^i)}{Var(\Delta q_t)}$	0.14	0.86	-0.16	1.16	0.43	0.57

Impulse responses: q_t^{UIP} vs q_t^{λ}



Common driver to FX puzzles

- Conditional dynamics also exhibit all famous exchange rate puzzles, suggesting a **common fundamental origin**
- Let us delve into the puzzles one at a time.
- Consider first deviations from Uncovered Interest Parity

$$\mathbb{E}_t(\underbrace{q_{t+1} - q_t + r_t^* - r_t}_{=\lambda_{t+1}}) = 0$$

1. On the one hand, ε_t^a and ε_t^v account for 50% of $Var(\mathbb{E}_t(\lambda_{t+1}))$.
2. On the other, we can also consider traditional UIP tests

$$\lambda_{t+1} = \alpha_{UIP} + \beta_{UIP}(r_t - r_t^*) + \varepsilon_{t+1}$$

$$\sum_{k=0}^{\infty} \mathbb{E}_t(\lambda_{t+k+1}) = \alpha_\Lambda + \beta_\Lambda(r_t - r_t^*) + \varepsilon_t$$

UIP deviations

	Uncondi-tional	Both	Technology	Exp. Noise
β_{UIP}	-2.46	-2.20		
$\text{Cov}(\lambda_{t+1}, r_t - r_t^*)$	-1.26	-0.82		
β_Λ	2.53	2.62		
$\text{Cov}(\sum_{k=0}^{\infty} \lambda_{t+k+1}, r_t - r_t^*)$	1.08	0.60		

UIP deviations

	Unconditional	Both	Technology	Exp. Noise
β_{UIP}	-2.46	-2.20	-2.08	-2.96
$\mathrm{Cov}(\lambda_{t+1}, r_t - r_t^*)$	-1.26	-0.82	-0.68	-0.14
β_Λ	2.53	2.62	2.33	1.72
$\mathrm{Cov}(\sum_{k=0}^{\infty} \lambda_{t+k+1}, r_t - r_t^*)$	1.08	0.60	0.54	0.06

Risk-sharing (Backus-Smith 93)

- An enduring puzzle is the mildly negative $corr(\Delta q_t, \Delta c_t - \Delta c_t^*)$
  - Debate in the literature if it is driven by "supply" or "demand" shocks
  - Our results can shed light on likely mechanism

	Unconditional	Both	Technology	Exp. Noise
$corr(\Delta q_t, \Delta(c_t - c_t^\star))$	-0.27	-0.35	-0.31	-0.38
$\text{Cov}(\Delta q_t, \Delta(c_t - c_t^\star))$	- 0.7	-0.28	-0.10	-0.18
$\text{Cov}(\Delta q_t^\lambda, \Delta(c_t - c_t^\star))$	- 0.49	-0.24	-0.13	-0.11

- We can decompose our effects based on fluctuations driven by *expectations* $\mathbb{E}_t(\varepsilon^a_{t+k})$ and those on realized (current and past) ε^a_{t-k}
  - $\text{Cov}(\Delta q_t, \Delta(c_t - c_t^\star)|\mathbb{E}_t(\varepsilon^a_{t+k})) = -0.22$
  - 80% of effects of our two shocks in "anticipation" phase, hence akin to "demand" shocks

Excess volatility and persistence

- The response of q_t is highly persistent in response to both shocks
- Excess volatility of exchange rate largely due to expectational noise

	Unconditional	Both	Technology	Exp. Noise
$autocorr(\Delta q_t)$	0.29	0.58	0.90	0.33
$autocorr(\Delta q_t^{\lambda})$	0.73	0.60	0.80	0.42
$\sigma(\Delta q_t)/\sigma(r_t - r_t^{\star})$	5.88	4.00	2.70	7.69
$\sigma(\Delta q_t)/\sigma(\Delta c_t)$	6.05	5.65	3.99	8.14
$\sigma(\Delta q_t^{\lambda})/\sigma(\Delta c_t)$	7.30	6.58	5.82	7.74

Common fundamental origin to FX Puzzles

Noisy news to TFP are primarily transmitted to q_t via UIP deviations

- In turn, the resulting volatile dynamics in $\mathbb{E}_t(\lambda_{t+1})$ also generate other famous puzzles such as Backus-Smith and excess volatility

⇒ common, fundamental origin of FX puzzles as modulated by fluctuations in currency excess returns due to noisy news about TFP

Echoes theoretical results emphasizing UIP wedge (Itskhoki&Mukhin 22)

However, our results are more specific and imply that

- UIP wedge fluctuations endogenous to noisy news about future TFP

Important about models, shifts focus back to TFP-driven mechanisms

- But driven by medium-to-long-run news, not surprises
- Lends support for "long-run risk" models a-la Colacito-Croce (2013)

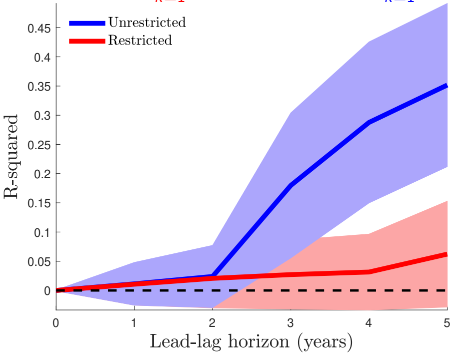
Discussion

- What is they key empirical regularity underlying our results?
  - In practice, TFP is virtually a random walk. Hence,

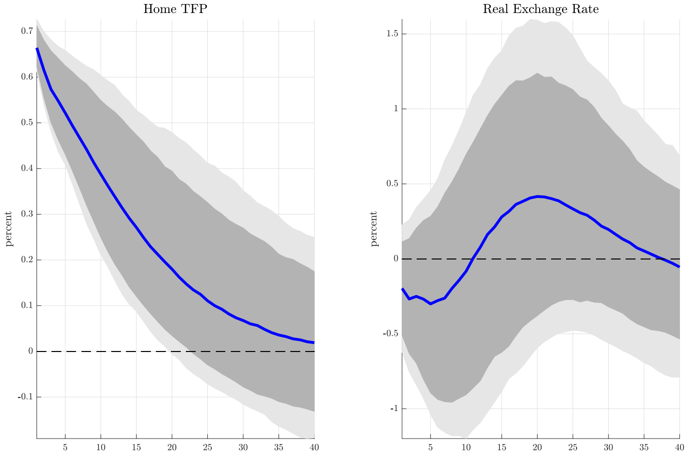
$$\varepsilon_t^a \approx \ln(a_t) - \ln(a_{t-1})$$

  - A simple, partial version of our VAR exercise is

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



Discussion – Cholesky TFP



- Cholesky-identified TFP shock assumed ε_t^a is complete surprise
  - Surprise-TFP shocks have no impact on q_t

Discussion – other shocks

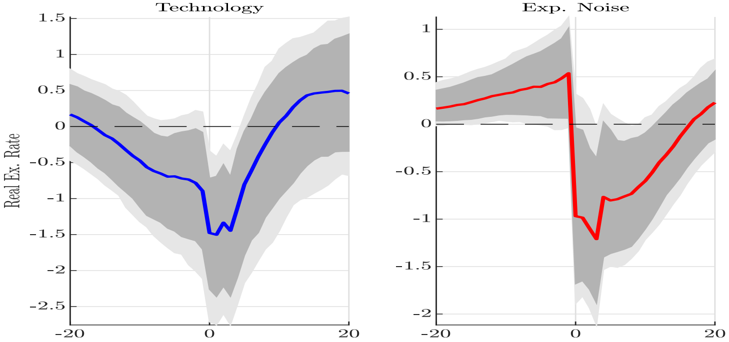
- Our basic result shows q_t is strongly related to fluctuations in TFP expectations
- Assuming TFP innovations are exogenous, we can interpret our results as driven by noisy-news about TFP
- A potential concern: endogenous TFP growth, driven by confounding shock which has its own, direct and separate impact on q_t
  - R&D productivity shocks – essentially a type of "news" shock anyways
  - Monetary policy shocks – possible only if *contractionary* monetary shocks spur R&D activity and future TFP growth

Correlation between Technology, Noise and Other Economic Shocks

	Technology	Exp. Noise
U.S. Monetary Policy Shocks	0.09	0.06
	p-value $= 0.46$	*p-value* $= 0.62$

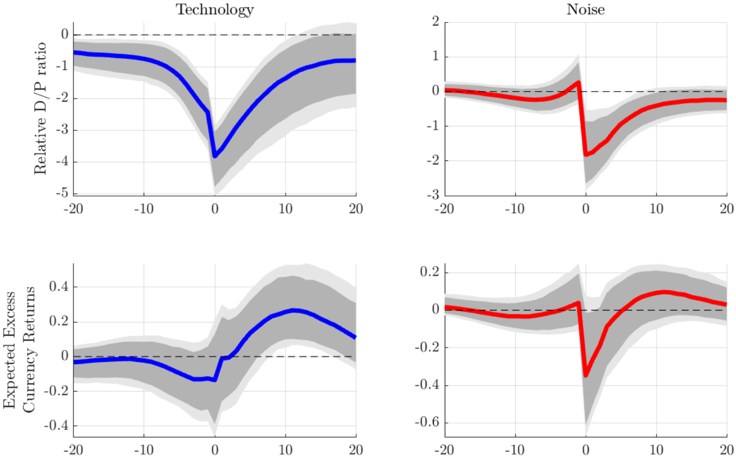
Discussion – noise shocks in q_t

- A related concern is that we are picking up Itskhoki-Mukhin(2021) style currency-specific shocks, since q_t is part of the forecast $\mathbb{E}_t(\varepsilon^a_{t+k})$
- We redo our analysis dropping q_t from the VAR set
  - Extracted shocks correlation is 0.99



Discussion – q_t and stock prices

- If we are truly capturing news about future TFP, then those should be reflected in other asset prices, such as stock prices
- Indeed, they are



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
- R&D Expenditures R&D
- Correlation with monetary shocks Monetary shocks
- Results without FX in VAR No FX

Conclusion

- Exchange rates are connected to macro fundamentals!
  - Noisy news about future TFP are the rare structural shocks that drive all of q_t, macro aggregates and stock prices
- Exchange rate puzzles have a common, fundamental origin
  - puzzles connected with each other via volatile, endogenous UIP wedge
- Moving forward: how do we model all of this?
  - Rich and precise set of results that sharply discriminate across models
  - Intuitively consistent with long-run risk style of models. Shifts focus back to fundamental mechanisms, deeply connected to macroeconomy
  - But more work remains to be done
    - e.g. excess currency returns fluctuate significantly *after* TFP improvement, not just before

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:

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

Anticipated vs surprise in fundamentals

- Our empirical procedure allows us to identify the following representation of the exchange rate

$$q_t|\{\varepsilon_t^a, \varepsilon_t^v\} = \sum_{k=-\infty}^{\infty} \zeta_k^q \varepsilon_{t+k}^a + \sum_{k=0}^{\infty} \zeta_k^v \varepsilon_{t-k}^v$$

$$= \underbrace{\sum_{k=1}^{\infty} \zeta_k^q \varepsilon_{t+k}^a + \sum_{k=0}^{\infty} \zeta_k^v \varepsilon_{t-k}^v}_{\text{Forward-looking/expectational comp}} + \sum_{k=0}^{\infty} \zeta_k^q \varepsilon_{t-k}^a$$

Var Decomposition: Forward-looking vs backward-looking components

	Fwd-looking	Bkwd-looking
q_t	0.29	0.71
Δq_t	0.69	00.31

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:

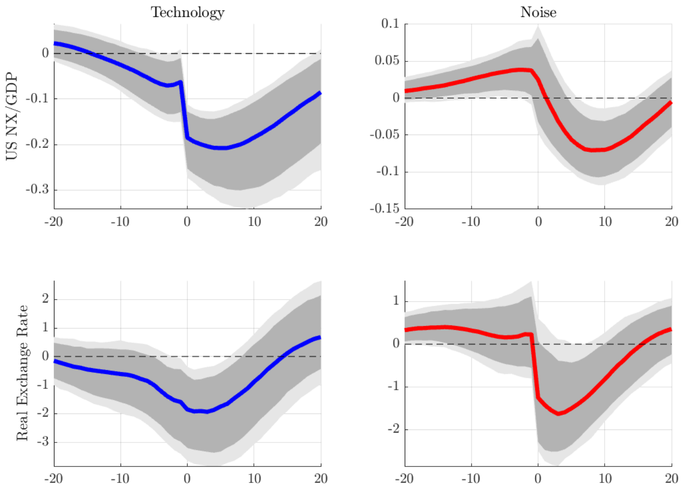
$$\begin{bmatrix} a_t \\ \eta_t \end{bmatrix} = \cdots + \begin{bmatrix} 0 & 0 \\ * & 0 \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t+1} \\ \varepsilon^v_{t+1} \end{bmatrix} + \begin{bmatrix} * & 0 \\ * & * \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t} \\ \varepsilon^v_{t} \end{bmatrix} + \begin{bmatrix}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

Compare to Cholesky:

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

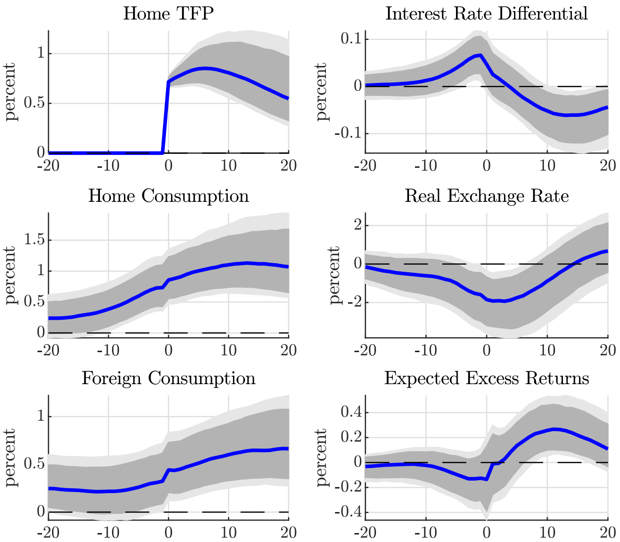
Return

Trade Balance and Exchange Rate

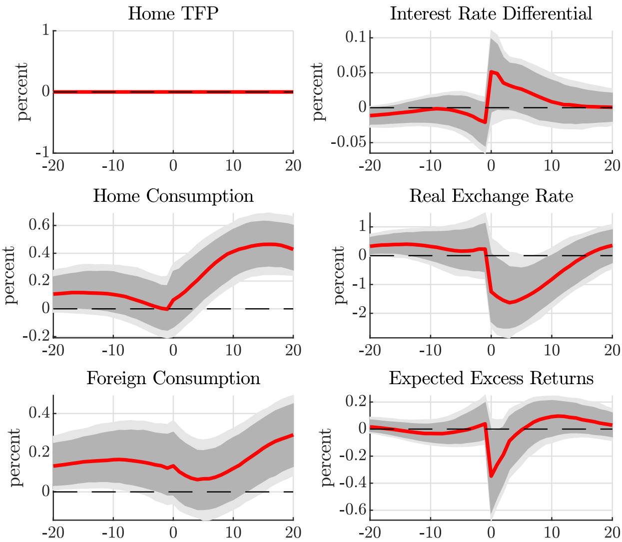


Return

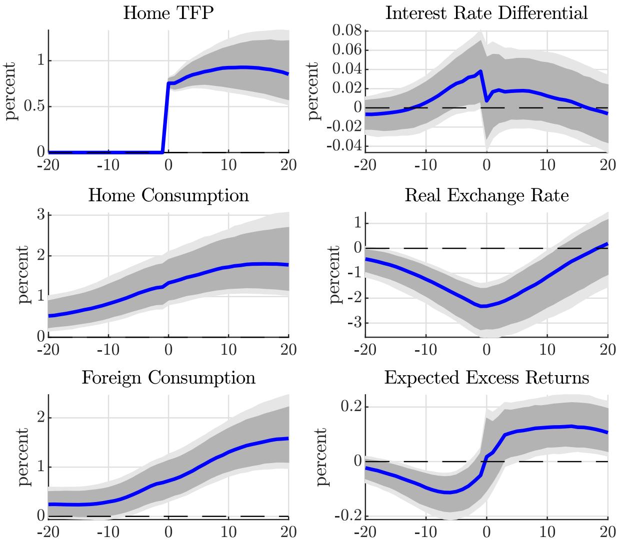
Conditional Dynamics – Technology (ε^a) – Extended Sample



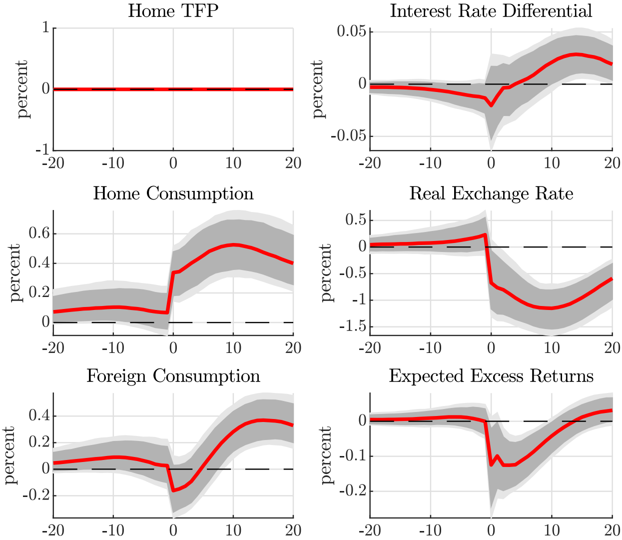
Conditional Dynamics – Expectational noise (ε^v)– Extended Sample



Conditional Dynamics – Technology (ε^a) – Canada

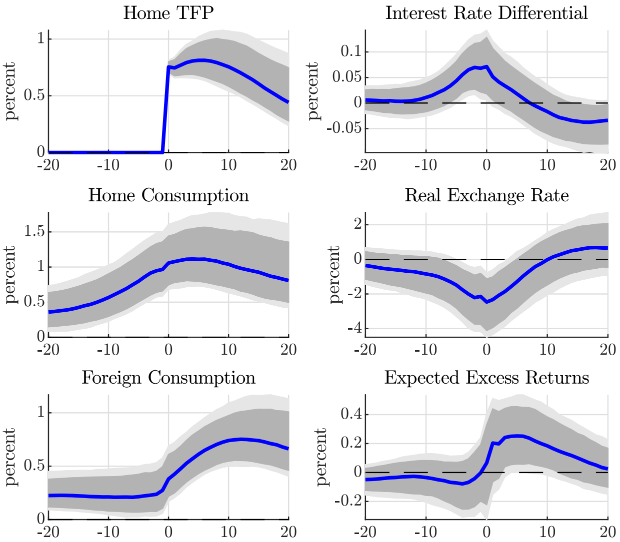


Conditional Dynamics – Expectational noise (ε^v)– Canada

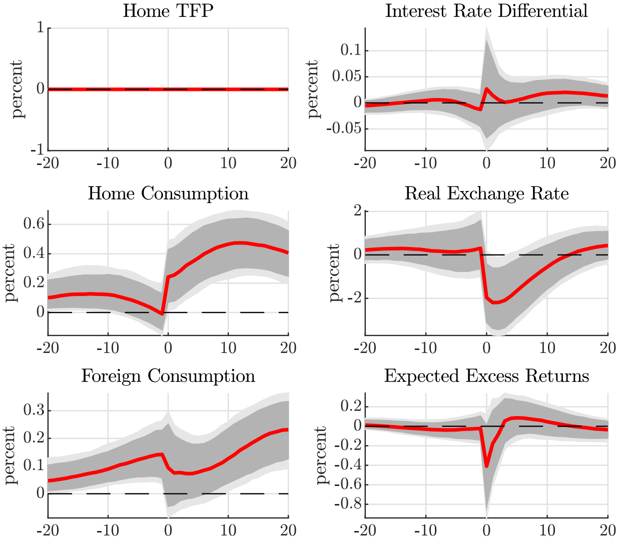


Return

Conditional Dynamics – Technology (ε^a) – France



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



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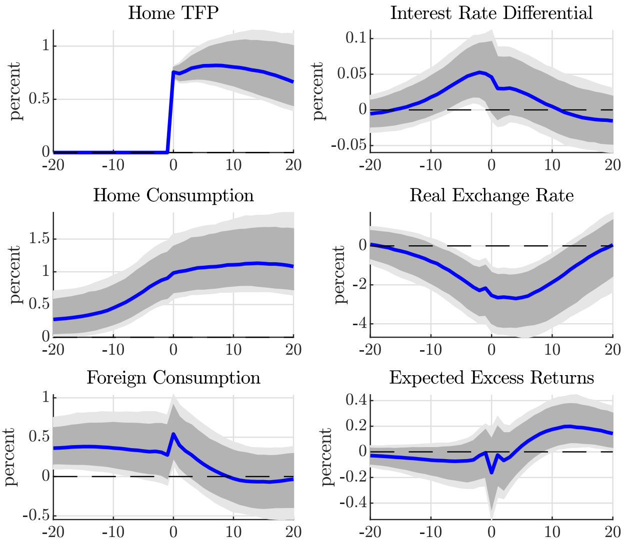
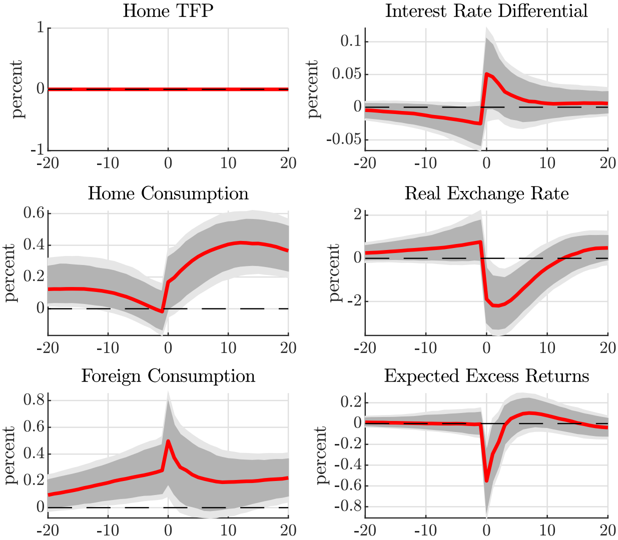
Conditional Dynamics – Technology (ε^a) – Germany



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



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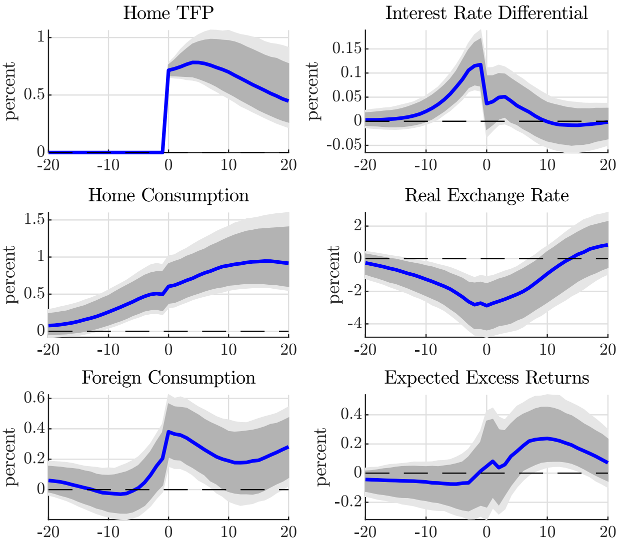
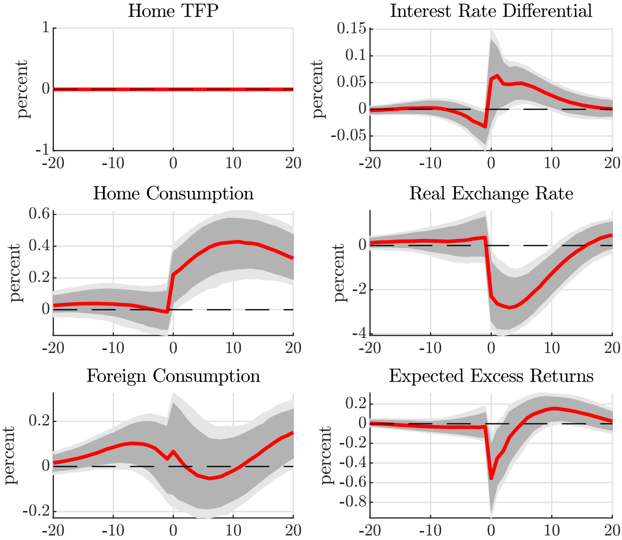
Conditional Dynamics – Technology (ε^a) – Italy



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



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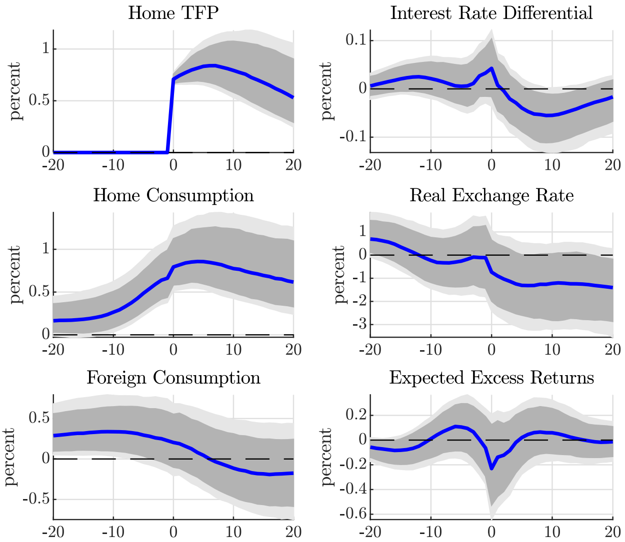
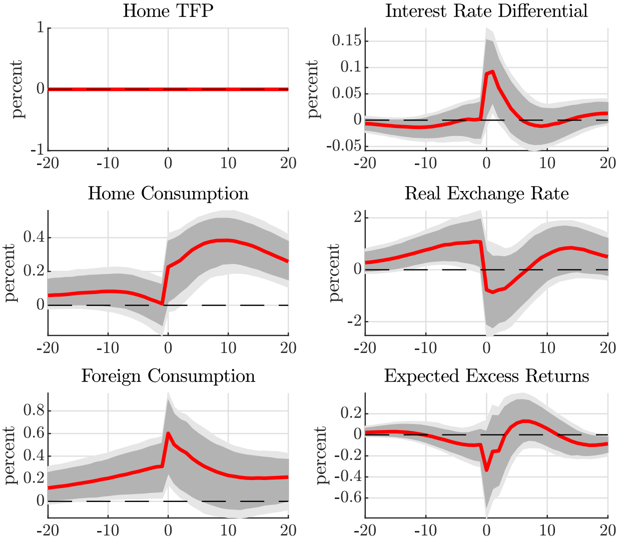
Conditional Dynamics – Technology (ε^a) – Japan



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



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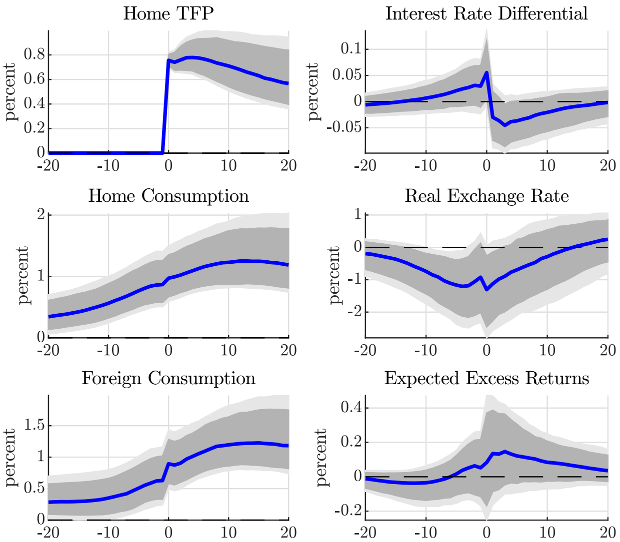
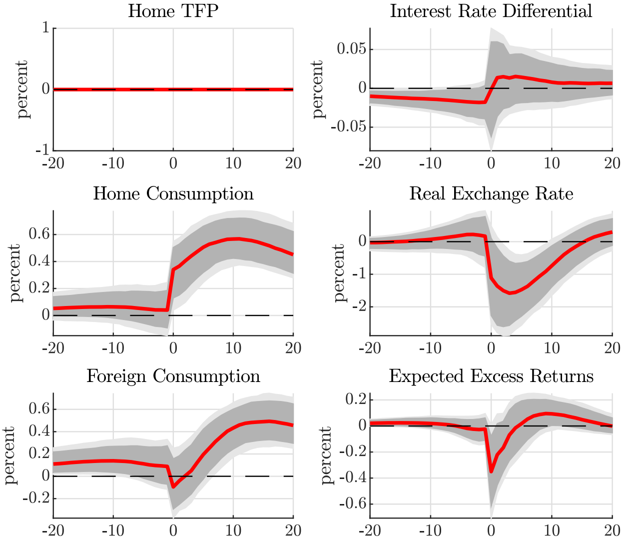
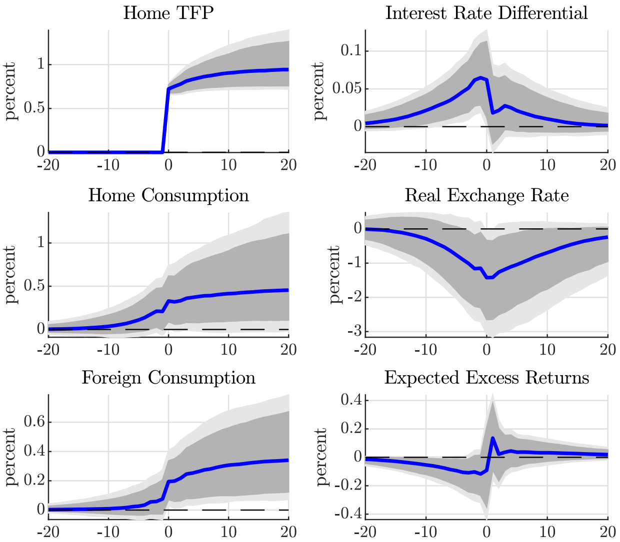
Conditional Dynamics – Technology (ε^a) – United Kingdom



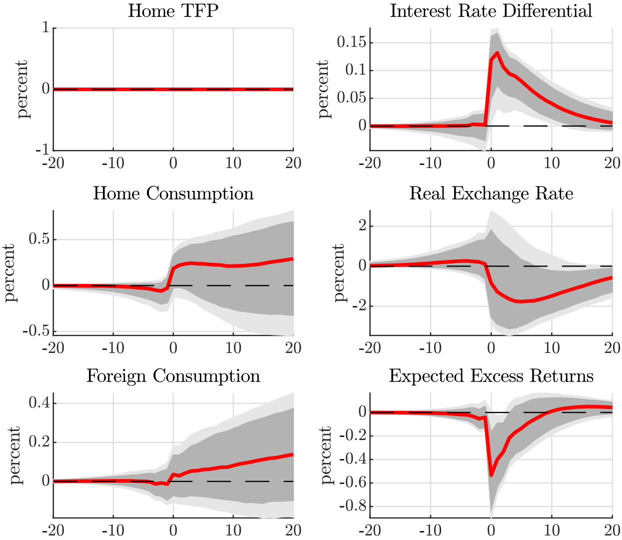
Conditional Dynamics – Expectational noise (ε^{v})– United Kingdom



Conditional Dynamics – Technology (ε^a) – VECM

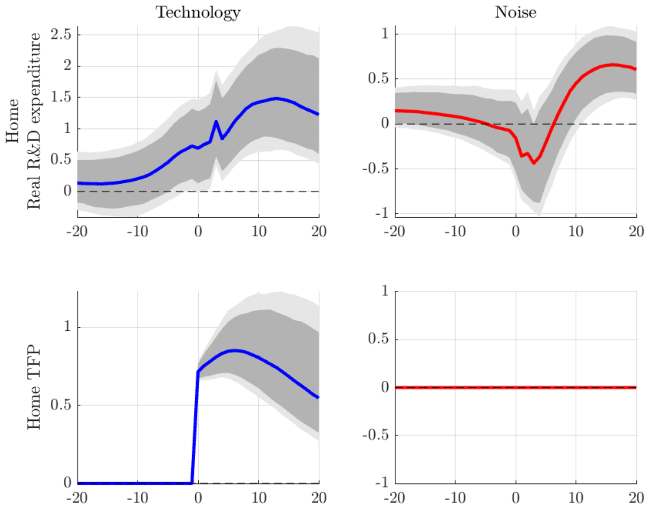


Conditional Dynamics – Expectational noise (ε^v)– VECM



Return

Conditional Dynamics – R&D Expenditure



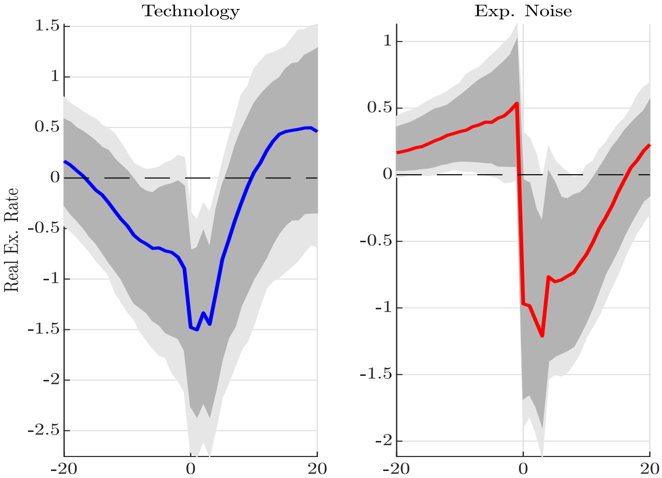
Correlation with monetary policy shocks

Correlation between Technology, Noise and Other Economic Shocks

	Technology	Exp. Noise
U.S. Monetary Policy Shocks	0.09	0.06
	p-value $= 0.46$	*p-value* $= 0.62$

Return

Conditional Dynamics – no FX in VAR



Return