Interest Rates, Global Risk and Inflation Expectations: Drivers of US Dollar Exchange Rates

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Motivation (1)

- Given the dominance of the USD in trade invoicing, asset issuance, and official reserve holdings worldwide, understanding the drivers of the USD FX-rate is of great importance.
- However, despite the large number of studies analysing driving factors of USD FX-rates, the evidence is far from conclusive → difficult to find economic variables that strongly co-move (i.e. the exchange rate disconnect puzzle).
- Empirical inconclusiveness may be result of omitted factors → next to monetary policy also other factors impact the USD FX rate.

Motivation (2)

I. Sizable share in FX rate movements is explained by a global factor closely related with global risk: *e.g. Lustig et al. (2011), Krishmanurthy & Lustig (2019), Georgiadis et al. (2023).*

II. Temporary and persistent monetary shocks have unique effects on FX-rates: *e.g. Schmitt-Grohe & Uribe (2021), Uribe (2022).*

III. Also US fiscal policy matters for fluctuations in the US dollar exchange rate; *e.g., Jiang (2021)*

Motivation (3)

- To our knowledge, no paper has simultaneously considered interest rates, global risk and inflation expectations to explain US Dollar exchange rate movements.
- **Objective of this paper:** We apply non-Gaussian identification that allows to account the complex interactions within the triplet of interest rates, exchange rates, and inflation expectations.

Data and Methodology

I. Data:

- Domestic economy: USA
- 8 foreign advanced economies (AE): Australia, Canada, Germany, Japan, New Zealand, Sweden, Switzerland, United Kingdom
- Sample size 1980M1-2022M11

II. For each of the eight AE, we estimate a country specific VAR model containing the following variables:

- i_t, US Treasury yield 1Y
- s_t bilateral nominal FX Rate against the USD ($\uparrow$ appreciation of the USD)
- π_t^e US 10Y Inflation Expectations (CPI inflation over the next 10 years, SPF)

Reduced and structural form

$$y_t = \nu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t, \quad (1)$$

$$= \nu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + D\varepsilon_t,\ t = 1, 2, ..., T \quad (2)$$

- Endogenous variables: $y_t = (\Delta i_t, \Delta s_t, \Delta \pi_t^e)'$.
- ν intercepts, $A_1, A_2, \ldots, A_p$: $K \times K$ parameter matrices.
- u_t is serially uncorrelated, has mean zero and covariance Σ_u.
- Reduced form parameters and the residuals u_t can be estimated consistently by OLS or ML estimation

Identification of the structural relation

- Core interest lies in the identification of structural shocks ε_t:

$$\varepsilon_t = D^{-1} u_t \tag{3}$$

- with $DD' = \Sigma_u$, D is non-singular.
- **Identification problem in a Gaussian framework**: The matrix D has several possible solutions and requires external information for a unique identification *(Sims (1980))*
- **Comon (1994)** shows that a unique recovery of D is possible in non-Gaussian systems, if...
  - (i) at most one of the elements of ε_{it} exhibits a Gaussian distribution
  - (ii) components of ε_{it} are mutually independent.

→ Choose the matrix D that minimizes the joint dependence among the implied shocks $\varepsilon_t = D^{-1} u_t$ through a numerical or analytical solution.

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Shock labelling

- **US Interest Rate (IR) Shock**: Innovation to the short-term US nominal interest rate (*i.e. aggregation of US monetary and natural rate shocks, e.g., Mueller et al. (2020)*).
- **External Shock**: Innovations in the bilateral FX rates against the US dollar. *(Related to global risk, e.g., Cormun and De Leo (2020))*.
- **US Inflation expectations (IE) Shock**: Innovations to US long-run inflation expectations. *(Signif. related to the fiscal authorities credibility to repay debt, e.g., Cochrane (2023), Herwartz, Trienens (2024))*.

Shock labelling - effect patterns

- Caveat of purely statistical identification procedures: It is not given that these shocks are also economically meaningful.
- To assure that the identified shocks correspond to economic shocks (i.e. IR shock, external shock and a IE shock):
  - Cross check with theoretical sign patterns derived from extensive literature review.
  - Test, whether we find qualitatively similar D matrices for the set of 8 country-specific SVAR estimations, i.e. correlation of US IR and IE shock should be high.

Shock identification

- Expected sign patterns derived from literature review:

Variables	US IR Shock	External	US IE Shock
i_t	$+$	$-$	?
s_t	?	$+$	?
π_t^*	?	$0/-$	$+$

- Sign frequencies of estimated shock responses over the cross section:

	Within one quarter $(h = 0, 1, 2, 3)$		
	US IR shock	External shock	US IE shock
i_t	$+(8) - (0)$	$+(1) - (7)$	$+(8) - (0)$
s_t	$+(7) - (1)$	$+(8) - (0)$	$+(0) - (8)$
π_t^e	$+(8) - (0)$	$+(0) - (8)$	$+(8) - (0)$

$\rightarrow$ Sign of of estimated effect directions almost common for entire cross section and broadly in line with expectations.

US IE shocks and fiscal credibility

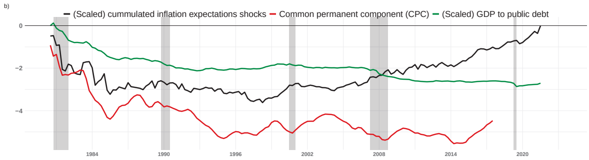
- **How can we interpret the shocks to US long-run inflation expectations?**
- Literature suggest that long-term inflation expectations are related to fiscal policy.
- Fiscal sustainability concerns drive inflation expectations (Cochrane, 2023; Herwartz & Trienens, 2024; Bianchi et al., 2023).

  ⇒ Analysis of the relationship between our inflation expectation shock and two conventional measures of fiscal sustainability:

  - Common permanent component in yields and inflation (CPC) (Uribe, 2022)
  - Sovereign debt to GDP ratio.

US IE shocks and fiscal credibility

Figure: Cumulated IE shocks, the CPC and the (rescaled) GDP to debt ratio



- Non-cumulated US IE shocks and CPC changes correlate with about 0.3, which is above the significance criterion of $2/\sqrt{T}$.

$\rightarrow$ Identified US IE shocks inform about a change in the fiscal authority's credibility to repay debt.

Non-cumulated

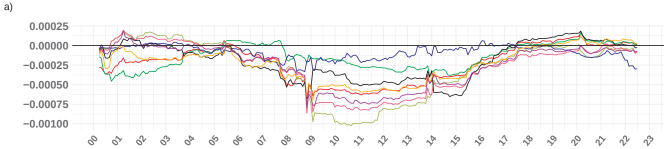
External shocks and global risk

- **How can we interpret the external shock/US dollar exchange rate shock?**
- The literature suggest that unexpected shifts in the US Dollar exchange rate can be attributed to investors risk aversion:
  - Important drivers of fluctuations in US dollar exchange rates are shifts in the demand and supply of safe dollar assets *(e.g. Krishnamurthy & Lustig (2019))*.
  - The average US Treasury basis against G-10 economies proxies the so-called convenience yield that investors are willing to pay for liquidity and safety.
  - When global risk aversion decreases, the convenience yield of US dollar assets rises as a compensation for international investors.

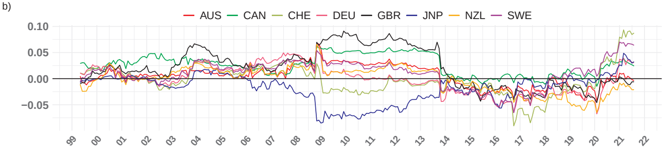
Treasury basis

External shocks and global risk

Rolling regression coefficients US dollar convenience yield and external shocks:

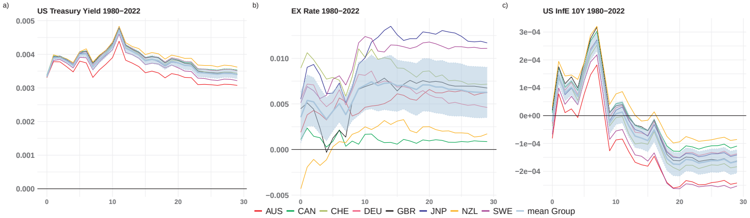


Rolling regression coefficients between VXO S&P 100 Volatility Index and external shocks:



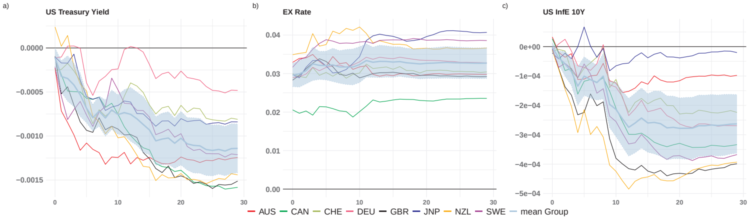
- Especially during crises periods, our identified external shocks are significantly related to a conventional proxy for global risk aversion.

Mean group results - Interest rate shock



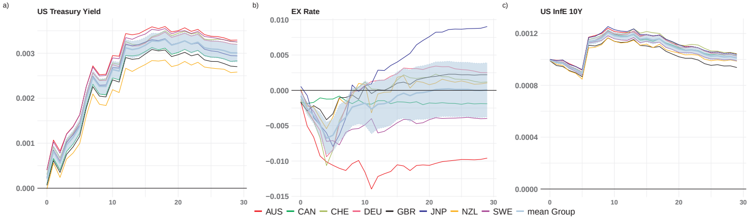
- Shaded areas show 'overall' significance in terms of mean group criteria.
- US Dollar FX rate appreciates in the first months and slowly depreciates thereafter → confirm often observed 'delayed overshooting' result *(Eichenbaum, Evans (1995))*.
- US inflation expectations (10Y) initially rise and then decline. The initial rise indicates that markets need time to learn if the shock is a monetary or natural rate shock (*Nakamura, Steinsson (2018), Müller et al. (2024)*).

Mean group results - External shock



- Recall: External shock associated with a decline in global risk aversion.
- This decline creates downward pressure on short-term yields.
- US inflation expectations (10Y) persistently decline, indicating expectations of a weakening economic outlook and disinflation *(Orlowski, Soper (2019))*

Mean group results - US IE shock



- Recall: Shock to long-term IE associated with fiscal authority's credibility to stabilize large debt.
- US short term yields rise in the first 12 months, indicating active monetary policies, on average *(Cieslack et al (2021); Herwartz, Trienens (2024))*.
- The USD significantly depreciates in the subsequent months confirming *Jiang (2021)* and *Schmitt-Grohé, Uribe (2022)*.

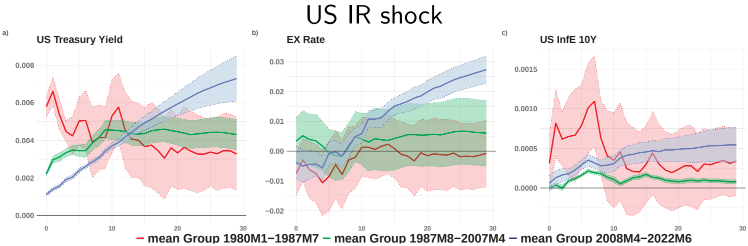
Robustness - The Volcker, pre- and post-GFC periods

- Evidence in the literature that response of interest rates, FX-rates, and inflation to macro-shocks depends on sample period:
  - Herwartz, Trienens (2024): Interest rate responses to US IE shock depend on the monetary stance perceived by households.
  - Kim et al. (2017): Delayed overshooting of FX-rates after monetary policy shocks predominantly phenomena of 1980s.
  - Bernoth et al. (2022): Structural break in the size of US Dollar excess returns with the onset of the Global Financial Crisis (GFC).

$\rightarrow$ Divide our dataset into three subsamples:

  - Volcker period: 1980M1 to 1987M6
  - Pre-crisis period: 1988M7 to 2007M4
  - Post-crisis period: 2008M4 to 2021M12

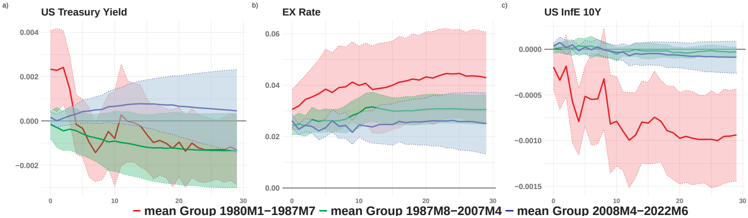
Robustness - The Volcker, pre- and post-GFC periods



- During the Volcker and pre-crisis periods, the US Dollar FX rate responds insignificantly.
- Plausible explanation: Interest rate shock reflects both, monetary policy shock (↑) and a natural rate shock (↓) (Mueller et al, 2024).
- In the post-crisis period, the US Dollar appreciates → interest rate shock dominated by monetary policy shock.

Robustness - The Volcker, pre- and post-GFC periods

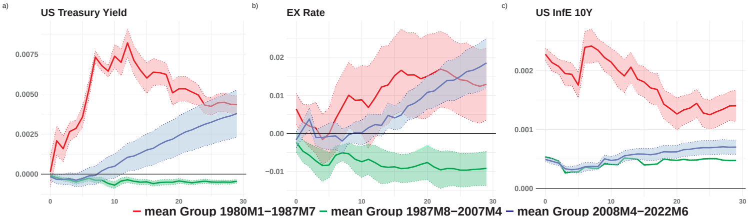
External shock



- Inflation expectations decline in response to external shock only during the Volcker period, which was characterized by strong disinflationary pressures.
- In line with Orlowski and Soper (2019):
  - Impact of global risk on inflation expectations is negative in a deflationary environment, and neutral when inflation is close to target.
  - US inflation expectations (5Y, 10Y) are unresponsive after a change in global risk from 2003 to 2007, decline from 2008 to 2012, and experience a muted decline from 2011 to 2019.

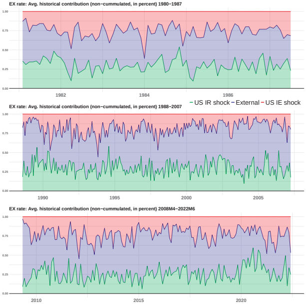
Robustness - The Volcker, pre- and post-GFC periods

US IE shock



- During the Volcker- and post-crisis period, US short-term yields respond positively to shocks to inflation expectations and US Dollar appreciates. $\rightarrow$ Indication for active monetary policies.
- In pre-crisis period, US interest rates decline and the USD depreciates $\rightarrow$ Indication for passive monetary policies.

Sub-samples avg. historical decomposition of exchange rate changes, 1980M1-2022M6



- Most studies focus on monetary, or one of the other two factors to explain exchange rate movements.
- By looking simultaneously at these drivers, we find that all three shocks analyzed are of equal importance.
- The impact of external shocks increases over time, highlighting the growing role of the US dollar in global safety demand (*Krishnamurthy, Lustig (2019)*).

Conclusion

- The USD FX rate is determined not only by monetary policy, but also inflation expectations and global risk aversion.
    - A contractionary interest rate shock leads to an appreciation of the US Dollar.
    - An external shock, which is the most influential driver, leads to an immediate appreciation of the US Dollar that persists in the following months.
    - A positive inflation expectations shock, associated with e.g. an uncovered fiscal spending shock, leads to a depreciation of the US Dollar.
- The design of the monetary reaction function influences the response of interest rates, but also affects the response of the US Dollar FX rate to shocks to inflation expectations.
- The growing relevance of external shocks reflects the growing role of the US Dollar in global safety demand.
- Our results could help solve the exchange rate disconnect puzzle and shed light on the optimal design of monetary policy.

Thank you for your attention!

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Independent component Analysis

- We use rotation matrices that structure the space of potential decompositions of the reduced form residual covariance estimates $\widehat{\Sigma}_u = G R_\theta R_\theta' G' = \widetilde{D}_\theta \widetilde{D}_\theta'$,
- G is a lower triangular Cholesky factor of $\widehat{\Sigma}_u$ and $R_\theta R_\theta'$ is the identity matrix.
- Hence, $\widehat{D} = G R_{\hat{\theta}}$. With $K = 3$, the rotation matrices are specified as the product of three Givens rotation matrices, i.e.

$$R_\theta = \begin{pmatrix} \cos\theta_1 & -\sin\theta_1 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos\theta_2 & 0 & -\sin\theta_2 \\ 0 & 1 & 0 \\ \sin\theta_2 & 0 & \cos\theta_2 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_3 & -\sin\theta_3 \\ 0 & \sin\theta_3 & \cos\theta_3 \end{pmatrix}.$$

- From a brute force perspective, we check the dependence between the shocks for any possible combination of θ_1, θ_2, θ_3 with $0 < \theta_i < \pi/2$, selecting the rotation where the three shocks are least dependent.
- The minimization of our mutual dependence criterion can be achieved by means of nonlinear optimization.

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Fiscal theory with sticky prices and rational expectations

- Fiscal theory focuses on fiscal shocks without a change in monetary policy, and vice versa (Cochrane (2023))
- Such uncoordinated changes in fiscal and monetary policies foster violations in the intertemporal government budget constraint (BCVs), which reads as

$$\frac{B_t}{P_t} = T_t - G_t + \frac{(T_{t+1} - G_{t+1})}{(1 + i_{t+1} - \pi_{t+1})} + \frac{(T_{t+2} - G_{t+2})}{(1 + i_{t+1} - \pi_{t+1})(1 + i_{t+2} - \pi_{t+2})} + \cdots + \frac{(T_{t+\infty} - G_{t+\infty})}{(1 + r_{t+1}) \ldots (1 + r^*)} \quad (4)$$

- The nature of inflation is to revert BCVs. When price rigidities exist, this adjustment pricess is likely to drive trend inflation (Bianchi et al. (2023))
- Fiscal theory centers on the Fisherian prediction that real yields are unresponsive in the long-run
- The Fisher effect creates a common permanent component in interest rates and inflation (CPC). Changes in the CPC align with persistent monetary shocks/ inflation targeting shocks (Uribe (2022)).
- Changes in the CPC correspond to the inflation concept of fiscal theory and occur to revert budget violations (*Herwartz, Trienens (2024)*)

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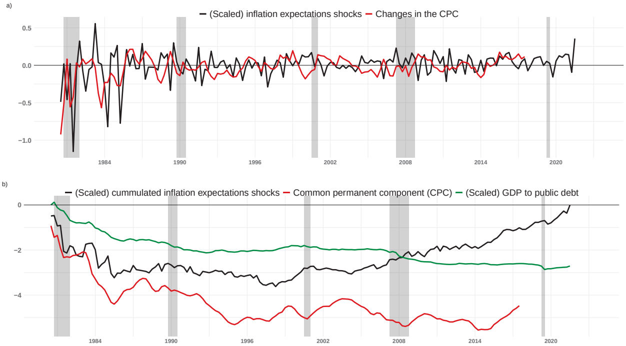
Structural innovations of US IE shocks

Figure: IE shocks, the CPC and the (rescaled) inverse DtGDP ratio



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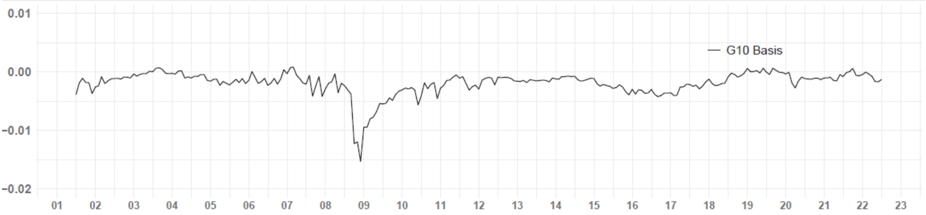
The convenience yield channel and the treasury basis

The bilateral US Treasury basis against the British pound, TB_t, is defined as:

$$TB_t = y_t^{\$,n} - \left(y_t^{£,n} - \left(f_t^{£/\$,n} - s_t^{£/\$}\right)\right) \quad (5)$$

- $y_t^{\$,n}$: cash position in US bonds, $y_t^{£,n}$: cash position in UK bonds.
- $f_t^{£/\$,n}$: forward rate with horizon n, $s_t^{£/\$}$: spot exchange rate in foreign currency to US dollars.
- Finally, we aggregate and average the bilateral US Treasury basis against the single G10 economies with a horizon of 12 months.



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