# Predicting risk premia in interest rates and exchange rates

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# Linking risk premia in interest rate and exchange rates

Theoretical link between interest rates and exchange rates: UIP

- Standard UIP: Low (high) interest rate currencies to appreciate (depreciate)
  - ★ NOT TRUE (Bilson, 1981; Fama, 1984; Chinn and Meredith, 2004)
- Forward-iterated UIP: Level of exchange rate determined by current and expectations of future short-term interest rates
  - ★ PARTLY TRUE (Engel and West, 2010; Engel, 2016)
- "Expectational error" UIP: Currency risk premia determined by unexpected changes in short-term rates (interest rate risk premia) and expectations thereof + changes in future risk premium
  - ★ TRUE (Andersen et al., 2003; Faust and Rogers, 2003; Stavrakeva and Tang, 2015)

# Predictability of interest rate risk premia

- Forecasting currency risk premia very difficult (Meese and Rogoff, 1983)
- Forecasting risk premia in bond marktes/interest rates much more promising
  - Bond risk premia can be predicted by linear combination of forward rates (Cochrane and Piazzesi, 2005)
  - Risk premia in short-term interest rates (fed funds futures) can be predicted by macro-financial indicators, incl. Treasury spread (Piazzesi and Swanson, 2008)
  - Short-term rates are better predicted by yield curve factors than by expectations hypothesis (Fama and Bliss, 1987; Diebold and Li, 2006; Nyholm, 2016)
- Idea: Exploit predictability of interest rate risk premia to forecast exchange rates

# This paper...

- ... extends literature on predictability of bond risk premia to short-term interest rates
  - tests whether yield curve has predictive power for risk premia in short-term interest rate in panel of G-10 economies
- ... tests whether relative interest rate risk premia contemporaneously explain currency risk premia
- ... tests whether very same linear combination of spot rates that predicts interest rate risk premia can predict currency risk premia

# Main findings

- Same tick-shaped linear combination of (relative) bond yields predicts risk premia in both interest rates and exchange rates
  - Result holds at maturities up to six months for *all* countries
- Single forecasting factor loads positively on short and long end of the curve and negatively on medium-term
  - inversely related to Nelson-Siegel curvature factor
- Supports hypothesis that hump of yield curve bears information about future interest rates
  - Relatively high curvature predicts (in-sample) rise in short-term interest rates and currency appreciation beyond expectations

# Three equivalent versions of UIP

- Standard UIP:

$$E_t \Delta s_{t+1}^{j/USD} = i_t^j - i_t^{USD} + \lambda_t^{j/USD} \tag{1}$$

- Forward iterated UIP:
  - Solving (1) forward: Level of exchange rate determined by expected path of short-term differentials + risk premia

$$s_t^{j/USD} = -E_t[\sum_{s=1}^{\infty} i_{t+s}^j - i_{t+s}^{USD} + \lambda_{t+s}^{j/USD}] + \bar{s}^{j/USD} \tag{2}$$

# Exchange rates and interest rates

- "Expectational error" UIP:
  - Taking first difference of (2) and subtracting (1) returns currency risk premium

$$\Delta s_{t+1}^{j/USD} - E_t \Delta s_{t+1}^{j/USD} = -(\tilde{i}_{t+1} - E_t \tilde{i}_{t+1}) - \sum_{s=2}^{\infty} (E_{t+1} \tilde{i}_{t+s} - E_t \tilde{i}_{t+s}) - \sum_{s=0}^{\infty} (E_{t+1} \lambda_{t+1+s}^{j/USD} - E_t \lambda_{t+1+s}^{j/USD}), \quad (3)$$

where $\tilde{i}_{t+1} = i_t^j - i_t^{USD}$

- Under expectations hypothesis, interest rate surprises can be directly linked to interest rate risk premia

$$-(i_{t+1}^1 - E_t i_{t+1}^1) = -(-i_{t+1}^1 + i_t^2 - i_t^1) = -(p_{t+1}^1 - p_t^2 - i_t^1) \quad (4)$$

# Data

- Country sample: all G10 countries
  - Australia, Canada, Germany, Japan, New Zealand, Norway, Switzerland, Sweden, United Kingdom and United States
- Sample period: January 1991 to December 2015
- Foreign exchange rates: end-of month spot and forward rates (Datastream)
- Interest rates: 1-months, 3-months, 6-months money market rates; 1 year to 10 year government bond yields (Datastream)

# Yield curve approximation

- Follow literature on risk premia in bond markets (Cochrane and Piazzesi, 2005) ▸ Tent
  - Relate risk premia in interest rates to initial yield curve
  - Maintain same degree of flexibility on relationship between yield curve and risk premia
  - Cater for distinct challenge of predicting risk premia in short-term rates
- Use three-months, two-year and ten-year interest rates to approximate yield curve
  - Linear combination of these maturities approximates Nelson-Siegel factors (Diebold and Li, 2006)

# Empirical framework

- Predicting interest rate risk premia (in-sample)

$$rx_{j,t+h}^{2h} = \alpha_j^h + \beta_1^h y_{j,t}^{3m} + \beta_2^h y_{j,t}^{2y} + \beta_3^h y_{j,t}^{10y} + \epsilon_{j,t}^h \tag{5}$$

  - Return horizon $h$: 1, 3, 6 and 12 months
  - Single forecasting factor, $FF_t^h$, equal to fitted value

- Relating currency risk premia to interest rate risk premia

$$xr_{t+h}^{j/USD} = \alpha_j^h + \beta_1^h (rx_{j,t+h}^{2h} - rx_{US,t+h}^{2h}) + \epsilon_{j,t}^h \tag{6}$$

- Predicting currency risk premia (in-sample)

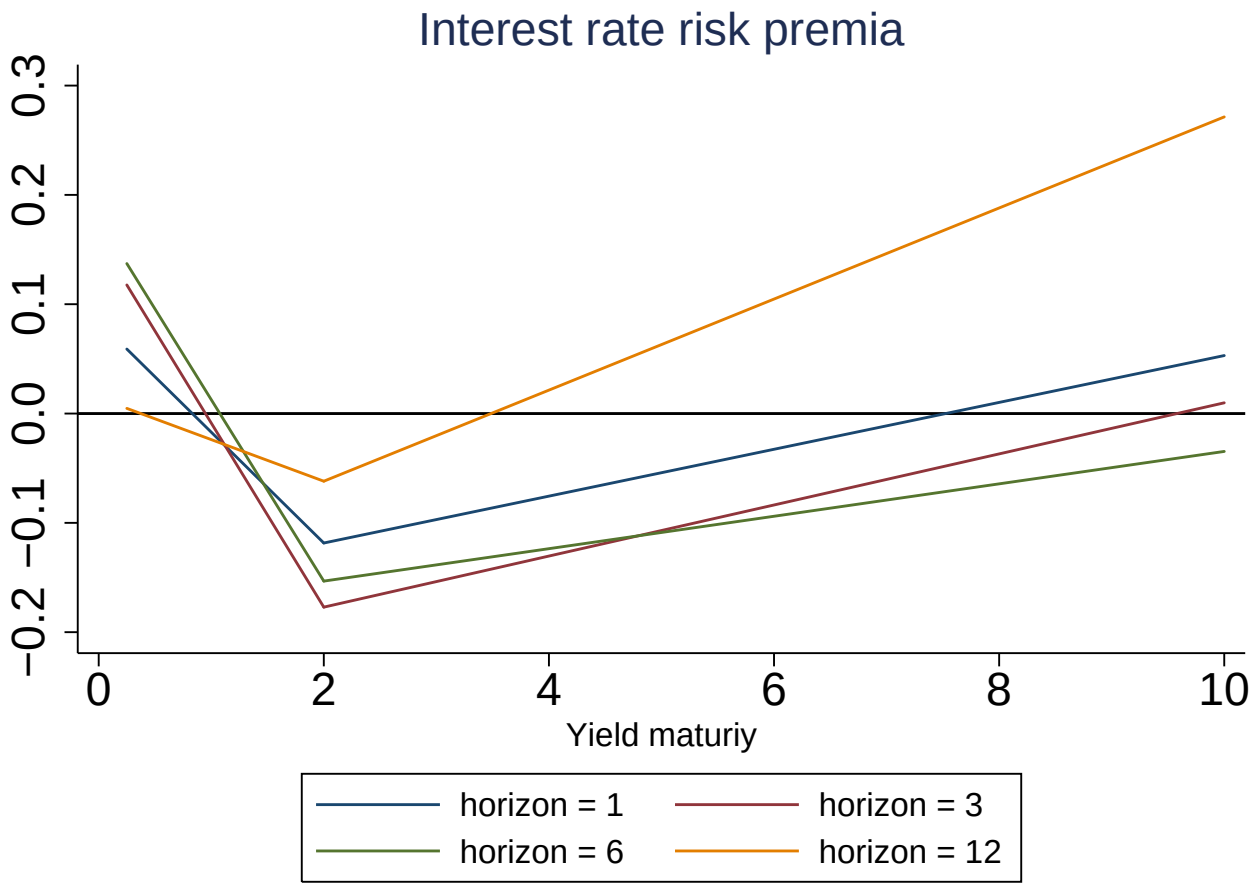
$$xr_{t+h}^{j/USD} = \alpha_j^h + \beta_1^h (y_{j,t}^{3m} - y_{US,t}^{3m}) + \beta_2^h (y_{j,t}^{2y} - y_{US,t}^{2y}) + \beta_3^h (y_{j,t}^{10y} - y_{US,t}^{10y}) + \epsilon_{j,t+h} \tag{7}$$

# Linear combination of spot rates predicts risk premia in short-term interest rates

| | (1) 1-months | (2) 3-months | (3) 6-months | (4) 12-months |
|---|---|---|---|---|
| 3-months yield | 0.059*** | 0.118* | 0.137 | 0.005 |
| | (3.61) | (2.26) | (1.83) | (0.05) |
| 2-year yield | -0.118*** | -0.177** | -0.153* | -0.062 |
| | (-4.87) | (-2.27) | (-1.65) | (-0.51) |
| 10-year yield | 0.053*** | 0.010 | -0.035 | 0.271*** |
| | (5.51) | (0.22) | (-0.71) | (4.79) |
| Constant | 0.105*** | 0.414*** | 0.680*** | -0.381** |
| | (8.65) | (5.43) | (6.75) | (-2.43) |
| Observations | 2250 | 2250 | 2250 | 2922 |
| No. of countries | 10 | 10 | 10 | 10 |
| R2 | 0.032 | 0.044 | 0.018 | 0.129 |

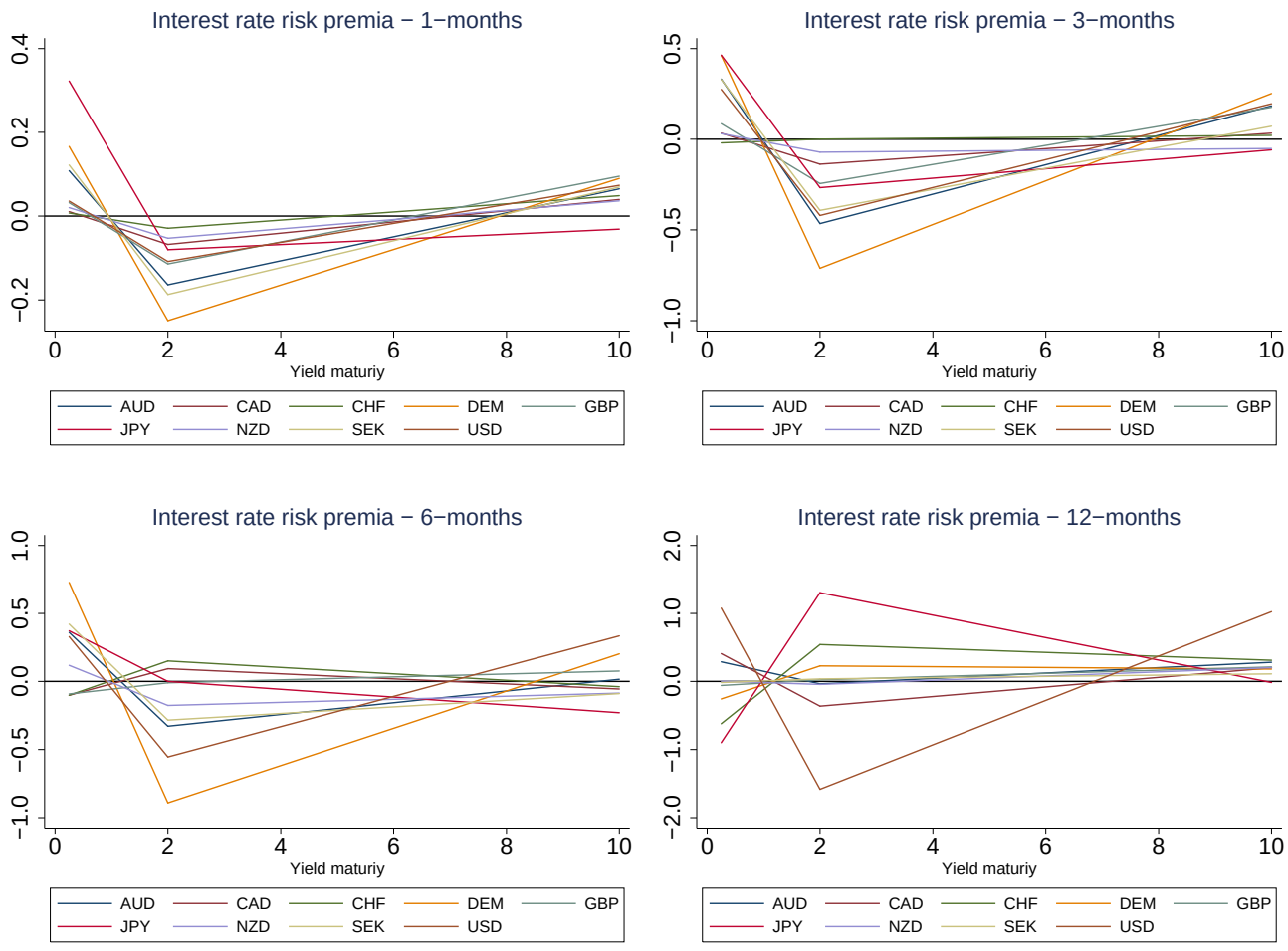
Robust standard errors.

# Linear combination of spot rates has tick-shape across all maturities




*Notes: Regression coefficients of interest rate risk premia on the yield curve*

# Tick-shaped function holds across countries




*Notes: Regression coefficients of interest rate risk premia on the yield curve*

# Interest rate risk premia contemporaneously drive currency risk premia across maturities

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | 1-months | 3-months | 6-months | 12-months |
| Relative interest rate risk premia | 0.011** | 0.032*** | 0.047*** | 0.029*** |
| | (2.41) | (5.42) | (7.09) | (4.78) |
| Constant | -0.002*** | -0.008*** | -0.014*** | -0.003 |
| | (-4.39) | (-7.85) | (-10.77) | (-1.77) |
| Observations | 1773 | 1773 | 1773 | 1773 |
| R2 | 0.01 | 0.06 | 0.14 | 0.08 |

Robust standard errors.

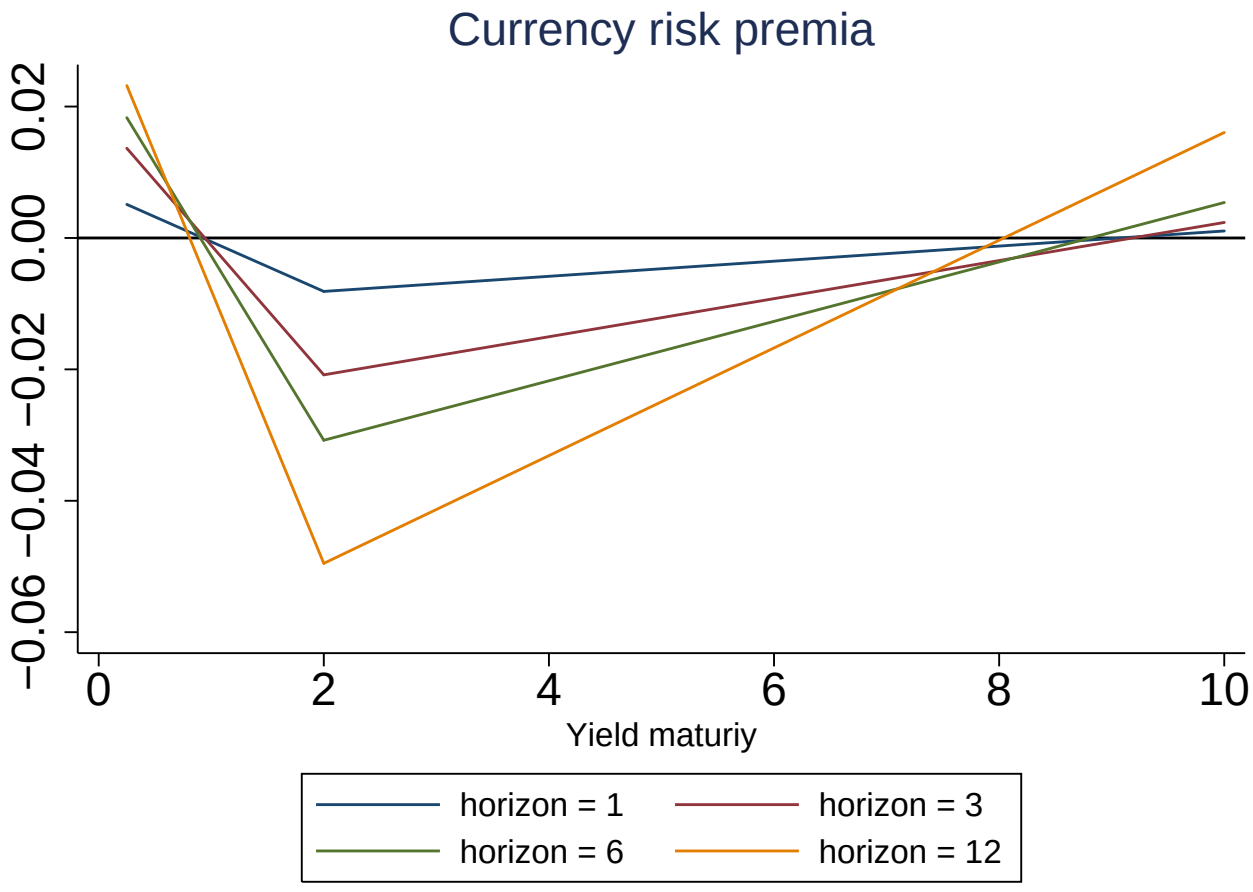
# Linear combination of spot rates predicts currency risk premia

| | (1) 1-months | (2) 3-months | (3) 6-months | (4) 12-months |
|---|---|---|---|---|
| 3-month rate diff | 0.005** | 0.014** | 0.018** | 0.023* |
| | (2.71) | (2.61) | (2.34) | (2.28) |
| 2-year rate diff | -0.008*** | -0.021*** | -0.031*** | -0.050*** |
| | (-3.56) | (-3.42) | (-3.49) | (-4.70) |
| 10-year rate diff | 0.001* | 0.002 | 0.005 | 0.016*** |
| | (1.94) | (1.21) | (1.60) | (3.96) |
| Constant | -0.001 | -0.003 | -0.002 | 0.001 |
| | (-1.49) | (-1.36) | (-0.64) | (0.20) |
| Observations | 2712 | 2694 | 2667 | 2613 |
| No. of currencies | 9 | 9 | 9 | 9 |
| R2 | 0.01 | 0.03 | 0.03 | 0.06 |

Robust standard errors.

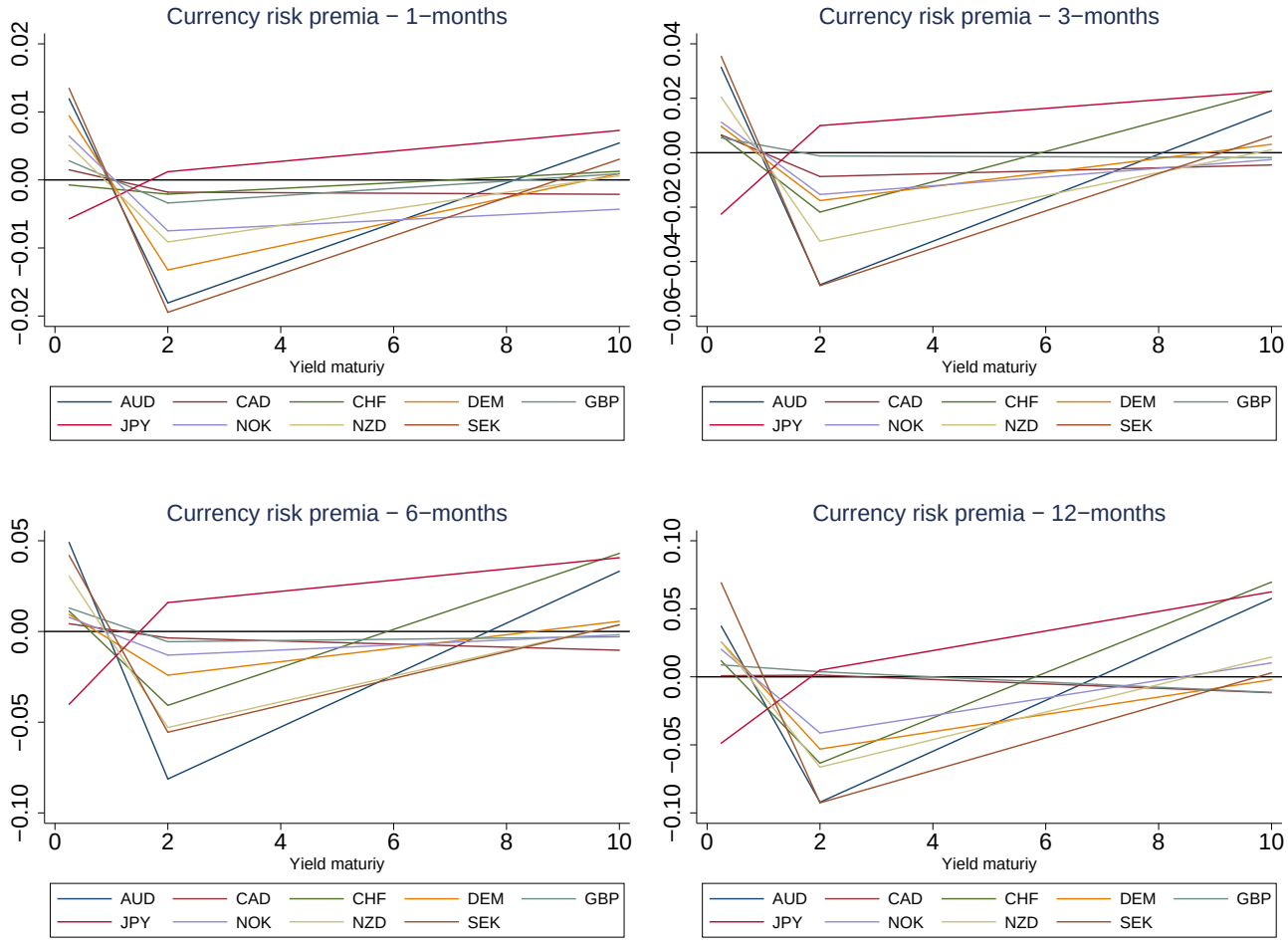
▸ Economic Significance

# Currency risk premia: very same tick-shape as observed for interest rate risk premia




*Notes: Regression coefficients of currency risk premia on the yield curve*

# Tick-shaped function holds across maturities and countries, except Japan




*Notes: Regression coefficients of currency risk premia on the yield curve*

# Tick-shaped forecasting factor highly correlated with curvature factor

| | (1) 1-months | (2) 3-months | (3) 6-months | (4) 12-months |
|---|---|---|---|---|
| Linear prediction | 0.736*** | 0.765*** | 0.818*** | 0.907*** |
| | (5.65) | (7.75) | (8.66) | (11.41) |
| Constant | -0.000 | -0.000 | -0.000 | -0.000 |
| | (-0.16) | (-0.15) | (-0.13) | (-0.17) |
| Observations | 2712 | 2694 | 2667 | 2613 |
| R2 | 0.013 | 0.027 | 0.033 | 0.064 |
| Corr Curvature*Forecasting-factor | -0.68 | -0.58 | -0.55 | -0.53 |

Robust standard errors.

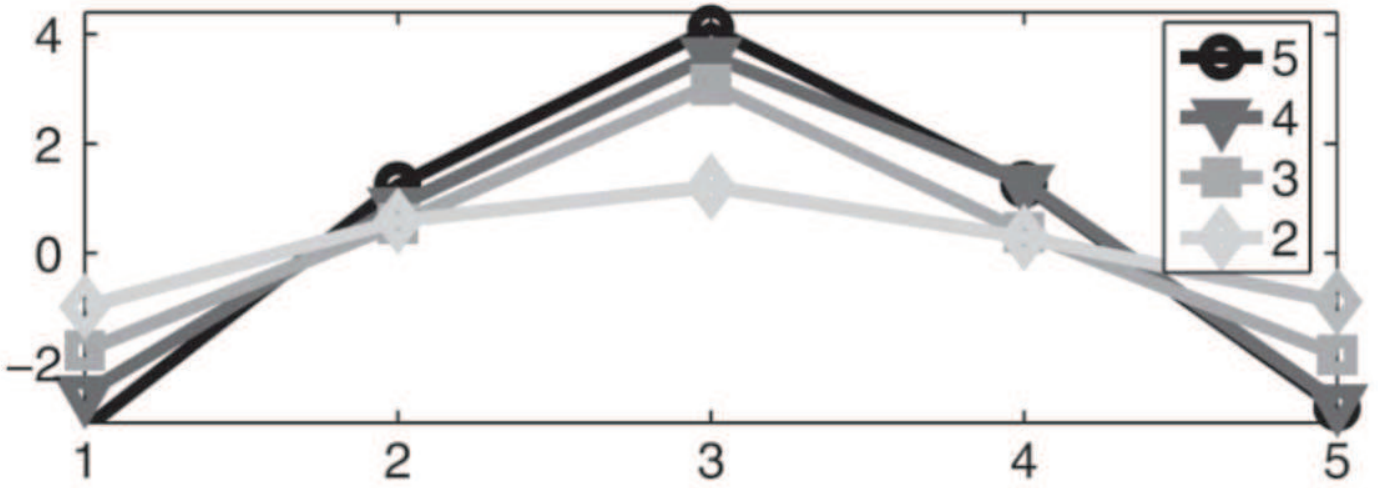
▸ Visual resemblance ▸ Nelson-Siegel factors

# Conclusion

- Paper studies predictive power of yield curve for risk premia in interest rates and exchange rates across G10 economies
- Strong evidence that shape of yield curve bears information for future interest rate and exchange rate movements
  - *Same* tick-shaped combination of spot yields predicts risk premia in both interest rates and exchange rates
  - Findings hold for *all* G10 countries/currencies, except one
- Tick-shaped forecasting factor closely resembles curvature factor
  - High curvature predicts interest rate rise/appreciation beyond expectations

# Functional form of single forecasting factor of Cochrane and Piazzesi (2005) of bonds with remaining maturity $\geq$ one year

Return



# In-sample prediction of interest rate risk premia: curvature dominant factor

| | (1) 1-months b/t | (2) 3-months b/t | (3) 6-months b/t | (4) 12-months b/t |
|---|---|---|---|---|
| Level | -2.471 | -42.561 | -37.264 | 283.812*** |
| | (-0.62) | (-1.73) | (-1.18) | (6.34) |
| Slope | 1.859 | -4.762 | -33.369 | 8.419 |
| | (0.43) | (-0.24) | (-0.91) | (0.22) |
| Curvature | -28.826*** | -47.305** | -46.956* | 3.782 |
| | (-6.34) | (-2.26) | (-1.94) | (0.11) |
| Constant | 0.081*** | 0.332*** | 0.569*** | -0.541** |
| | (5.84) | (3.58) | (5.18) | (-2.69) |
| Observations | 2250 | 2250 | 2250 | 2928 |
| No. of countries | 10 | 10 | 10 | 10 |
| R2 | 0.029 | 0.038 | 0.011 | 0.139 |

Robust standard errors.

Return

# In-sample prediction of currency risk premia: curvature dominant factor

| | (1) 1-months b/t | (2) 3-months b/t | (3) 6-months b/t | (4) 12-months b/t |
|---|---|---|---|---|
| Relative level | -1.752*** | -4.035** | -7.010*** | -5.752 |
| | (-3.69) | (-3.22) | (-3.37) | (-1.58) |
| Relative slope | -0.557 | -1.754 | -1.466 | 4.159 |
| | (-0.93) | (-1.00) | (-0.48) | (0.82) |
| Relative curvature | -2.018*** | -5.243*** | -8.293*** | -11.502*** |
| | (-4.12) | (-4.04) | (-4.35) | (-4.61) |
| Constant | -0.001 | -0.002 | -0.003 | 0.002 |
| | (-1.62) | (-1.53) | (-1.03) | (0.55) |
| Observations | 2790 | 2772 | 2745 | 2691 |
| No. of currencies | 9 | 9 | 9 | 9 |
| R2 | 0.01 | 0.03 | 0.04 | 0.05 |

Robust standard errors.

# At currency level, curvature predicts economically significant variation in future currency risk premia

| | (1) AUD | (2) GBP | (3) NOK | (4) SEK | (5) DEM | (6) JPY | (7) NZD | (8) CHF | (9) CAD |
|---|---|---|---|---|---|---|---|---|---|
| Relative level | 29.61 | 13.89 | -91.43*** | -44.67*** | -35.34*** | 30.57*** | -24.46 | -9.31 | -53.41*** |
| | (1.25) | (0.85) | (-6.27) | (-3.40) | (-3.14) | (3.58) | (-1.14) | (-0.72) | (-4.40) |
| Relative slope | -13.40$^{+}$ | -11.86$^{+}$ | -6.10 | -10.76* | -9.00 | 10.22** | -0.86 | 8.09 | -30.51*** |
| | (-1.64) | (-1.50) | (-1.03) | (-1.66) | (-1.05) | (2.00) | (-0.10) | (1.24) | (-3.32) |
| Relative curvature | -20.81*** | -9.96** | -3.72 | -19.22*** | -17.04*** | -0.44 | -13.79*** | -7.99* | -10.74*** |
| | (-5.80) | (-2.56) | (-1.04) | (-4.43) | (-3.61) | (-0.13) | (-3.90) | (-1.68) | (-3.19) |
| Constant | -0.04* | -0.00 | -0.02** | -0.00 | -0.02** | 0.10*** | 0.03 | -0.01 | -0.02*** |
| | (-1.72) | (-0.62) | (-2.12) | (-0.38) | (-2.17) | (4.91) | (1.08) | (-0.31) | (-4.07) |
| Observations | 197 | 197 | 197 | 197 | 197 | 197 | 197 | 197 | 197 |
| $R^2$ | 0.13 | 0.04 | 0.15 | 0.11 | 0.11 | 0.14 | 0.07 | 0.07 | 0.20 |

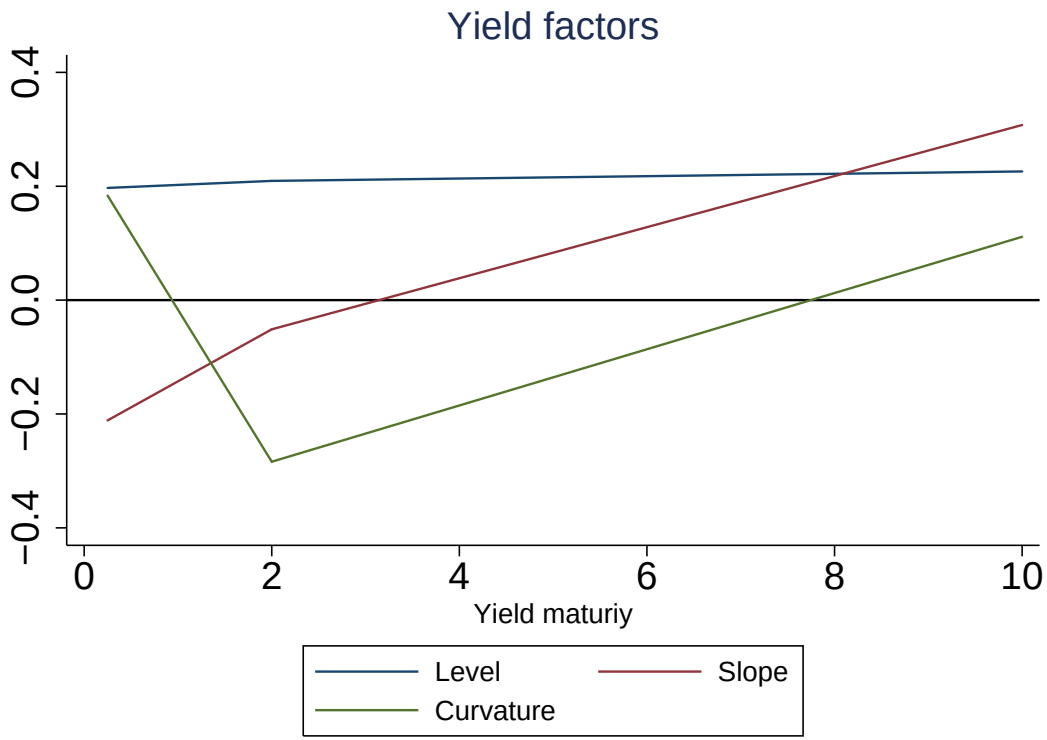
$t$ statistics in parentheses

Robust standard errors.

$^{+}$ $p < 0.2$, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

▸ Return

# Tick-shaped forecasting factor closely resembles curvature factor visually




*Notes: Loading structure of three principal components approximating Nelson-Siegel factors as a function of yield maturity*

▸ Return

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