# Risk Factors in Currency Markets Cont'd

Anisha Ghosh*

*McGill University

Asset Management – November $7^{th}$ 2019

# Outline

1. Lustig, Roussanov, and Verdelhan (2011)
   - Common Factors in Currency Returns
   - Cross-Sectional Asset Pricing

# Methodology

- Linear factor models predict that average returns on a cross-section of assets can be attributed to risk premiums associated with their exposure to a small number of risk factors. CAPM, 3, 4, 5
- These factors capture common variation in individual asset returns.
- A principal component analysis of the currency portfolios reveals that two factors explain more than 80% of the variation in returns on these six portfolios.

# Principal Components

**Table 3**
**Principal components**

about the same loading

monotonic

**Panel I: All Countries**

excess return

| *Portfolio* | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 0.42 | 0.43 | 0.18 | −0.15 | 0.74 | 0.20 |
| 2 | 0.38 | 0.24 | 0.15 | −0.27 | −0.61 | 0.58 |
| 3 | 0.38 | 0.29 | 0.42 | 0.12 | −0.28 | −0.71 |
| 4 | 0.38 | 0.04 | −0.35 | 0.83 | −0.03 | 0.18 |
| 5 | 0.43 | −0.08 | −0.72 | −0.44 | −0.03 | −0.30 |
| 6 | 0.45 | −0.81 | 0.35 | −0.03 | 0.11 | 0.06 |
| % Var. | 71.95 | 11.82 | 5.55 | 4.00 | 3.51 | 3.16 |

lowest → highest

add up to 1.

**Panel II: Developed Countries**

| *Portfolio* | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 0.44 | 0.66 | −0.54 | −0.25 | 0.12 |
| 2 | 0.45 | 0.25 | 0.75 | 0.01 | 0.41 |
| 3 | 0.46 | 0.02 | 0.19 | 0.04 | −0.86 |
| 4 | 0.44 | −0.27 | −0.29 | 0.78 | 0.20 |
| 5 | 0.45 | −0.66 | −0.14 | −0.57 | 0.17 |
| % Var. | 78.23 | 10.11 | 4.97 | 3.49 | 3.20 |

same informative

set I $Rx^1, Rx^2 \cdots Rx^6$

set II

$PC_1 = a_1 Rx^1 + a_2 Rx^2 + \cdots a_6 Rx^6$

$PC_2 = b_1 Rx^1 + b_2 Rx^2 + \cdots b_6 Rx^6$

$PC_3$

$PC_4$

$PC_5$

$PC_6$

uncorrelated.

$PC_1$: could explain the maximum variation of the 6 portfolios

$Rx^1 = z_0^{(1)} + z_1^{(1)} PC_1 + \varepsilon^1$

$Rx^2 = z_0^{(2)} + z_1^{(2)} PC_1 + \varepsilon^2$

$$\underset{PC_1}{\arg\min} \frac{Var(z_0^{(1)}) + Var(z_0^{(2)}) + \cdots}{Var(Rx^1) + Var(Rx^2) + \cdots}$$

$PC_2$: explain the maximum variation that is not explained by $PC_1$.

# Interpretation

① Explain most of variation

② Have clear interpretation

- The first principal component explains 70% of the common variation in portfolio returns, and can be interpreted as a level factor, since all portfolios load equally on it.
- The second principal component, that is responsible for almost 12% of common variation, can be interpreted as a slope factor, since portfolio loadings increase monotonically across portfolios.

Note: Average excess returns increase monotonically across portfolios $\Rightarrow$ the second principal component is the only plausible candidate risk factor that might explain the cross-section of portfolio excess returns (since none of the other principal components exhibit monotonic variation in loadings).

# Two Candidate Risk Factors guided by PC.

$RX = \frac{1}{6}\sum_{i=1}^{n} Rx^i$

## RX

The average currency excess return, RX: is the average portfolio return of a U.S. investor who buys all foreign currencies available in the forward market (the correlation of the first principal component with *RX* is .99).

## Carry Trade Factor: $HML_{FX}$ Foreign Exchange

The difference between the return on the last portfolio and the one on the first portfolio (the correlation of the second principal component with $HML_{FX}$ is .94). This is the return in dollars on a zero-cost strategy that goes long in the highest interest rate currencies and short in the lowest interest rate currencies.

$HML_{FX} = Rx^6 - Rx^1$

# Assessing the Performance of Factors

- A linear factor model implies that the expected excess return is equal to the factor risk price times the beta of each portfolio:

transpose ,

$$E\left[Rx^j\right] = \underbrace{\lambda}_{\text{factor prices}}{}' \underbrace{\beta^j}_{\text{portfolio betas}}$$

$$E[Rx^j] = \beta^j_{Rx} E(RX) + \beta^j_{HML_{FX}} E(HML)$$

$$= \underbrace{\begin{bmatrix} E(Rx) & E(HML) \end{bmatrix}}_{\lambda} \underbrace{\begin{bmatrix} \beta^j_{Rx} E(RX) \\ \beta^j_{HML_{FX}} E(HML) \end{bmatrix}}_{\beta^j}$$

# Approach to Estimation

$$RX^{i}_{t+1} = \alpha^{i} + \beta^{i}_{RX} RX_{t+1} + \beta^{i}_{HML_{FX}} HML_{FX,t+1} + \varepsilon^{i}_{t+1}$$

- A two-stage ordinary least squares (OLS) estimation:
  1. Step 1: Run a time-series regression of returns on the factors.
  2. Step 2: Run a cross-sectional regression of average returns on the betas.

# Model Evaluation

**Table 4**
**Asset pricing—U.S. investor**

Panel I: Risk Prices

| | All Countries | | | | | | | Developed Countries | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\lambda_{HML_{FX}}$ | $\lambda_{RX}$ | $b_{HML_{FX}}$ | $b_{RX}$ | $R^2$ | RMSE | $\chi^2$ | $\lambda_{HML_{FX}}$ | $\lambda_{RX}$ | $b_{HML_{FX}}$ | $b_{RX}$ | $R^2$ | RMSE | $\chi^2$ |
| $GMM_1$ | 5.50 | 1.34 | 0.56 | 0.20 | 70.11 | 0.96 | | 3.29 | 1.90 | 0.29 | 0.20 | 64.78 | 0.64 | |
| | [2.25] | [1.85] | [0.23] | [0.32] | | | 14.39% | [2.59] | [2.20] | [0.23] | [0.23] | | | 45.96% |
| $GMM_2$ | 5.51 | 0.40 | 0.57 | 0.04 | 41.25 | 1.34 | | 3.91 | 3.07 | 0.35 | 0.32 | −55.65 | 1.34 | |
| | [2.14] | [1.77] | [0.22] | [0.31] | | | 16.10% | [2.52] | [2.05] | [0.22] | [0.22] | | | 52.22% |
| $FMB$ | 5.50 | 1.34 | 0.56 | 0.20 | 70.11 | 0.96 | | 3.29 | 1.90 | 0.29 | 0.20 | 64.78 | 0.64 | |
| | [1.79] | [1.35] | [0.19] | [0.24] | | | 9.19% | [1.91] | [1.73] | [0.17] | [0.18] | | | 43.64% |
| | (1.79) | (1.35) | (0.19) | (0.24) | | | 10.20% | (1.91) | (1.73) | (0.17) | (0.18) | | | 44.25% |
| *Mean* | **5.08** | **1.33** | | | | | **3.14** | **1.90** | | | | | | |

# Model Evaluation cont'd

**Table 4**
**Continued**

Panel II: Factor Betas

annualized

| | All Countries | | | | | | Developed Countries | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portfolio | $\alpha_0^j$ | $\beta_{HML_{FX}}^j$ | $\beta_{RX}^j$ | $R^2$ | $\chi^2(\alpha)$ | *p–value* | $\alpha_0^j$ | $\beta_{HML_{FX}}^j$ | $\beta_{RX}^j$ | $R^2$ | $\chi^2(\alpha)$ | *p–value* |
| 1 | −0.10 | −0.39 | 1.05 | 91.64 | | | 0.36 | −0.51 | 0.99 | 94.31 | | |
| | [0.50] | [0.02] | [0.03] | | | | [0.53] | [0.03] | [0.02] | | | |
| 2 | −1.55 | −0.11 | 0.94 | 77.74 | | | −1.17 | −0.09 | 1.01 | 80.69 | | |
| | [0.73] | [0.03] | [0.04] | | | | [0.85] | [0.04] | [0.04] | | | |
| 3 | −0.54 | −0.14 | 0.96 | 76.72 | | | 0.62 | −0.00 | 1.04 | 86.50 | | |
| | [0.74] | [0.03] | [0.04] | | | | [0.79] | [0.03] | [0.03] | | | |
| 4 | 1.51 | −0.01 | 0.95 | 75.36 | | | −0.17 | 0.12 | 0.97 | 82.84 | | |
| | [0.77] | [0.03] | [0.05] | | | | [0.85] | [0.03] | [0.04] | | | |
| 5 | 0.78 | 0.04 | 1.06 | 76.41 | | | 0.36 | 0.49 | 0.99 | 94.32 | | |
| | [0.82] | [0.03] | [0.05] | | | | [0.53] | [0.03] | [0.02] | | | |
| 6 | −0.10 | 0.61 | 1.05 | 93.84 | | | | | | | | |
| | [0.50] | [0.02] | [0.03] | | | | | | | | | |
| *All* | | | | | 6.79 | 34.05% | | | | | 2.63 | 75.64% |

standard error

significant

monotonicly increase

close to 1.

large

⇒ Model performs well

small

monotonic increasing

close to 1

high

High interest rate currency is highly expose to value risk.