Common risk factors in currency markets

by
Hanno Lustig, Nick Roussanov and Adrien Verdelhan

Discussion by Fabio Fornari

Frankfurt am Main, 18 June 2009
Common risk factors in currency markets

What does the paper do?
Introduction (what does the paper do?)

- Lots of things! So discussion necessarily focuses on a limited subset.
- Overall, a very nice paper.
- Lots of robustness to convince you results do hold.
- Takes care of transaction costs
- Different investor perspective (various residences)
- Different sample periods and country groupings.
- For reference see also: Brunnermeier, M. K., S. Nagel and L. H. Pedersen, 2008 (Carry trades and currency crashes)
Synthesis

• A single factor – resembling carry trade - explains variation – cross sectionally - in currency excess returns.

• The outcome can be rationalised within a 2-factor affine term structure model... BUT...there must be heterogenous loadings of currencies on the common factor
Introduction (what does the paper do?)

**Synthesis**

- Let us see why:
- \( \text{HML}_{t+1} - \mathbb{E}_t[\text{HML}_{t+1}] = [(\delta^L_t)^{0.5} - (\delta^H_t)^{0.5}] (z^w_t)^{0.5} u^w_{t+1} \)

If loadings \( \delta \) are equal across L (low yielding) and H (high yielding) countries then the carry trade factor does not exist.

- In addition model requires some parameter restrictions: i) the loadings on the common shock \( \delta \) must be equal between high and low yielding countries ii) all countries must load equally on the domestic shock \( (\gamma^i = \gamma) \)
Introduction (what does the paper do?)

• The paper identifies two factors that account for quite a fraction of cross sectional returns on 6 fx portfolios.
• One factor fixes the level of the portfolios.
• The other differentiates the returns of the various portfolios from this level.
• This second factor retains the bulk of the cross sectional power. It is built as a carry trade factor, or better, it looks like a carry trade factor.
Introduction (what does the paper do?)

• The paper borrows a methodology developed originally in the equity market: reduce idiosyncratic risk through the use of portfolios.

• How?

• Build portfolios of currencies based on the foreign interest rate relative to a given home currency.

• There are six portfolios, from the lowest yielding ($p_1$) to the highest yielding ($p_6$).

• As said, the first factor is an average of the 6 portfolios.

• The second is built as $p_6-p_1$. It is a carry trade factor as you short some currencies in order to be long in other currencies.
Introduction (what does the paper do?)

- **Portfolios are formed dynamically, i.e. at the end of each month currencies are allocated to portfolios according to their interest rate level.**
- **There are 37 currencies from 1983 to end-2008; the number of currencies in each portfolio changes from month to month.**
- **The second portfolio then looks like a ‘slope’ factor, i.e. some assets load positively on it, some other load negatively.**
- **It is a remarkable analogy with yield curve modeling that 2 factors price fx returns.**
- **Of course there bonds of different maturity are priced, here is different currencies over same holding interval to be priced.**
Relation with yield curve issues

- At times – or in previous versions – the paper aimed to connect to Cochrane and Piazzesi.
- A combination of forward interest rates loads with remarkable regularity on ex-post bond returns.
- However, the CP model is a forecasting model
- \[ r_{x_{t,t+k}} = \alpha + \sum_{j=1,4} \beta_j f_{j,j+1} + \eta_t \]
- while here we deal with a factor model, i.e. focus is on cross sectional pricing.
- Factors have in fact negligible out of sample power, with R squared passing from 80-90% when factors are contemporaneous to zero when they are lagged by between 1 and 12 months (but portfolios returns are calculated over a 1-month horizon, maybe low predictability)
**HML co-varies with average returns**

\[ \text{Cov}(r_x^{(k)}, \text{sdf}) \]

Figure 1: Mean Excess Returns and Covariances between Excess Returns and Principal Components - Developed and Emerging Countries
Factors are priced sources of risk

FIRST PASS
REGRESSION

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>$\hat{\alpha}_0$</th>
<th>$\beta_{HMLFX}$</th>
<th>$\beta_{RX}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.56</td>
<td>-0.39</td>
<td>1.06</td>
<td>91.36</td>
</tr>
<tr>
<td></td>
<td>[0.52]</td>
<td>[0.02]</td>
<td>[0.03]</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-1.21</td>
<td>-0.13</td>
<td>0.97</td>
<td>78.54</td>
</tr>
<tr>
<td></td>
<td>[0.76]</td>
<td>[0.03]</td>
<td>[0.05]</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-0.13</td>
<td>-0.12</td>
<td>0.95</td>
<td>73.73</td>
</tr>
<tr>
<td></td>
<td>[0.82]</td>
<td>[0.03]</td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.62</td>
<td>-0.02</td>
<td>0.93</td>
<td>68.86</td>
</tr>
<tr>
<td></td>
<td>[0.86]</td>
<td>[0.04]</td>
<td>[0.06]</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.84</td>
<td>0.05</td>
<td>1.03</td>
<td>76.37</td>
</tr>
<tr>
<td></td>
<td>[0.80]</td>
<td>[0.04]</td>
<td>[0.05]</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-0.56</td>
<td>0.61</td>
<td>1.06</td>
<td>93.03</td>
</tr>
<tr>
<td></td>
<td>[0.52]</td>
<td>[0.02]</td>
<td>[0.03]</td>
<td></td>
</tr>
</tbody>
</table>

Portfolios returns on factors

SECOND PASS
REGRESSION

<table>
<thead>
<tr>
<th>$\lambda_{HMLFX}$</th>
<th>$\lambda_{RX}$</th>
<th>$\beta_{HMLFX}$</th>
<th>$\beta_{RX}$</th>
<th>$R^2$</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMM1</td>
<td>5.46</td>
<td>1.35</td>
<td>0.59</td>
<td>0.26</td>
<td>60.28</td>
</tr>
<tr>
<td></td>
<td>[2.34]</td>
<td>[1.68]</td>
<td>[0.25]</td>
<td>[0.32]</td>
<td></td>
</tr>
<tr>
<td>CMM2</td>
<td>4.88</td>
<td>0.58</td>
<td>0.52</td>
<td>0.12</td>
<td>47.89</td>
</tr>
<tr>
<td></td>
<td>[2.23]</td>
<td>[1.63]</td>
<td>[0.24]</td>
<td>[0.31]</td>
<td></td>
</tr>
<tr>
<td>FMB</td>
<td>5.46</td>
<td>1.35</td>
<td>0.58</td>
<td>0.26</td>
<td>69.28</td>
</tr>
<tr>
<td></td>
<td>[1.82]</td>
<td>[1.34]</td>
<td>[0.19]</td>
<td>[0.23]</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>5.37</td>
<td>1.36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Unconditional pricing works nicely

- brown: average fx return and HML
- orange: average fx return, HML, stock market volatility and return
Volatility matters for fx movements

- Volatility has a clear relationship with currencies movements, recently also for currencies for which it typically has not.
Volatility matters for fx movements

Average fx volatility, 1 month horizon (lhs)
- aud/eur
- nzd/eur
- gbp/eur
Volatility matters for fx movements

Time varying correlations (rolling over 6-month windows; daily data)

-1.0
-0.8
-0.5
-0.3
0.0
0.3
0.5
0.8
1.0
Jan. 01 Jan. 02 Jan. 03 Jan. 04 Jan. 05 Jan. 06 Jan. 07 Jan. 08 Jan. 09

between eur/usd rate and and sp500 implied volatility
between eur/usd rate and and eur/usd implied volatility
Unconditional pricing works nicely

\[ \beta_{fx} \quad \beta_{HML} \quad \beta_{\sigma} \quad \beta_{sm} \]

<table>
<thead>
<tr>
<th>( p )</th>
<th>( \beta )</th>
<th>T-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.399</td>
<td>-0.466</td>
</tr>
<tr>
<td>2</td>
<td>0.008</td>
<td>-0.009</td>
</tr>
<tr>
<td>3</td>
<td>0.361</td>
<td>-0.269</td>
</tr>
<tr>
<td>4</td>
<td>0.013</td>
<td>0.005</td>
</tr>
<tr>
<td>5</td>
<td>0.384</td>
<td>-0.297</td>
</tr>
<tr>
<td>6</td>
<td>0.024</td>
<td>0.012</td>
</tr>
<tr>
<td>7</td>
<td>0.390</td>
<td>-0.018</td>
</tr>
<tr>
<td>8</td>
<td>0.003</td>
<td>-0.032</td>
</tr>
<tr>
<td>9</td>
<td>0.435</td>
<td>0.085</td>
</tr>
<tr>
<td>10</td>
<td>-0.001</td>
<td>0.028</td>
</tr>
<tr>
<td>11</td>
<td>0.469</td>
<td>0.784</td>
</tr>
<tr>
<td>12</td>
<td>0.000</td>
<td>-0.005</td>
</tr>
</tbody>
</table>

Loadings of first pass: \( fx \) and \( hml \) get significance and nice path across portfolios but stock market vola and stock market return do not.

Loadings of second pass: \( fx \) and \( hml \) are priced source of risk, stock market vola and stock market return are not.
Volatility vs HML

• Within the LRV paper easy to bring volatility into the picture. Intuition: recall that a low volatility environment fosters carry trade.

• HRV show that in their affine yield curve model

\[ \text{Corr}(\text{HML}_{t+1}, m_{t+1})^2 = \frac{\delta z^w_t}{\delta z^w_t + \gamma z_t} \]

where \( z^w \) is the world shock and \( z_t \) is the country-specific shock.

When the global component of risk rises the correlation rises to unity.

If innovations to the common component of the marginal utility growth \( u^w \) are correlated with innovations to global volatility \( z^w \) then volatility innovations can proxy for HML innovations.
Volatility matters but HML dominates

- Menkhoff, Sarno, Schmeling and Schirmpf (2009) perform a similar analysis but they look at volatility as a factor.
- They find that volatility is related to exchange rate returns. Low interest rate currencies are a hedge against volatility shocks.
- Excess returns are related to unexpected volatility rather than to expected volatility.
- LRV also look at volatility: they show that volatility loadings decrease monotonically across portfolios. However, stock market volatility innovations cannot replace HML as a pricing factor.
Volatility leads to lower growth

Figure 2: The estimated combined stock market levels and volatility impact of the credit crunch on GDP

- Reduction in GDP due to the credit crunch (%)
- January 2009
- One standard-error bound
- Impact of the 30% fall in stock market levels & the 3x increase in volatility
- One standard-error bound
Low yielding currencies compensate for consumption risk

Relative to: US, UK, Canada, Australia, France (euro area)
Some challenges: what factors really work and conditional models are good representations?

- From fx excess returns $z_t = \Delta s_{t+1} - (i_t^*-i_t)^{(1)}$ build portfolios $p_1$-$p_6$.

- Form $Z_t = [p_1, p_2, p_4, p_5, p_6, HML, \sigma(sm), smr]$ ($\sigma$ is stock market volatility, smr is stock market return)

- Assume the following conditional pricing model

  - $Z_{t,8x1} = \mu + \Sigma_k \Phi_k Z_{t-k} + \Psi[H_t, H_{t-1}, H_{t-2}] + \eta_t$
   - $H_{t,8x8} = w'w + A' \eta'_t \eta_t A + B'H_{t-1}B$

- Obviously for each $p_i$ the $\Psi$ is allowed to load only on the covariance between itself and the factors HML, $\sigma$ and smr. All remaining interactions are closed.
HML Covariances rank neatly across portfolios

covariances between portfolios and HML


p1  p2  p3  p4  p5  p6
Stock market variance Covariances less so …

covariances between portoflios and stock market volatility
But stock market returns covariances do
All factors give same picture?

portfolio 1: fitted premia

-10.0 -7.5 -5.0 -2.5 0.0 2.5 5.0 7.5 10.0


all 3 factors
var only
hml only
smr only
All factors give same picture?

portfolio 6: fitted premia

-8 -6 -4 -2 0 2 4 6


-8

all 3 factors  var only
hml only  smr only
So, how much can we fit conditionally?
So, how much can we fit conditionally?
Thanks a lot
Introduction (what does the paper do?)

- \( m_{i,t+1} = \lambda z_{i,t} + (\gamma i z_{i,t})^{0.5} u_{i,t+1} + \tau i z_{w,t} + (\delta i z_{w,t})^{0.5} w_{t+1} \)
- \( z_{i,t+1} = (1-\phi i) z_{i,t} + \phi i z_{i,t} + \sigma i z_{i,t}^{0.5} w_{t+1} \)
- \( z_{w,t+1} = (1-\phi w) z_{w,t} + \phi w z_{w,t} + \sigma w z_{w,t}^{0.5} w_{t+1} \)
- \( E_t(m_t) = -\lambda z_{i,t} - \tau i z_{w,t} \) [1]
- \( \text{Var}_t(m_t) = (\gamma i z_{i,t}) + (\delta i z_{w,t}) \) [1B]
- \( \Delta q_{i,t+1} = m_{i,t+1} - m_{i,t+1} = \lambda i z_{i,t} + (\gamma i z_{i,t})^{0.5} u_{i,t+1} + \tau i z_{w,t} + (\delta i z_{w,t})^{0.5} w_{t+1} - \lambda i z_{i,t} + (\gamma z_{i,t})^{0.5} u_{t+1} + \tau z_{w,t} + (\delta z_{w,t})^{0.5} w_{t+1} = \)
- \( \lambda i z_{i,t} + (\gamma i z_{i,t})^{0.5} u_{i,t+1} - \lambda z_{i,t} + (\gamma z_{i,t})^{0.5} u_{t+1} + (\tau - \tau i) z_{w,t} + [(\delta i)^{0.5} - (\delta)^{0.5}] (z_{w,t})^{0.5} u_{t+1} \)
- \( r_{x_{i,t+1}} = -\Delta q_{i,t+1} + r_i - r_t \)
- As: \( E(M) = -R \rightarrow E(m_{t+1}) + 0.5 \text{Var}(m_{t+1}) = -r_t \) and from [1] and [1B]
- \( r_i = \lambda i z_{i,t} + \tau i z_{w,t} - 0.5[(\gamma i z_{i,t}) + (\delta i z_{w,t})] = (\lambda i - 0.5 \gamma i) z_{i,t} + (\tau i - 0.5 \delta i) z_{w,t} \) so:
- \( r_{x_{i,t+1}} = \lambda i z_{i,t} + (\gamma i z_{i,t})^{0.5} u_{i,t+1} - \lambda z_{i,t} + (\gamma z_{i,t})^{0.5} u_{t+1} + (\tau - \tau i) z_{w,t} + [(\delta i)^{0.5} - (\delta)^{0.5}] (z_{w,t})^{0.5} u_{t+1} + (\lambda i - 0.5 \gamma i) z_{i,t} + (\tau i - 0.5 \delta i) z_{w,t} - (\lambda - 0.5 \gamma) z_{i,t} + (\tau - 0.5 \delta) z_{w,t} \)
- \( = -0.5 \gamma i z_{i,t} - (\gamma i z_{i,t})^{0.5} u_{i,t+1} + 0.5 \gamma z_{i,t} + (\gamma z_{i,t})^{0.5} u_{t+1} + (0.5 \delta - 0.5 \delta i) z_{w,t} - [(\delta i)^{0.5} - (\delta)^{0.5}] (z_{w,t})^{0.5} u_{t+1} \) [2]
- \( E[r_{x_{i,t+1}}] = 0.5[\gamma z_{i,t} - \gamma i z_{i,t} + (\delta - \delta i) z_{w,t}] \)
- \( \text{Var}[r_{x_{i,t+1}}] = \gamma i z_{i,t} - \gamma z_{i,t} + [(\delta i)^{0.5} - (\delta)^{0.5}]^2 z_{w,t} \)
Figure 3: Kernel density estimates of distribution of foreign exchange returns depending on interest rate differential. Interest rate differential groups quarterly (Panel A): < -0.005 (dashed red), -0.005 to 0.005 (solid magenta), > 0.005 (dotted blue); weekly (Panel B): < -0.01 (dashed red), -0.01 to 0.01 (solid magenta), > 0.01 (dotted blue).
Carry trades and interest rate shocks

Figure 5: Impulse response functions from VAR(3) for shock to interest rate differential with 90 percent confidence intervals.