Discussion: Currency Risk Factors in a Recursive Multi-Country Economy
by Riccardo Colacito, Max Croce, Federico Gavazzoni, Robert Ready

Harjoat S. Bhamra

Imperial College Business School

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1 Motivation & Contributions

2 Models & Aims

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4 Comments & Conclusions
FX Returns and Countries I

- FX returns – linked to characteristics of countries – their economic structure – trade links – financial flows – fiscal and monetary policy
- FX markets – trillions of dollars traded each day (5 trillion USD per day in 2016), about 100 times daily trade in goods and services
FX Returns and Countries II

- More to FX markets than simple business transactions across borders
- Most of FX trade driven by risk sharing and speculation
FX Returns and Countries III

- FX returns not as well understood as equity returns
- Given huge size of FX markets, why not try and understand risk-return tradeoffs in FX in same way as for equities
  - look at time series of FX premia
  - look at cross-section of FX premia
- Build asset pricing models with SDF’s – at first they won’t fit all empirical facts – refine them and they shall hopefully improve – see work of Backus and co-authors
- Given huge size of FX markets, they could tell us more about SDF then equities. At very least, they should tell us something new!
Paper’s Contributions

- focus on **risk sharing** motive for FX trade
  - assume perfect risk sharing
  - no role for speculation
- **long-run risk** model to explain carry trade and net borrowing/lending
- previous work with long-run risk models in international finance by Max & Ric ('i due re' of recursive international risk sharing)
  - UIP: Colacito and Croce (2011)
  - FX vol and cross country risk sharing: Colacito and Croce (2013)
  - International capital flows Colacito, Croce, Ho, Howard (2014):
- this paper
  - introduce global news shocks – countries have differing (also stochastic and persistent) exposures to global shock
  - statistical assumptions behind the exposures to global shock tantamount to adding in a new form of long-run risk
  - generate risk-return relation for carry trade – make money by investing in currencies with high interest rates while shorting currencies with low interest rates
  - Net Foreign Asset position (countries with low interest rates are net lenders)
\textbf{Model Summary}

- $N$ countries
- Rep agent in each country has EZW preferences (no heterogeneity)
- Cobb-Douglas consumption aggregator, home bias – heterogeneity across countries
- Endowment

\begin{align*}
x_{i,t} &= \mu_x + x_{i,t-1} + z_{i,t-1} - \tau \left[ x_{i,t-1} - \frac{1}{N} \ln \left( \sum_{j=1}^{N} e^{x_{i,t}} \right) \right] + \epsilon_{i,t}^X \quad (1) \\
z_{i,t} &= \rho_i z_{i,t-1} + \epsilon_{i,t}^z, \; \forall i \in \{1, \ldots, N\} \quad (2) \\
\epsilon_{i,t}^z &= (1 + \beta_{i,t-1}^z) \epsilon_{\text{global},t}^z + \tilde{\epsilon}_{i,t}^z \quad (3) \\
\beta_{i,t}^z &= \rho \beta_{i,t-1}^z + \epsilon_{\text{global},t}^{\beta,z} \quad (4)
\end{align*}

- new source of long-run risk – lots of it too! $\rho_z^\beta = 0.999$
Some Puzzles in International Finance

- Explaining size of FX risk premia (UIP failure)
- Explaining cross-sectional differences in FX risk premia (Carry Trades)
- NFA (Net Foreign Assets) and interest rates – countries with low interest rates are net lenders
Use SDF approach to organize way we think about UIP and carry trade (see work of Backus and coauthors)

date-\( t \) price of one unit of home country \( i \)'s consumption at date-\( u \) in units of country \( i \)'s consumption, \( \frac{M_{HC,u}}{M_{HC,t}} \)

\( S_{HC/FC,t} \), date-\( t \) price of one unit of home country's consumption at date-\( t \) in units of foreign country's consumption at date-\( t \) – real exchange rate

No arbitrage

\[
E_t \left[ \frac{M_{HC,u}}{M_{HC,t}} \right] = \frac{1}{S_{HC/FC,t}} E_t \left[ \frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u} \right]
\]  

(5)
FX returns I

- set $u = t + dt$ in

$$E_t \left[ \frac{M_{HC,u}}{M_{HC,t}} \right] = \frac{1}{S_{HC/FC,t}} E_t \left[ \frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u} \right]$$  \hspace{1cm} (6)

- obtain

$$E_t \left[ \frac{dS_{ij,t}}{S_{ij,t}} \right] = (r_{j,t} - r_{i,t}) dt - E_t \left[ \frac{dM_{j,t}}{M_{j,t}} \frac{dS_{ij,t}}{S_{ij,t}} \right]$$  \hspace{1cm} (7)

Risk premium

$$E_t \left[ \frac{dM_{j,t}}{M_{j,t}} \frac{dS_{ij,t}}{S_{ij,t}} \right]$$  \hspace{1cm} (8)
FX returns II

- in log form

\[
E_t [ds_{ij,t}] + \frac{1}{2}E_t[(ds_{ij,t})^2] = (r_{j,t} - r_{i,t}) dt - E_t [dm_{j,t}ds_{ij,t}]
\]

- UIP assumes there is no risk premium – deviations from UIP tell us about

\[
E_t \left[ \frac{dM_{j,t}}{M_{j,t}} \frac{dS_{ij,t}}{S_{ij,t}} \right] = E_t [dm_{j,t}ds_{ij,t}]
\]
Backus-Smith condition

- No arbitrage

\[ E_t \left[ \frac{M_{HC,u}}{M_{HC,t}} \right] = \frac{1}{S_{HC/FC,t}} E_t \left[ \frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u} \right] \]  \hspace{1cm} (10)

- With complete markets

\[ \frac{M_{HC,u}}{M_{HC,t}} = \frac{1}{S_{HC/FC,t}} \frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u} \] \hspace{1cm} (11)

\[ m_{HC,u} - m_{HC,t} = m_{FC,u} - m_{FC,t} + s_{HC/FC,u} - s_{HC/FC,t} \] \hspace{1cm} (12)

\[ \Delta s_{HC/FC,t} = \Delta m_{HC,t} - \Delta m_{FC,t} \] \hspace{1cm} (13)

- Link between real exchange rate and differences between SDF’s across countries (Backus-Smith (1993), Kollman (1991))

\[ ds_{HC/FC,t} = dm_{HC,t} - dm_{FC,t} \]
FPP - regressions

- regression of realized change in log real FX rate against realized interest rate differentials for \( t \in \{0, 1, \ldots, N - 1\} \) (\( N \) observations)

\[
s_{ij,t+1} - s_{ij,t} = \alpha + \beta (r_{j,t} - r_{i,t}) + \epsilon_{t+1} \tag{14}
\]

\[
\beta = \frac{\text{Cov}[s_{ij,t+1} - s_{ij,t}, r_{j,t} - r_{i,t}]}{\text{Var}[r_{j,t} - r_{i,t}]} \tag{15}
\]

where

\[
\Delta s_{ij,t} = s_{ij,t+1} - s_{ij,t} = \Delta m_{i,t} - \Delta m_{j,t} \tag{16}
\]

\[
r_{i,t} = - \left( E[m_{i,t}] + \frac{1}{2} \text{Var}[m_{i,t}] \right) \tag{17}
\]

\[
r_{j,t} - r_{i,t} = - \left( E[m_{i,t} - m_{j,t}] + \frac{1}{2} (\text{Var}[m_{i,t}] - \text{Var}[m_{j,t}]) \right) \tag{18}
\]

- Colacito & Croce (2011) – stochastic volatility generates failure of UIP
- This paper – risk sharing of local shocks – endogenous stochastic vol
Consider return on carry trade on country with low global risk exposure less return on carry trade on country with high global risk exposure, i.e.

\[ E \ln E_t[RX^{k,L}_{t+1}] - E \ln E_t[RX^{k,H}_{t+1}], \] (19)

where

\[ RX^{k,i}_{t+1} = \exp \{ \Delta s_{ki,t+1} - r_{k,t} + r_{i,t} \} \] (20)

From Backus-Smith-Kollman

\[ \ln E_t[RX^{k,i}_{t+1}] = Var_t[\Delta m_{k,t}] - Cov_t[\Delta m_{k,t}, \Delta m_{i,t}]. \] (21)

Hence

\[ \ln E_t[RX^{k,L}_{t+1}] - \ln E_t[RX^{k,H}_{t+1}] = Cov_t[\Delta m_{k,t}, \Delta m_{L,t} - \Delta m_{H,t}] \] (22)

- want \( Cov_t[\Delta m_{k,t}, \Delta m_{L,t}] \) and \( Cov_t[\Delta m_{k,t}, \Delta m_{H,t}] \) to be different
- heterogeneity in magnitudes of risk prices
- heterogeneous exposures to global shocks – carry trade returns
NFA I

- NFA: value of overseas assets owned by a nation, minus the value of its domestic assets that are owned by foreigners, $NFA > 0$ for net lender

- Negative global shock means country with low exposure to global shock (AUS) will export more to high exposure countries (CHF) in the future, reducing NFA of low exposure countries

- Negative global shocks assigned more probability mass under $Q$ because of EZW preferences, so mean NFA of low exposure countries is negative

**FIG. 7** - Each dot represents the estimated sensitivity of the net foreign assets over GDP of a country with respect to global long-run risk (see equation (20), coefficient $\lambda_i^{NFA}$). For each dot, the vertical line represents the 90% confidence interval associated to the estimated coefficient. The dashed line corresponds to the point estimate of the line $\theta_0^{NFA} + \theta_i^{NFA} \cdot \beta_i^z$ in equation (21). The estimated $\beta_i$'s are reported in Table 1. Standard errors are adjusted for heteroscedasticity.
Compute portfolio weight – extend Cochrane’s SDF approach to international context

If we had a nice equation for this, could understand more of this paper’s dark matter

should have a myopic component (scaled mean-variance portfolio) and an intertemporal hedging component (long-run risks, exposure to global shocks)

decompose NFA into component asset classes – bonds and equity are not the same but appear in undifferentiated form within NFA
Net Foreign Asset Position – Suggestions II

Data Source: Federal Reserve, Bureau of Economic Analysis

www.cfr.org/cgs
Test Time Series Implications of Model I

- Model has strong implications for short-run time series behavior of capital account etc, in response to global shocks
- Are the observed capital account dynamics of AUS and CHF consistent with simulated data from model?
- What about Germany and the US?

Net Foreign Assets and Capital Gains/Losses
In percent of GDP

[Graph showing net foreign asset position and cumulative net capital gain/loss for Germany and USA from 1991 to 2012]
Test Time Series Implications of Model II
What are the underlying economic differences driving heterogeneity in exposure to global shocks?

Is it related to trade networks? E.g. Richmond (2016)

- Trade network centrality is highly persistent
- Explore the relationship between a country's trade network centrality and its exposure to global shocks
- Mathematically, the relationship is positive (see Proposition 1 in Richmond (2016))
- Germany is central to trade networks, but Norway?
- What does a plot of your exposures against Richmond's trade network centrality measures reveal?
- What does Richmond (2016) find vis-a-vis centrality and risk premia?

<table>
<thead>
<tr>
<th>Panel C: Exposure to Global Long-Run Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZ</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>$\beta^*$</td>
</tr>
<tr>
<td>(S.E.)</td>
</tr>
<tr>
<td>Chow</td>
</tr>
</tbody>
</table>
$y = 0.11x + 1.2$

Linear: norm of residuals = 0.18386
### Table 2: Portfolios Sorted on Centrality and Forward Spreads

<table>
<thead>
<tr>
<th></th>
<th>Panel A: Trade Network Centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peripheral</td>
</tr>
<tr>
<td>Previous Centrality: $v_{it-12}$</td>
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</tr>
<tr>
<td>mean</td>
<td>1.08</td>
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<tr>
<td>Forward Spread: $f_t - s_t$</td>
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<tr>
<td>mean</td>
<td>5.42</td>
</tr>
<tr>
<td>std</td>
<td>1.23</td>
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<tr>
<td>se</td>
<td>0.23</td>
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<tr>
<td>Risk Premia: $r_{xt}$</td>
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</tr>
<tr>
<td>mean</td>
<td>4.62</td>
</tr>
<tr>
<td>std</td>
<td>7.53</td>
</tr>
<tr>
<td>se</td>
<td>1.38</td>
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<tr>
<td>Sharpe ratio</td>
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</tr>
<tr>
<td>mean</td>
<td>0.61</td>
</tr>
<tr>
<td>se</td>
<td>0.21</td>
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<tr>
<td>Real Interest Differential: $r_{it} - r_t$</td>
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</tr>
<tr>
<td>mean</td>
<td>2.73</td>
</tr>
<tr>
<td>std</td>
<td>0.52</td>
</tr>
<tr>
<td>se</td>
<td>0.10</td>
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<tr>
<td>Consumption Growth Coefficient: $\beta_i$</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>0.13</td>
</tr>
<tr>
<td>se</td>
<td>0.23</td>
</tr>
</tbody>
</table>
There is link between centrality and global shock exposure which needs to be looked at more carefully.
How to become a high (or low) exposure country?

- The UK is Europe’s investment banker (Mark Carney says so) and the US is the world’s investment banker, but their exposures are different
- What are the pros and cons of high exposure?
- Does welfare change much if exposure to global shocks changes?
- If citizens desire less exposure, how can this be brought about?
If you slightly reduce persistence of global shock exposure, by how much do cross-sectional differences in FX premia fade away?
Conclusions

- Intriguing that a small addition to a fairly standard consumption-based international finance model with recursive preferences can generate sizable cross-sectional heterogeneity in FX premia.
- More on time series of NFA from model relative to data.
- Breakdown NFA into asset classes.
- Economics underlying global risk exposure – relation to trade centrality (Richmond (2016)).