Origins of International Factor Structures

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This paper

- **Theory:** A model to link international trade to a measure of network closeness

- **Empirical work:** In the data, countries that are closer in the network tend to have more correlated exchange rates and stock returns

- **Bottom line:** The trade network generates factor structures in equity returns and exchange rate movements
Discussion

- Background:
  - Why do we need this research
- Overview of the model and empirical results
  - What each assumption buys us
- Comments
  - A simple suggestion to go further
Risk and Returns in Currency Portfolios

- Carry trade risk: sort currencies by their short-term interest rates

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- “Global” risk: sort currencies by their exchange rate FX betas, long if average interest rate > U.S. interest rate, short otherwise

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- Two long-short factors built from the two cross-sections of returns above describe a significant share of the bilateral exchange rates (20% to 80% depending on the country)
Global and Country-Specific Shocks in Exchange Rates

- Let $s_{t+1}^i$ denote the log exchange rate of country $i$, in units of U.S. dollar per foreign currency. When $s_{t+1}^i$ increases, the foreign currency appreciates.

- Let $f_{t+1}$ denote global shocks and $\epsilon_{t+1}^i$ and $\epsilon_{t+1}^d$ denote country-specific shocks:

$$\Delta s_{t+1}^i = \alpha^i + \delta^i f_{t+1} + \epsilon_{t+1}^i + \epsilon_{t+1}^d.$$ 

- Assuming that the country-specific shocks $\epsilon_{t+1}^i$ average out:

$$\text{Base Factor}^i_{t+1} \equiv \frac{1}{N} \sum_i \Delta s_{t+1}^i = \frac{1}{N} \sum_i \alpha^i + \frac{1}{N} \sum_i \delta^i f_{t+1} + \epsilon_{t+1}^d.$$
Global Shocks and Heterogeneity to Account for Betas

\[
\Delta s_{t+1}^\$ = \alpha^i + \delta^i f_{t+1} + \epsilon^i_{t+1} + \epsilon^\$_{t+1}
\]

\[
\text{Base Factor}_{t+1}^\$ = \frac{1}{N} \sum_i \alpha^i + \frac{1}{N} \sum_i \delta^i f_{t+1} + \epsilon^\$_{t+1}
\]

- Regress \( \Delta s_{t+1}^\$ \) on the Base factor:

\[
\beta_{Base, t}^{\$, i} = \frac{\text{cov}_t(\Delta s_{t+1}^\$, i, \text{Base Factor}_{t+1}^\$)}{\text{var}_t(\text{Base Factor}_{t+1}^\$)} = \frac{\text{var}_t(\epsilon^\$_{t+1})}{\text{var}_t(\text{Base Factor}_{t+1}^\$)} + \frac{\text{cov}_t(\delta^i f_{t+1}, \frac{1}{N} \sum_j \delta^j f_{t+1})}{\text{var}_t(\text{Base Factor}_{t+1}^\$)}
\]

- The first term is the same for all currencies \( i \).

- To reproduce differences in betas, we need some global shocks \( f_{t+1} \) and some heterogeneity (\( \delta^i \neq \delta^j \)) across countries. **Where do they come from?**

  - In complete markets, \( \Delta s_{t+1}^\$, i = m_{t+1}^i - m_{t+1}^\$ \), where \( m \) denotes the log SDF.
    Are global SDF shocks due to global primitive shocks or due to trade?

- That’s why we need to study the Origins of International Factor Structures
Model: Key Ingredients & Results

- **Ingredients:**
  - N countries, log utility
  - Each country produces one good that is both an intermediary input in everyone’s production function and a consumption good
  - No storage technology

- **Closed-form results:**
  - Optimal production and consumption
  - Exchange rate changes
  - Return on wealth
Exchange Rates in Complete Markets

- Let $M$ and $M^i$ denote the domestic and foreign SDFs:

\[
E_t \left( M_{t+1} R_{t+1} \right) = 1,
\]

\[
E_t \left( M_{t+1}^i R_{t+1} \frac{S_t^i}{S_{t+1}^i} \right) = 1
\]

where $S_t^i$ denotes the nominal exchange rate in domestic currency (e.g., U.S. dollars) per unit of foreign currency. When $S_t^i$ increases, the foreign currency appreciates.

- In complete markets, there is only one way to price an asset. Thus, the log change in exchange rates is:

\[
\Delta s_{t+1}^i = m_{t+1}^i - m_{t+1}
\]
Log utility

- In complete markets, the log change in exchange rates is:

\[ \Delta s_{t+1}^i = m_{t+1}^i - m_{t+1} \]

- With log utility: \( \Delta s_{t+1}^i = \Delta c_{t+1} - \Delta c_{t+1}^i \) (cf. Backus and Smith, 1993)

- With log utility, the price of the wealth portfolio is:

\[
P_W^t = E_t \sum_{j=1}^{\infty} \beta^j \frac{u'(C_{t+j})}{u'(C_t)} C_{t+j} = E_t \sum_{j=1}^{\infty} \beta^j \frac{C_t}{C_{t+j}} C_{t+j} = \frac{\beta}{1-\beta} C_t.
\]

- Thus the return on wealth is proportional to consumption growth:

\[
R_{t+1}^W = \frac{P_{t+1}^W + C_{t+1}}{P_t^W} = \frac{1}{\beta} \frac{C_{t+1}}{C_t}
\]

- Once we know consumption growth, we know the exchange rate change and the return on wealth
Consumption bundle & Production function

- **Consumption bundle**

\[
\overline{C}_{it} = \prod_{j=1}^{n} C_{ijt}^{v_{ij}} \text{ where } \sum_{j=1}^{n} v_{ij} = 1, \; v_{ij} > 0
\]

- **Production function**

\[
\overline{X}_{it} = A_{it} L_{it}^{\theta_i} \prod_{j=1}^{n} X_{ijt}^{w_{ij}} \text{ where } \theta_i + \sum_{j=1}^{n} w_{ij} = 1, \; \theta_i, \; w_{ij} > 0
\]

- **Primitive shocks:** \( a_{i,t+1} = a_{it} + \epsilon_{it+1} \)

- **Note the heterogeneity in input of consumption goods** \( v_{ij} \), **in input shares of intermediate goods** \( w_{ij} \), **and in labor shares** \( \theta_i \)

- **Elegant solution in terms of trade network matrices** \( V \) and \( W \):

\[
\Delta \overline{C}_{it} = V (I - W)^{-1} \epsilon_{t+1}
\]
Suggestions

- Interpretation of the FX moments:
  - Country-specific shocks or exposure to global factors?
  - What is the key source of heterogeneity? Different home-biases in consumption? Different labor shares? Different input shares?

- Interpretation of the equity moments:
  - Equity return correlations appear significantly related to network closeness, but the return on wealth may not be the return on equity

- Endogenous network? Other measures of closeness?
Base factor variances versus those implied by the network closeness. Network closeness is constructed as the implied correlation of consumption from the world input output network assuming that shocks across countries are iid.
Interpretation of the base factor variance?

\[
\Delta s_{t+1}^{\$,i} = \alpha^i + \delta^i f_{t+1} + \epsilon_{t+1}^i + \epsilon_{\$ t+1} \\
\text{Base Factor}_{t+1}^{\$} = \frac{1}{N} \sum_i \alpha^i + \frac{1}{N} \sum_i \delta^i f_{t+1} + \epsilon_{\$ t+1}
\]

• The variance of the base factor is:

\[
\text{Var}(\text{Base Factor}_{t+1}^\$) = \left( \frac{1}{N} \sum_i \delta^i \right)^2 \text{Var}(f_{t+1}) + \text{var}(\epsilon_{t+1}^\$)
\]

• By triangular arbitrage: \( s_{t+1}^{\text{CHF},i} = s_{t+1}^{\text{CHF},\$} \times s_{t+1}^{\$,i} \), and thus:

\[
\Delta s_{t+1}^{\text{CHF},i} = \Delta s_{t+1}^{\$,i} - \Delta s_{t+1}^{\$,\text{CHF}} = \alpha^i - \alpha^{\text{CHF}} + (\delta^i - \delta^{\text{CHF}}) f_{t+1} + \epsilon_{t+1}^i - \epsilon_{\text{CHF} t+1}.
\]

• And the variance of the corresponding base factor is:

\[
\text{Base Factor}_{t+1}^{\text{CHF}} = \frac{1}{N} \sum_i \Delta s_{t+1}^{\text{CHF},i} = \cdots + \left( \frac{1}{N} \sum_i \delta^i - \delta^{\text{CHF}} \right) f_{t+1} - \epsilon_{t+1}^{\text{CHF}}
\]

\[
\text{Var}(\text{Base Factor}_{t+1}^{\text{CHF}}) = \left( \frac{1}{N} \sum_i \delta^i - \delta^{\text{CHF}} \right)^2 \text{Var}(f_{t+1}) + \text{Var}(\epsilon_{t+1}^{\text{CHF}})
\]
Interpretation of the base factor variance?

- The variance of the dollar base factor is:
  \[
  \text{Var}(\text{Base Factor}^\$_{t+1}) = \left( \frac{1}{N} \sum_i \delta^i \right)^2 \text{Var}(f_{t+1}) + \text{Var}(\epsilon^\$_{t+1})
  \]

- The variance of CHF base factor is:
  \[
  \text{Var}(\text{Base Factor}^{CHF}_{t+1}) = \left( \frac{1}{N} \sum_i \delta^i - \delta^{CHF} \right)^2 \text{Var}(f_{t+1}) + \text{Var}(\epsilon^{CHF}_{t+1})
  \]

- When looking at differences in the variances of the base factor, are we learning about differences in \( \delta^i \) across countries or differences in the variances of the country-specific shocks, i.e. var(\( \epsilon^\$_{t+1} \)) vs Var(\( \epsilon^{CHF}_{t+1} \))? 

- Let's go for more direct measures of the \( \delta^i \)'s in the data.

- Among the three sources of heterogeneity in the model that are linked to the network structure, which one matters?
Hope

Loading of the EUR/USD bilateral rate on the CHF-based global factor, obtained from 5-min data over non-overlapping weekly samples.
I really liked this paper! This is exactly the kind of research we need to understand exchange rates.

Elegant model that justifies interesting empirical work

- Network-induced global shocks matter more for the FX factor structure than global primitive shocks

Suggestions:

- Disentangle the exposures to global SDF shocks from the volatilities of country-specific SDF shocks
- Narrow down the list of cross-country differences that the subsequent literature will have to study & explain