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

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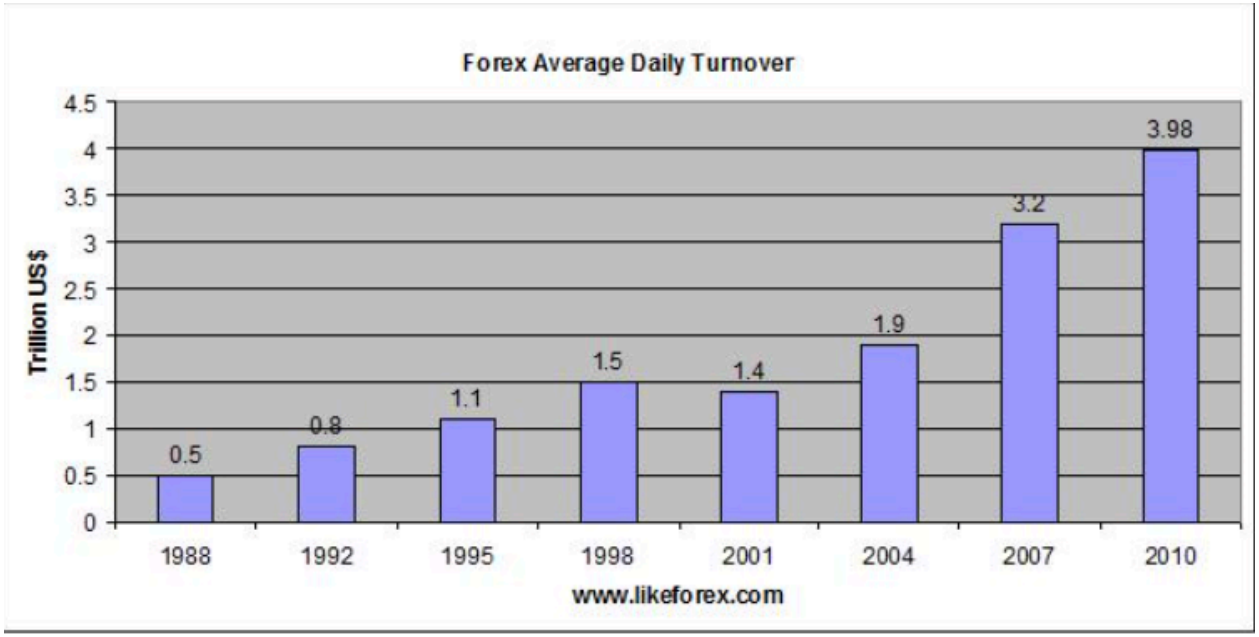
FX Returns and Countries I

- 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)

Model Summary

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

$$x_{i,t} = \mu_x + x_{i,t-1} + z_{i,t-1} - \tau \left[x_{i,t-1} - \frac{1}{N} \ln \left(\sum_{j=1}^{N} e^{x_{i,t}} \right) \right] + \epsilon^x_{i,t} \quad (1)$$

$$z_{i,t} = \rho_i z_{i,t-1} + \epsilon^z_{i,t}, \ \forall i \in \{1, \ldots, N\} \quad (2)$$

$$\epsilon^z_{i,t} = (1 + \beta^z_{i,t-1}) \epsilon^z_{\text{global},t} + \epsilon^{\tilde{z}}_{i,t} \quad (3)$$

$$\beta^z_{i,t} = \rho^\beta_z \beta^z_{i,t-1} + \epsilon^{\beta,z}_{i,t} \quad (4)$$

- new source of long-run risk – lots of it too! $\rho^\beta_z = 0.999$

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

Asset Pricing Theory and International Finance I

- 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, $\frac{M_{\text{HC},u}}{M_{\text{HC},t}}$
- $S_{HC/FC,t}$, 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

$$E_t\left[\frac{M_{HC,u}}{M_{HC,t}}\right] = \frac{1}{S_{HC/FC,t}} E_t\left[\frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u}\right] \tag{5}$$

FX returns I

- set $u = t + dt$ in

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

- obtain

$$E_t\left[\frac{dS_{ij,t}}{S_{ij,t}}\right] = (r_{j,t} - r_{i,t})dt - \underbrace{E_t\left[\frac{dM_{j,t}}{M_{j,t}}\frac{dS_{ij,t}}{S_{ij,t}}\right]}_{\text{risk premium}} \tag{7}$$

(8)

FX returns II

- in log form

$$\boxed{E_t\left[ds_{ij,t}\right] + \frac{1}{2}E_t[(ds_{ij,t})^2] = (r_{j,t} - r_{i,t})dt - \underbrace{E_t\left[dm_{j,t}ds_{ij,t}\right]}_{\text{risk premium}}} \tag{9}$$

- UIP assumes there is no risk premium – deviations from UIP tell us about $E_t\left[\frac{dM_{j,t}}{M_{j,t}}\frac{dS_{ij,t}}{S_{ij,t}}\right] = E_t\left[dm_{j,t}ds_{ij,t}\right]$

Backus-Smith condition

- No arbitrage

$$E_t\left[\frac{M_{HC,u}}{M_{HC,t}}\right] = \frac{1}{S_{HC/FC,t}} E_t\left[\frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u}\right] \tag{10}$$

- With complete markets

$$\frac{M_{HC,u}}{M_{HC,t}} = \frac{1}{S_{HC/FC,t}} \frac{M_{FC,u}}{M_{FC,t}} S_{HC/FC,u} \tag{11}$$

$$m_{HC,u} - m_{HC,t} = m_{FC,u} - m_{FC,t} + s_{HC/FC,u} - s_{HC/FC,t} \tag{12}$$

$$\tag{13}$$

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

$$\boxed{\Delta s_{HC/FC,t} = \Delta m_{HC,t} - \Delta m_{FC,t}}$$

or

$$\boxed{ds_{HC/FC,t} = dm_{HC,t} - dm_{FC,t}}$$

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)

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

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

where

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

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

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

- Colacito & Croce (2011) – stochastic volatility generates failure of UIP
- This paper – risk sharing of local shocks – endogenous stochastic vol

Carry Trade

- 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.

$$E \ln E_t[RX_{t+1}^{k,L}] - E \ln E_t[RX_{t+1}^{k,H}], \tag{19}$$

where

$$RX_{t+1}^{k,i} = \exp\{\Delta s_{ki,t+1} - r_{k,t} + r_{i,t}\} \tag{20}$$

From Backus-Smith-Kollman

$$\ln E_t[RX_{t+1}^{k,i}] = Var_t[\Delta m_{k,t}] - Cov_t[\Delta m_{k,t}, \Delta m_{i,t}]. \tag{21}$$

Hence

$$\ln E_t[RX_{t+1}^{k,L}] - \ln E_t[RX_{t+1}^{k,H}] = Cov_t[\Delta m_{k,t}, \Delta m_{L,t} - \Delta m_{H,t}] \tag{22}$$

- want $Cov_t[\Delta m_{k,t}, \Delta m_{L,t}$ and $\mathrm{Cov}_t[\Delta m_{k,t}, \Delta m_{H,t}$ 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 $\mathbb{Q}$ because of EZW preferences, so mean NFA of low exposure countries is negative

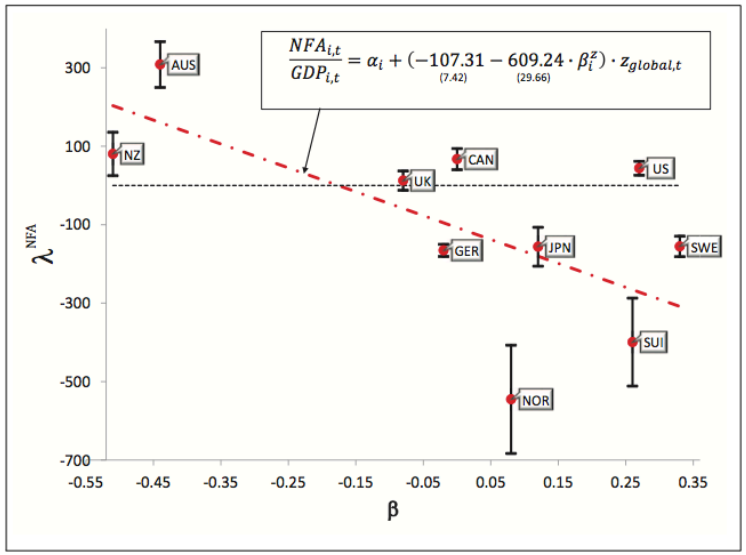
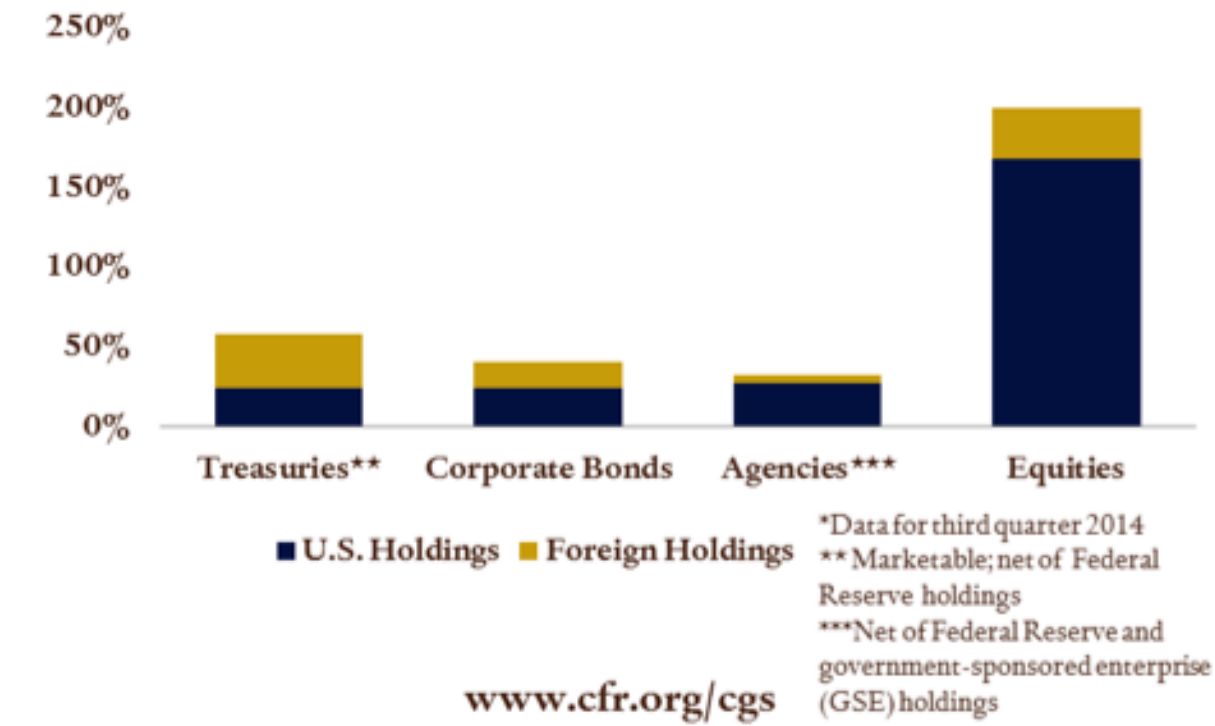


FIG. 7 - Each dot represents the estimated sensitivity of the net foreign assets over GDP of a country with respect to global long-run risk (see equation (20), coefficient λ_i^{NFA}). For each dot, the vertical line represents the 90% confidence interval associated to the estimated coefficient. The dashed line corresponds to the point estimate of the line $\vartheta_0^{NFA} + \vartheta_1^{NFA} \cdot \beta_i^z$ in equation (21). The estimated β's are reported in Table 1. Standard errors are adjusted for heteroscedasticity.

Net Foreign Asset Position – Suggestions I

- 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

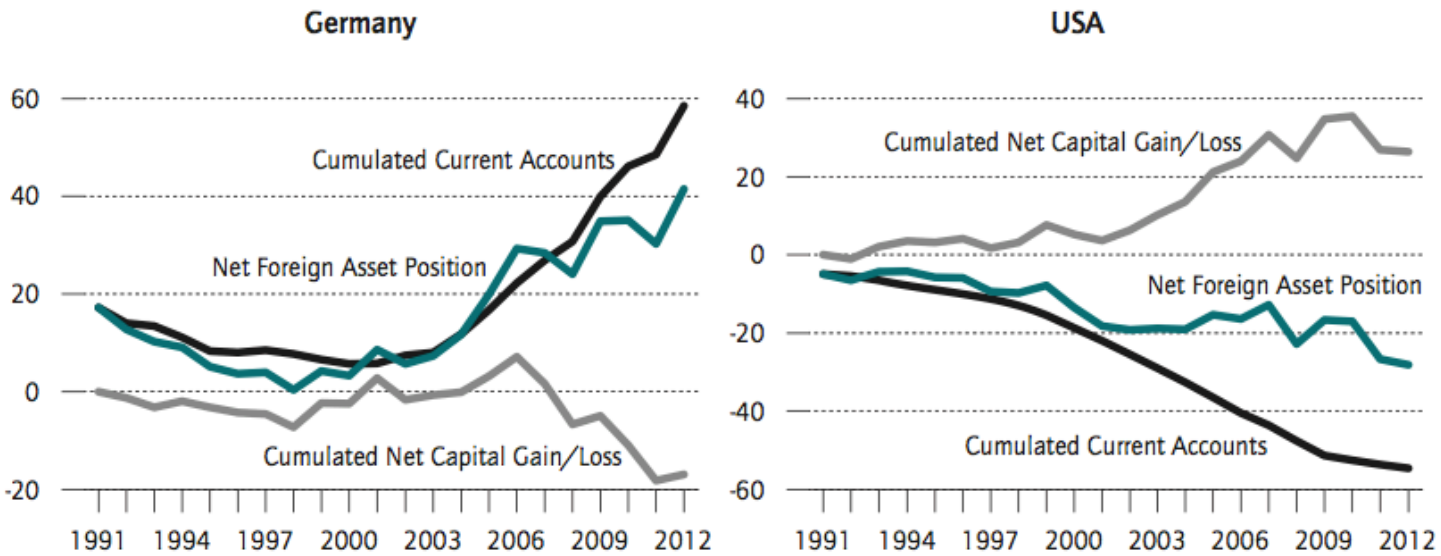


Data Source: Federal Reserve, Bureau of Economic Analysis

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



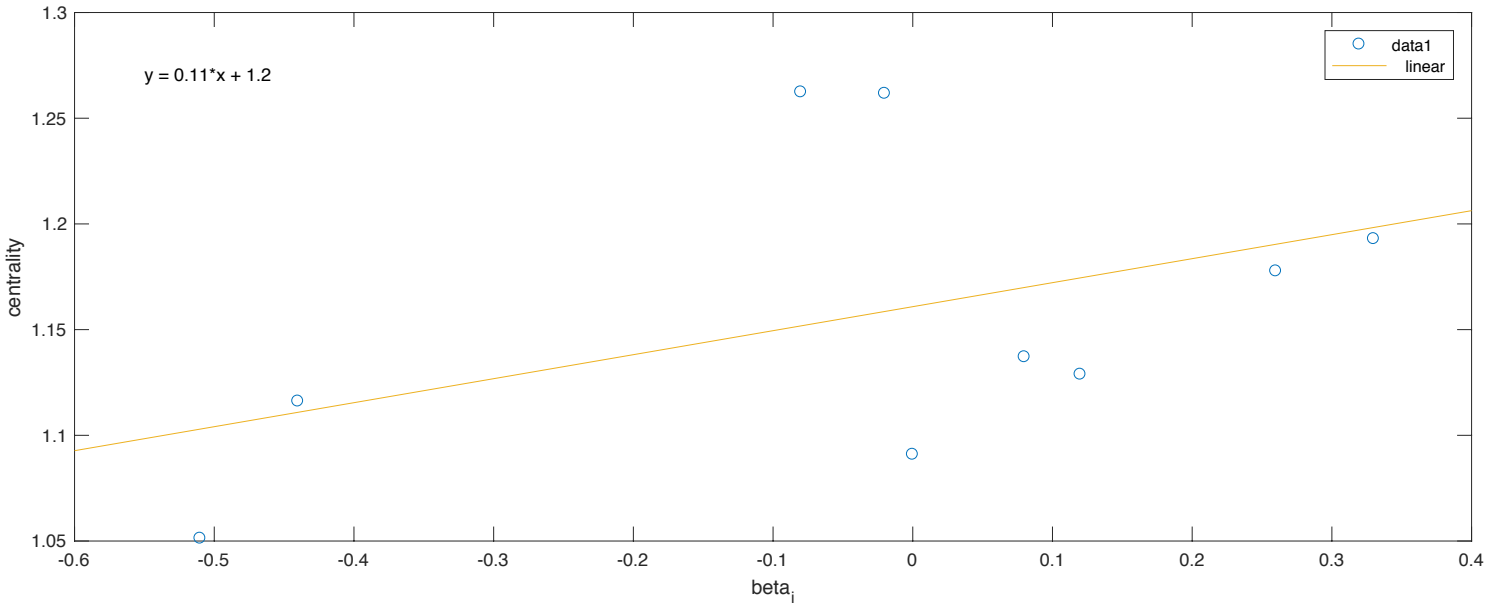
Test Time Series Implications of Model II

Trade Centrality and Exposure to Global Shocks I

- 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 it's 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?

Panel C: Exposure to Global Long-Run Risk

	NZ	AUS	UK	GER	CAN	NOR	JPN	SUI	US	SWE
β^i	-0.51^{***}	-0.44^{***}	-0.08	-0.02	0.00	0.08	0.12	0.26^{**}	0.27^{*}	0.33^{**}
(S.E.)	(0.154)	(0.064)	(0.098)	(0.094)	(0.131)	(0.173)	(0.165)	(0.130)	(0.166)	(0.148)
Chow	[0.109]	[0.245]	[0.299]	[0.841]	[0.729]	[0.506]	[0.802]	[0.667]	[0.596]	[0.385]


y = 0.11*x + 1.2
data1
linear
centrality
beta_i
1.3
1.25
1.2
1.15
1.1
1.05
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

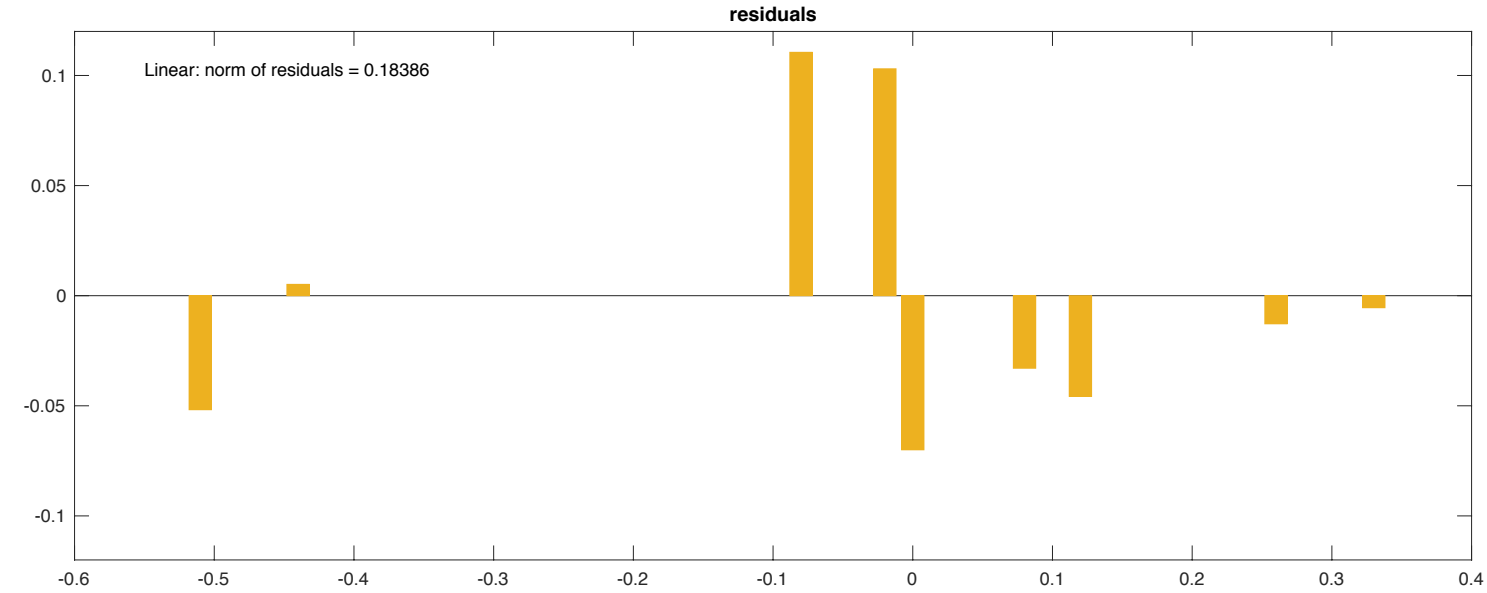

residuals
Linear: norm of residuals = 0.18386
0.1
0.05
0
-0.05
-0.1
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

Table 2: Portfolios Sorted on Centrality and Forward Spreads

	Panel A: Trade Network Centrality				
	Peripheral	2	3	Central	PMC
Previous Centrality: v_{it-12}					
mean	1.08	1.13	1.19	1.36	-0.28
Forward Spread: $f_t - s_t$					
mean	5.42	1.66	1.42	0.01	5.41
std	1.23	0.56	0.60	0.51	1.24
se	0.23	0.10	0.11	0.09	0.23
Risk Premia: rx_t					
mean	4.62	2.84	2.59	1.62	3.01
std	7.53	9.10	8.80	6.05	5.95
se	1.38	1.66	1.62	1.10	1.10
Sharpe ratio					
mean	0.61	0.31	0.29	0.27	0.50
se	0.21	0.19	0.19	0.19	0.20
Real Interest Differential: $r_{it} - r_t$					
mean	2.73	1.10	0.95	0.55	2.18
std	0.52	0.58	0.57	0.57	0.62
se	0.10	0.11	0.11	0.11	0.11
Consumption Growth Coefficient: β_i					
mean	0.13	0.52	0.54	0.85	-0.72
se	0.23	0.05	0.07	0.08	0.30

- 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?

Usual LRR Model Complaints

- 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 premie
- 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))