Invoicing Currency Concentration And Currency Risk Premia

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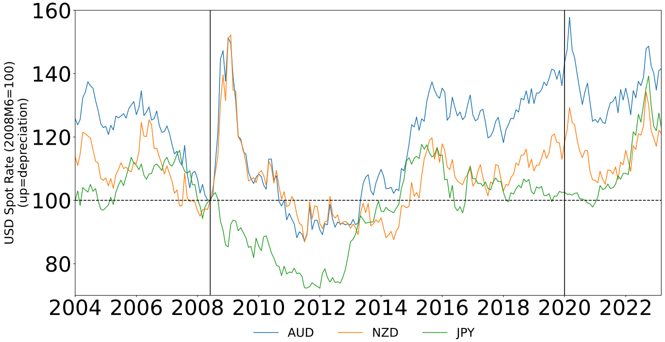
Currency Risk Premia

Carry trade/UIP deviations can be motivated as risk premia
(Lustig & Verdelhan 2007)

- The Yen (JPY) ***appreciates*** in global "bad times"



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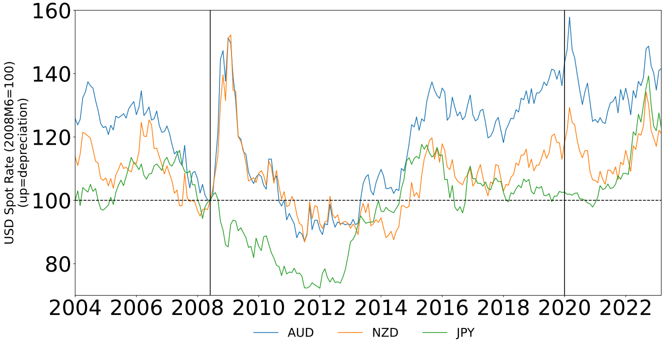

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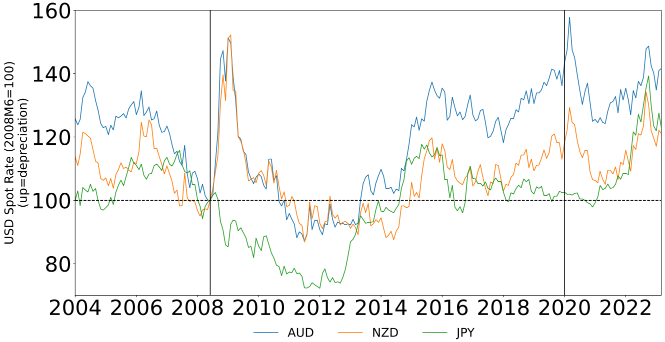
- The Yen (JPY) ***appreciates*** in global “bad times”
- The New Zealand Dollar (NZD) ***depreciates*** in global “bad times”
- For an investor in Hong Kong: Safe JPY Assets $\succ$ Safe NZD assets
- Yields on safe JPY assets < yields on safe NZD assets



Understanding this:

- Under log-normality of SDFs (M^i) and real exchange rates (Q_i^j): (Engel, 2014 Handbook Chapter)

$$\lambda_{i,t}^j \equiv \underbrace{r_{i,t} - r_{j,t} + \mathbb{E}\left[\Delta q_{i,t+1}^j\right]}_{\text{UIP gap}} = -\text{Cov}_t\left(\frac{m_{t+1}^i + m_{t+1}^j}{2}, \Delta q_{i,t+1}^j\right).$$

- Cov$(SDF, return_i - return_j)$.
- Except pricing kernel is an *average* of each country's SDF.

Any macro/finance theory explaining carry trade needs to:

- Model global bad states $(m^i + m^j) \uparrow$.
- Model which currencies appreciate and which depreciate in bad times $\Delta q_i^j \uparrow\downarrow$?.
- Key: global shocks (SDFs co-move) but asymmetric exposure (Δq_i^j changes)!

Previous work and our work:

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- Countries producing downstream/final goods have more global influence.
- Global Production Networks: Central countries have out-sized influence.

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- Dominance of the USD and Euro in global trade amplify US & Euro Area shocks.
- Bad shock in US $m^{US} \uparrow$ = bad shock globally $m^{i} \uparrow$ and $\Delta q_{USD}^{j} \uparrow$.

What we do:

Model:

- Currency invoicing and bond pricing in a tractable multi-country model.
- ***No financial frictions*** : markets are complete.
- ***Trade frictions:*** prices are sticky *bilaterally* in an arbitrary currency.

Empirical: ***Link currency composition to***

1. Bilateral consumption correlations.
2. Carry trade risk premia.

What we find:

Currency Concentration of Consumption **(CCC)** $\rightarrow$ **Carry trade risk premia**

- US/EU/Japan ***consume*** largely in their own currencies $\rightarrow$ low rates!
- US dominance in non-US trade – less relevant for risk free rates.

Empirical Result #1: Bilateral consumption correlations

- *Covariances* of common currencies explain **consumption correlations.**
  - Even controlling for correlation with world consumption.
- Consistent with model mechanism

Empirical Result 2: Carry Trade Factors

- **CCC** can explain Forward/Spot spreads (measure of $r_i^{rf} - r_{US}^{rf}$).
  - Even when controlling for size and centrality.
- Portfolio sorts on **CCC** show that it explains much of (unconditional) carry trade.

Sketch of model

- Open-economy New-Keynesian model with N countries, 2 periods ($t = 0, 1$).
- Households have log-linear utility:

$$U^k = \log(C_0^k) - L_0^k + \beta E_0 \left[\log(C_1^k) - L_1^k\right].$$

- Armington structure:
  - Cobb-Douglas aggregator: $C_t^k = \prod_{n=1}^N \left(C_{n,t}^k\right)^{\omega_n^k}$.
  - CRS production: $Y_t^k = Z_t^k L_t^k$.
- Price stickiness and invoicing currency:
  - Prices from origin n to destination k fully rigid in some currency j: $p_n^k = \bar{p}_n^j \times \mathcal{E}_j^k$ ($\bar{p}_n^j$ normalized to 1, $\mathcal{E}_j^k \equiv$ nominal ER)

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  - **Nests popular benchmarks:**
    Producer Currency Pricing (PCP) — set $j = n \; \forall n$

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    Dominant Currency Pricing (DCP) — set $j = \begin{cases} d & \text{if } n \neq k \\ n & \text{if } n = k \end{cases}$

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  - Let γ_j^k denote (exogenous) aggregate share of country k's consumption invoiced in currency j.
    $\gamma_j^k \equiv \sum_{n=1}^{N} \omega_n^k \mathbb{1}_{n,j}^k$ — ($\mathbb{1}_{n,j}^k = 1$ if trade from n to k is in currency j)

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- Financial markets are complete (payoffs in some nominal currency).
- Monetary policy stabilizes nominal marginal costs in each country.

Invoicing currencies & consumption risk

- Consumption growth between dates 0 and 1 given by

$$\Delta c_1^k = \sum_{j=1}^{N} \gamma_j^k z_1^j.$$

- Efficient allocation (or sticky prices with PCP), where $\Delta c_1^k = \sum_{j=1}^{N} \omega_j^k z_1^j$.

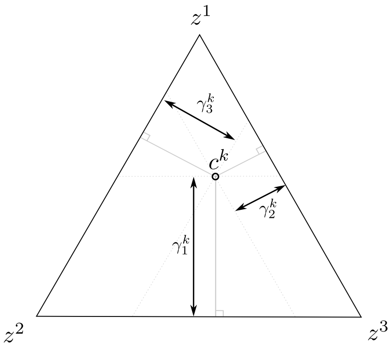

Figure: Consumption risk for country k.

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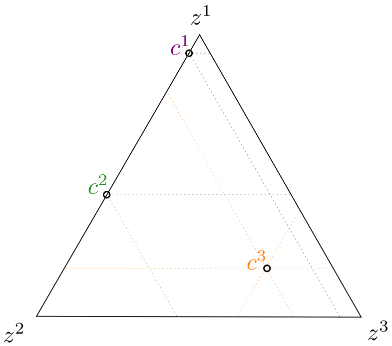
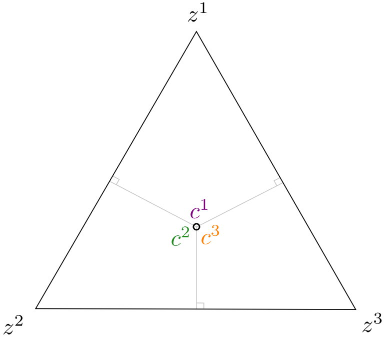


Figure: Equilbrium allocation of consumption risk.

Consumption risk exposures under PCP vs DCP

Illustration with 3 countries of symmetric size, no home bias ($N = 3$, $\omega_j^k = \theta_k = 1/3\ \forall j,k$)

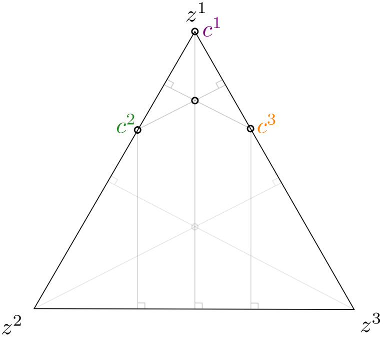
PCP



Perfect risk-sharing
+ balanced exposures

$$\forall k\colon\ c^k = \tfrac{1}{3}z^1 + \tfrac{1}{3}z^2 + \tfrac{1}{3}z^3$$

DCP



Imperfect risk-sharing
+ imbalanced exposures

$$c^1 = z^1; \quad c^k = \tfrac{2}{3}z^1 + \tfrac{1}{3}z^k \text{ for } k = 2,3$$

▸ home-bias ▸ asymmetric size

Invoicing currencies & return differences

Log currency risk premium (UIP deviation) between countries n and k:

$$\lambda_{n,0}^{k} \equiv r_0^n - r_0^k + E_0[\Delta q_{n,1}^k]$$
$$= -Cov_0\left(\frac{m_1^n + m_1^k}{2}, \Delta q_{n,1}^k\right)$$

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$$= -\sum_{i=1}^{N}\sum_{j=1}^{N} \underbrace{-\frac{\gamma^k_i + \gamma^n_i}{2}}_{\substack{\text{Exposure of}\\ \text{average SDF}\\ \text{to country } i \text{ risk}}} \times \underbrace{\left(\gamma^k_j - \gamma^n_j\right)}_{\substack{\text{Exposure of}\\ \text{real exchange rate}\\ \text{to country } i \text{ risk}}} \times \underbrace{\sigma_{z,i}\sigma_{z,j}\rho_{i,j}}_{\substack{\text{Correlation}\\ \text{structure}\\ \text{of shocks}}}.$$

- To simplify: assume no correlation of shocks $\rho_{i,j} = \mathbb{1}_{i=j}$

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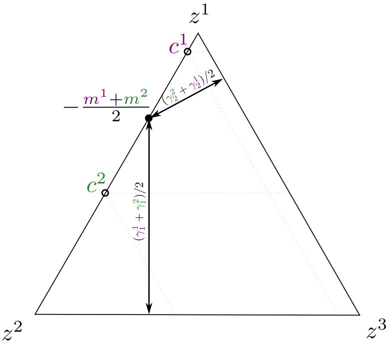

Figure: Determination of most relevant shock for a country pair.

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- Lowest return on currency that is best hedge against most relevant shocks.

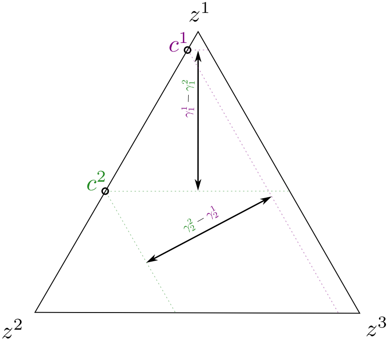
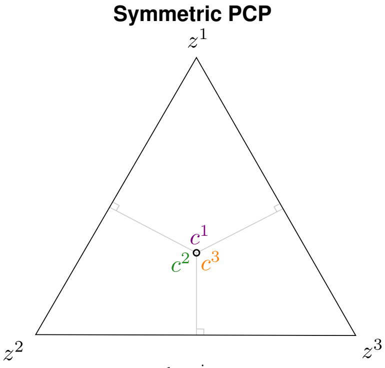


Figure: Risk properties of (real) currencies.

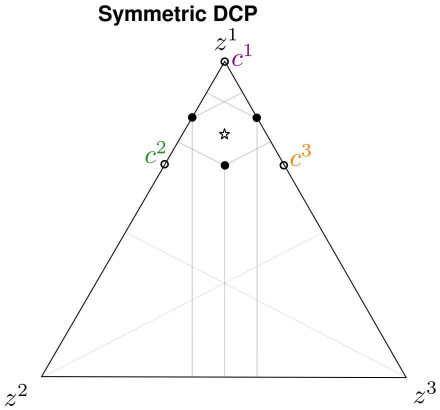
Risk premia under PCP/DCP

Illustration with 3 countries of symmetric size, no home bias ($N = 3$, $\omega_j^k = \theta_k = 1/3\ \forall j,k$)



Same c^k, $q_i^j = 1$, $\forall i, j$

Same SDF, same risk-free rates



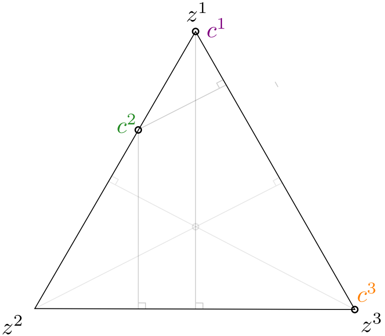
All m^i loads highest on z^1

$q_1^k \uparrow$ when $z^1 \downarrow$

Country 1 has lowest risk free rates

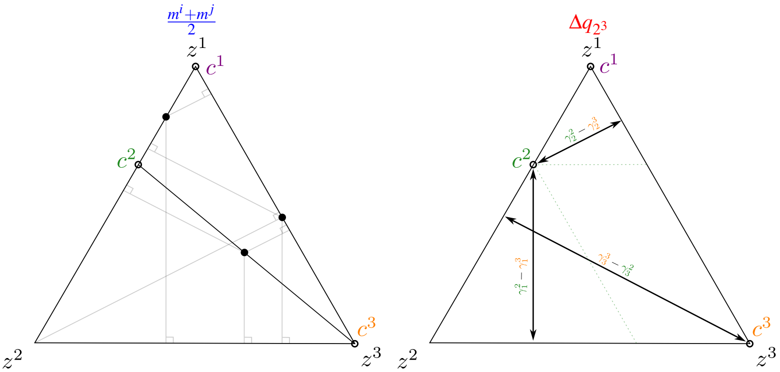
Final Example – Euro/Japan

Consumption



Same as DCP graph except 3 is 100% own currency

Final Example – Euro/Japan



Two effects:

1. Pricing kernel $(m^2+m^3)/2$ exposure to z^2 and z^3 are low

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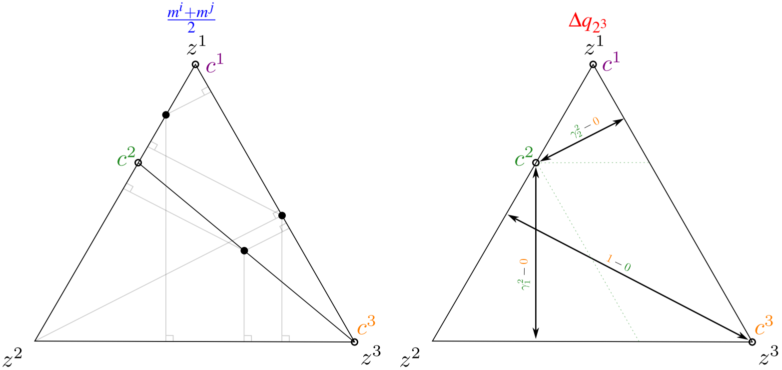

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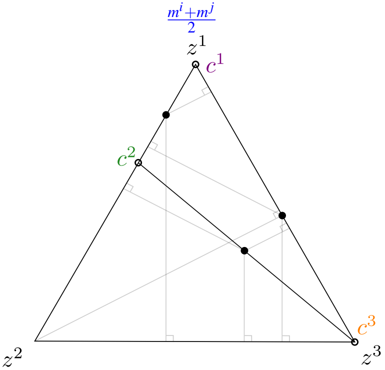

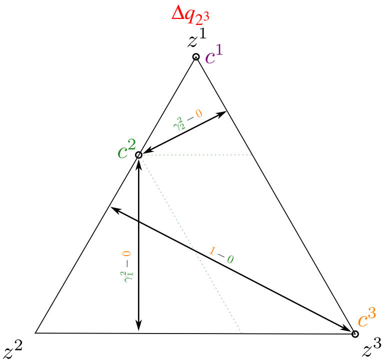

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End result:

◇ $r^3 < r^2$ because country 3's invoicing currency “concentration” is higher

Measuring currency concentration in the data

$$\lambda_{n,0}^{k} = -\sum_{i=1}^{N}\sum_{j=1}^{N} \underbrace{-\frac{\gamma_i^k+\gamma_i^n}{2}}_{\substack{\text{Exposure of}\\ \text{average SDF}\\ \text{to country } i \text{ risk}}} \times \underbrace{\left(\gamma_j^k-\gamma_j^n\right)}_{\substack{\text{Exposure of}\\ \text{real exchange rate}\\ \text{to country } i \text{ risk}}} \times \underbrace{\sigma_{z,i}\sigma_{z,j}\rho_{i,j}}_{\substack{\text{Correlation}\\ \text{structure}\\ \text{of shocks}}}.$$

◇ Assuming i.i.d shocks across countries, currency risk premium simplifies to

$$\lambda_{n,0}^{k} \equiv r_0^n - r_0^k = \frac{\sigma_z^2}{2}\sum_{i=1}^{N}\left[\left(\gamma_i^k\right)^2 - (\gamma_i^n)^2\right].$$

⇒ Testable prediction: *Invoicing currency concentration of consumption* (CCC) is a determinant of currency risk premia and return differences.

◇ Define our empirical CCC measure:

$$\xi_k \equiv \sum_{i=1}^{N}(\gamma_i^k)^2$$

◇ Constructing ξ_k assuming *uncorrelated* $\{z^i\}$ ***works against us*** in empirical tests.

Data

Currency Invoice Shares

- From Boz, et al (2022). Time series from 1990-2020 (but very sparse coverage).
- Data on share of imports in USD, Euros, Home Currency and "Other"
- Use Import/Consumption to convert to share of consumption (for now)

UIP Deviations and interest rate gaps

- Many countries don't have risk-free assets (default risk)
- But if CIP holds $r_{i,t}^{rf} - r_{US,t}^{rf} \approx f_{US,t}^{i} - s_{US,t}^{i}$ and $rx_{i,t} = r_{i,t}^{rf} - r_{US,t}^{rf} + \Delta s_{US,t+1}^{i} \approx f_{US,t}^{i} - s_{US,t+1}^{i}$
- We show analysis with <u>both</u> raw rate differences and forward/spot spreads

Other data

- Size: NGDP shares
- Centrality: follow Richmond (2019) including data sources
- Real consumption: Sourced from Haver (aggregated from national accounts)

Evidence of link between invoicing shares and consumption growth

- Model predicts $\Delta c_t^k = \sum_{j=1}^N \gamma_j^k z_t^k$, and thus $Corr(\Delta c_t^k, \Delta c_t^i) \equiv \xi_{k,i} = \sum_{j=1}^N \gamma_j^k \gamma_j^i$
- Construct empirical measure as $\xi_{k,i} = \gamma_{USD}^k \gamma_{USD}^i + \gamma_{EUR}^k \gamma_{EUR}^i$

Table: Consumption correlation regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Prod of size	12.26***				18.44***	
	(4.60)				(5.91)	
Prod of correlation with world cons.		-0.48***		0.0431		
		(0.11)		(0.10)		
Prod of cons. invoice shares $\xi_{k,i}$			0.33***	0.26***	0.28***	0.20*
			(0.027)	(0.03)	(0.03)	(0.10)
Prod of output invoice shares						0.15
						(0.12)
N	351	351	351	351	351	351

Robust standard errors are in parenthesis. *, ** and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level respectively.

Evidence of link between invoicing shares and return differential: regression

- Test main model prediction by running panel regression

$$\log(F^k_{US,t}) - \log(S^k_{US,t}) = \delta_t + \beta \times \xi_{k,t} + \Gamma \text{controls}_{i,t} + \varepsilon_{k,t}$$

Table: Forward spread regressions

	Forward/Spot Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
NGDP share	-18.01***			-12.54***	-5.73	-7.84*
	(3.0)			(4.01)	(4.3)	(4.5)
Richmond (2019) Centrality (standardized)		-1.36***		-0.66**	-0.61**	-0.6**
		(0.2)		(0.27)	(0.27)	(0.27)
Consumption Currency Concentration			-9.31***		-5.4***	-9.35***
			(1.68)		(1.99)	(3.18)
Output Currency Concentration						4.7*
						(2.55)
N	239	239	246	239	239	239
Time Series Effect	✓	✓	✓	✓	✓	✓
Country Series Effect	×	×	×	×	×	×

Robust standard errors are in parenthesis. *, ** and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level respectively.

Evidence of link between invoicing shares and return differential: regression

- Test main model prediction by running panel regression

$$\log(r^{rf}_{k,t}) - \log(r^{rf}_{US,t}) = \delta_t + \beta \times \xi_{k,t} + \Gamma\text{controls}_{i,t} + \varepsilon_{k,t}$$

Table: Short rate differences regressions

	Short Rate Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
NGDP share	-14.43***			-5.09**	4.0	3.73
	(1.89)			(2.26)	(3.91)	(4.09)
Richmond (2019) Centrality (standardized)		-1.69***		-1.29***	-1.2***	-1.21***
		(0.17)		(0.21)	(0.21)	(0.21)
Consumption Currency Concentration			-9.18***		-6.86***	-8.21***
			(1.41)		(2.63)	(2.85)
Output Currency Concentration						1.6
						(2.32)
N	239	239	246	239	239	239
Time Series Effect	✓	✓	✓	✓	✓	✓
Country Series Effect	×	×	×	×	×	×

Robust standard errors are in parenthesis. *, ** and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level respectively.

Evidence of link between invoicing shares and return differential: portfolios

- Sort currencies into portfolios (Lustig and Verdelhan, 2007) using our model-based invoicing currency concentration measure $\xi_{i,t}$.

Table: Portfolios sorted on Currency Concentration

	Dispersed	2	3	Concentrated	*DMC*
Previous Concentration $\xi_{i,t-12}$					
mean	0.43	0.52	0.63	0.76	-0.33
Forward Spread $f^i_{US,t} - s^i_{US,t}$					
mean	3.59	3.54	2.20	-0.32	3.90
standard error	0.24	0.25	0.16	0.16	0.36
Excess Returns $rx^i_{US,t}$					
mean	2.91	3.36	1.63	0.36	2.54
standard deviation	10.19	11.29	9.80	9.83	8.14
standard error	2.31	2.55	2.22	2.23	1.85
Real Forward Spread					
mean	2.04	2.12	1.59	0.17	1.86
standard error	0.13	0.16	0.10	0.12	0.19
Sharpe Ratio					
mean	0.29	0.30	0.17	0.04	0.31
standard error	0.24	0.22	0.23	0.23	0.24

Carry Trade
Unconditional Carry Trade

Evidence of link between invoicing shares and return differential: risk factors

- Denote by HML_t^{FX} and $UHML_t^{FX}$ risk factors constructed by sorting portfolios using current forward spreads and average 1988-2001 forward spreads.

- Run time-series regressions:

$$(U)HML_t^{FX} = \alpha + \beta DMC_t^{FX} + \varepsilon_t.$$

Table: Explanatory Regressions for Benchmark Risk Factors

	HML^{FX} (1)	UHML^{FX} (2)
α	5.39***	1.74
	(1.67)	(1.41)
β on DMC	0.32***	0.51***
	(0.07)	(0.08)
N	233	180
Adjusted R^2	0.14	0.21

Conclusion

- Present multi-country sticky price model indicating that countries with more concentrated invoicing currency structures should face lower risk free rates.
- Provide empirical support for:
  - mechanism relying on influence of invoicing currencies onto consumption risk exposures,
  - effect of currency concentration on return differentials and carry trade.

Implications:

- USD Trade dominance $\rightarrow$ financial advantage of US *even with complete markets.*
  - Gopinath & Stein (2021) generated with with financial frictions.

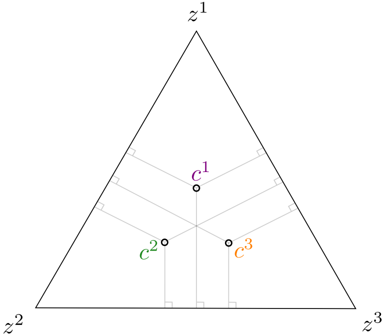
What we're working on:

- Currency Areas could be thought of as a mechanism to reduce risk-free rates.
- Same as Exchange rate pegs (Hassan, Mertens and Zhang, 2022).

Consumption risk exposures under PCP vs DCP with **home bias**

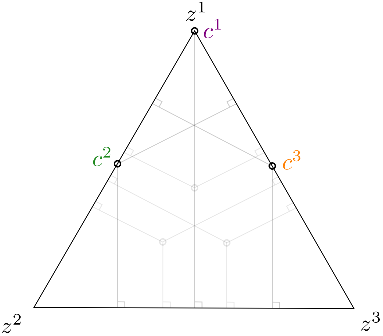
3 countries of symmetric size & **home bias** ($N=3$, $\theta_k=1/3$, $\omega_k^k=\tilde{\omega}/(\tilde{\omega}+2)$, $\omega_j^k=1/(\tilde{\omega}+2)$, $\forall j\neq k$, $\tilde{\omega}>1$)

PCP



$\forall k$: $c^k=\frac{\tilde{\omega}}{\tilde{\omega}+2}z^k+\sum_{n\neq k}\frac{1}{\tilde{\omega}+2}z^n$

DCP

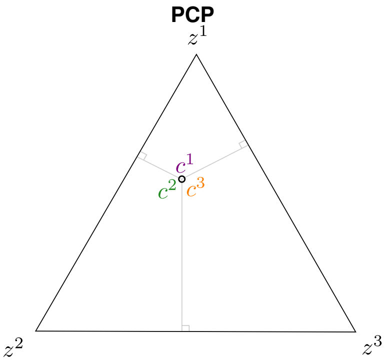


$c^1=z^1$; $c^k=\frac{2}{\tilde{\omega}+2}z^1+\frac{\tilde{\omega}}{\tilde{\omega}+2}z^k$ for $k=2,3$

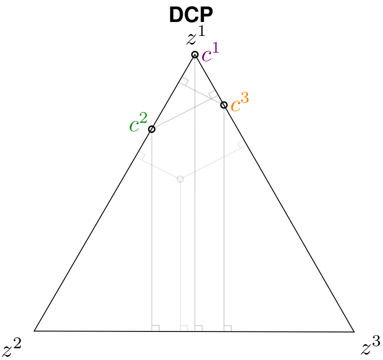
back

Consumption risk exposures under PCP vs DCP with **asymmetric size**

3 countries of **asymmetric size**, no home bias ($N = 3,\ \omega_j^k = \theta_k\ \forall j,k$)



$\forall k$: $c^k = \theta_1 z^1 + \theta_2 z^2 + \theta_3 z^3$



$c^1 = z^1$; $c^k = (1-\theta_k)z^1 + \theta_k z^k$ for $k = 2, 3$

back

Carry Trade Factor (HML)

Table: Portfolios sorted on Current Forward Spread $f_{i,t-1} - s_{i,t-1}$

	Low	2	3	High	HML^{FX}
Average Forward Spread $f^i_{US,t-1} - s^i_{US,t-1}$					
mean	-1.56	0.31	2.00	6.52	8.08
Forward Spread $f^i_{US,t} - s^i_{US,t}$					
mean	-1.35	0.38	2.01	6.18	7.52
standard error	0.08	0.09	0.08	0.12	0.13
Excess Returns $rx^i_{US,t}$					
mean	-2.06	-0.51	2.99	3.36	5.41
standard deviation	6.22	5.84	7.40	9.02	7.14
standard error	1.16	1.09	1.38	1.67	1.32
Sharpe Ratio					
mean	-0.33	-0.09	0.040	0.37	0.76
standard error	0.19	0.19	0.19	0.19	0.20

back

Unconditional Carry Trade Factor (UHML)

Table: Portfolios sorted on Average Forward Spread (1988-2001)

	Low	2	3	High	$UHML^{FX}$
Average Forward Spread (1988-2001)					
mean	-1.24	0.66	2.24	8.13	9.37
Forward Spread $f^i_{US,t} - s^i_{US,t}$					
mean	-0.42	0.36	1.16	2.95	3.37
standard error	0.07	0.17	0.10	0.10	0.09
Excess Return $rx^i_{US,t}$					
mean	0.48	1.11	2.07	2.79	2.31
standard deviation	5.58	2.65	9.79	9.84	6.55
standard error	1.46	0.69	2.55	2.54	1.69
Sharpe Ratio					
mean	0.09	0.42	0.21	0.28	0.35
standard error	0.26	0.26	0.27	0.27	0.27

back