Currency Risk and Capital Accumulation

Jingye Wang

Boston University

Dec 29, 2021

The Lucas Paradox and Currency Risk

- Large cross-country variation in **capital-output ratios(K/Y)**
  - suggests variation in **returns to capital**.
  - even within the **developed world**.
  - K/Y in Japan is 44% higher than in New Zealand.

The Lucas Paradox and Currency Risk

- Large cross-country variation in **capital-output ratios**(K/Y)
  - suggests variation in **returns to capital**.
  - even within the **developed world**.
  - K/Y in Japan is 44% higher than in New Zealand.
- Idea in finance: currency risk $\Rightarrow$ **risk-free rates**
  - safe currency appreciates in global bad times.
  - risk-free bonds in safe currencies offer lower returns.
  - currency return in JPN is 5.70% percent lower than NZL.

The Lucas Paradox and Currency Risk

- Large cross-country variation in **capital-output ratios(K/Y)**
  - suggests variation in **returns to capital**.
  - even within the **developed world**.
  - K/Y in Japan is 44% higher than in New Zealand.
- Idea in finance: currency risk $\Rightarrow$ **risk-free rates**
  - safe currency appreciates in global bad times.
  - risk-free bonds in safe currencies offer lower returns.
  - currency return in JPN is 5.70% percent lower than NZL.
- This paper: **link currency risk to capital-output ratios**.
  - Currency risk should also matter for returns to capital and thus capital accumulation!

The Lucas Paradox and Currency Risk

- Large cross-country variation in **capital-output ratios(K/Y)**
  - suggests variation in **returns to capital**.
  - even within the **developed world**.
  - K/Y in Japan is 44% higher than in New Zealand.
- Idea in finance: currency risk $\Rightarrow$ **risk-free rates**
  - safe currency appreciates in global bad times.
  - risk-free bonds in safe currencies offer lower returns.
  - currency return in JPN is 5.70% percent lower than NZL.
- This paper: **link currency risk to capital-output ratios**.
  - Currency risk should also matter for returns to capital and thus capital accumulation!

Research Question: How much of the large cross-country variation in capital-output ratios can be explained by currency risk?

Details

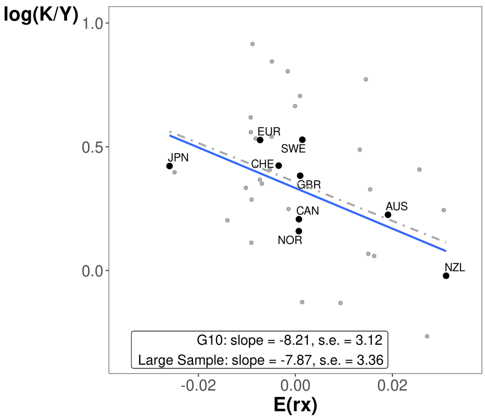
Negative Correlation between Log K/Y and $\mathbb{E}(rx)$: G10

- Currency risk premium:

  $$\mathbb{E}_t(rx^i_{t+1}) = r^i_{f,t} - \mathbb{E}_t[\Delta ex_{t+1}] - r^{US}_{f,t}$$

  Think of risk-free rate diffs.

- Large cross-country variations in $\log(K/Y)$ and $\mathbb{E}(rx)$
- Currency risk $\Rightarrow \mathbb{E}(rx)$ $\Rightarrow$ return to capital $\Rightarrow K/Y$



Pic for Interest Rate Differences | Robustness | Alternative Measure of K | Returns

This Paper...

- Endogenize capital accumulation within a **quantitative** international asset pricing framework.
- Two key asset pricing features:
  - **heterogeneous loadings** on a global productivity shock;
    - Induce currency risk: currency of high loading country appreciate in global bad times.
  - **external habit**: quantitative performance.
- Estimate the model using **GDP data** of countries issuing the G10 currencies.

Main Findings

- Loadings that are estimated **from comovements of GDP alone** are highly correlated with $\mathbb{E}(rx)$ and $\log(K/Y)$.
- Model generated cross-country variation in $\log(K/Y)$ accounts for roughly **55%** of that in the data for the G10.
- Model generated currency risk premia comes predominately from interest rate differences, consistent with the data.

Literature Review

- Papers that explains interest rate differentials with riskiness of exchange rates.
  - Reduced form or qualitative: Lustig and Verdelhan (2007), Lustig, Roussanov and Verdelhan (2011, 2014), Hassan (2013), Richmond (2019), Ready, Roussanov and Ward (2017), among others
  - Quantatitive: **Colacito, Croce, Gavazzoni and Ready (2018)**, Gourio, Siemer and Verdelhan (2013), Bansal and Shaliastovich (2013)

    This paper: **endogenize capital, quantitative, better match $r_f^\star - r_f$**
- Lucas Paradox. Details
  - Karabarbounis and Neiman (2014),Hsieh and Klenow (2009), Caselli and Feyrer (2007), Monge-Naranjo, Sanchez and Santaeulalia-Llopis (2019). Hall and Jones (1997), Jorgenson (1996), Alfaro, Kalemli-Ozcan, and Volosovych (2008), David, Henriksen and Simonovska (2016)
  - Hassan, Mertens and Zhang (2016), Richers (2021)

    This paper: **Study $\mathbb{E}(r)$ and G10, quantitative, focus on CR and loadings**
- External Habit
  - **Verdelhan (2010)**, Heyerdahl-Larsen (2014), Stathopoulos (2017)
  - Campbell and Cochrane (1999), **Chen (2017)**

    This paper: **endogenize K in a heterogenous-country framework.**

Outline

- Set-up
- Intuition and Mechanism
- Estimation & Results

Model Setup: Households

Population: There are N countries, indexed by $i \in \{1, 2, \cdots, N\}$, each populated with a unit measure of households.
Preference:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \eta^t \frac{(C_t^i - H_t^i)^{1-\gamma} - 1}{1-\gamma}$$

where H_t^i denote the habit level.
Surplus Consumption Ratio: Define the surplus consumption ratio as $S_t^i = \frac{C_t^i - H_t^i}{C_t^i}$, $s_t^i = \log(S_t^i)$ follows (Chen (2017), Campbell and Cochrane (1999))

$$s_t^i = (1-\rho_s)\bar{s} + \rho_s s_{t-1}^i + \lambda_s(\Delta c_t^i - \mu)$$

$\bar{s}, \rho_s$, μ and λ_s are assumed to be the same across countries.
Labor Supply: Households supply 1 unit of labor inelastically.

Model Setup: Firms

Production Function: In each country, a representative firm produces a country specific good under the production function:

$$Y_t^i = e^{z_t^i}(K_t^i)^\alpha (e^{\mu t} N_t^i)^{1-\alpha}$$

Productivity process: Different loadings on a global shock.

$$z_t^i = \rho z_{t-1}^i + \beta_z^i \sigma_g \varepsilon_{z,t}^g + \sigma_z^i \varepsilon_{z,t}^i$$

Capital accumulation:

$$K_{t+1}^i = \Phi(I_t^i / K_t^i) K_t + (1-\delta) K_t^i$$

where the capital adjustment cost follows Jermann(1998)

$$\Phi(\frac{I}{K}) = a_1 + \frac{a_2}{1-\frac{1}{\xi}} \left(\frac{I}{K}\right)^{1-\frac{1}{\xi}}$$

Model Setup: Final Good and Resource Constraints

Final Good: with home bias parameter $\nu > 0$

$$F_t^i = (X_{i,t}^i)^\nu \prod_{j=1}^{N} \left(X_{j,t}^i\right)^{\frac{1-\nu}{N}}$$

Resource Constraints

$$F_t^i = C_t^i + I_t^i$$

$$Y_t^i = \sum_{j=1}^{N} X_{i,t}^j \qquad \forall i, t$$

Markets are complete. Solve the model by solving a social planner's problem with all the resource constraints.

International Asset Pricing

Under complete market (Backus, Foresi and Telmer (2001))

$$\Delta ex^{i,j}_{t+1} = m^i_{t+1} - m^j_{t+1}$$

If SDFs are lognormal, then

$$r^i_f = -\mathbb{E}_t(m^i_{t+1}) - \frac{1}{2}\text{var}_t(m^i_{t+1})$$

and currency risk premium is given by

$$\begin{aligned}\mathbb{E}_t(rx^{i,j}_{t+1}) &= r^j_{f,t} - \mathbb{E}_t(\Delta ex^{i,j}_{t+1}) - r^i_{f,t} \\ &= -\frac{1}{2}\left[\text{var}_t(m^j_{t+1}) - \text{var}_t(m^i_{t+1})\right]\end{aligned}$$

Note that $m^i_{t+1} = \log(\eta) - \gamma(\Delta s_{t+1} + \Delta c_{t+1})$.

Examining the Mechanism: A Simplified Version

Suppose

- $N = 2$.
- The economy is at its deterministic steady state at period 0 and the world ends at period 1.
- No capital adjustment cost: $\Phi(\frac{I}{K}) = \frac{I}{K}$.
- Capital fully depreciates: $\delta = 1$.
- Country specific shocks feature the same volatility: $\sigma_z^\star = \sigma_z = \sigma$

Result #1: Change in Exchange Rate and Currency Risk

Change in exchange rate (foreign/home) is given by:

$$\Delta ex = m - m^\star$$

$$\approx \frac{\nu\gamma(1+\lambda_s)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\left[(\boldsymbol{\beta_z^\star} - \boldsymbol{\beta_z})\boldsymbol{\sigma_g}\boldsymbol{\varepsilon_g} + \sigma(\varepsilon^\star - \varepsilon)\right]$$

Proposition 1

If $\beta_z > \beta_z^\star$

- *if* $\varepsilon_g < 0, \Delta ex > 0$: *the real exchange rate increases (appreciation of the high loading home currency) when a negative global shock hits.*
- *expected change in exchange rate is 0, and currency risk premium are driven by interest rate differences.* $E(rx) = r_f^\star - r_f$

details

Intuition: Prices of Country-Specific Good and Final Good

Consider a negative global productivity shock $\varepsilon_g < 0$:
Shadow price of country specific good:

$$\lambda_X \approx -\Theta(\beta_z + \beta_z^\star)\varepsilon_g - \frac{\gamma(1+\lambda_s)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\beta_z\varepsilon_g$$

Shadow price of final consumption bundle:

$$\lambda_C^i = -\Theta'(\beta_z + \beta_z^\star)\varepsilon_g - \frac{\nu\gamma(1+\lambda_s)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\beta_z\varepsilon_g$$

Intuition: Prices of Country-Specific Good and Final Good

Consider a negative global productivity shock $\varepsilon_g < 0$:
Shadow price of country specific good:

$$\lambda_X \approx -\Theta(\beta_z + \beta_z^\star)\varepsilon_g - \frac{\gamma(1+\lambda_s)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\beta_z \varepsilon_g$$

Shadow price of final consumption bundle:

$$\lambda_C^i = -\Theta'(\beta_z + \beta_z^\star)\varepsilon_g - \frac{\nu\gamma(1+\lambda_s)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\beta_z \varepsilon_g$$

Intuition: when a negative global shock hits:

- The country-specific good of the high loading country is especially scarce, and more expensive;
- Because of home bias, the price of its consumption bundle increase: its currency appreciates.

Result #2: Currency Risk, r_f and Capital Accumulation

Proposition 2

Under the simplified specification, the higher loading country

- *...features lower currency risk premium and risk-free rates .*

$$\mathbb{E}(rx) = r_f^\star - r_f - \mathbb{E}(\Delta ex) = -1/2[var(m^\star) - var(m)]$$
$$\approx -\frac{1}{2}\frac{\nu\gamma^2(1+\lambda_s)^2}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\left[(\beta_z^\star)^2 - (\beta_z)^2\right]\sigma_g^2$$

- *...features lower required return to capital*

$$\mathbb{E}(r^\star - r) \approx -\frac{1}{2}[\gamma(1+\lambda_s)(1+\nu(1-\alpha))(1-\nu)+\nu^2(1-\alpha)]$$
$$\times\frac{\nu^2(1-\gamma(1+\lambda_s))^2}{(\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2)^2}\left[(\beta_z^\star)^2 - (\beta_z)^2\right]\sigma_g^2$$

- *...accumulates more capital.*

$$k^\star - k \approx \frac{1}{2}\frac{\nu^2(1-\gamma(1+\lambda_s))^2}{\gamma(1+\lambda_s)(1+\nu)(1-\nu)+\nu^2}\left[(\beta_z^\star)^2 - (\beta_z)^2\right]\sigma_g^2$$

Linking K/Y to Currency Risk Premium

High currency risk premium country accumulates less capital and has higher return to capital.

$$\mathbb{E}(r^\star - r) \approx \nu \left(1 - \frac{1}{(1+\lambda_s)\gamma}\right)^2 B\,\mathbb{E}(rx)$$
$$k^\star - k \approx -\frac{1}{B}\,\mathbb{E}(r^\star - r)$$

where $B > 0$ is a constant.

Linking K/Y to Currency Risk Premium

High currency risk premium country accumulates less capital and has higher return to capital.

$$\mathbb{E}(r^\star - r) \approx \nu \left(1 - \frac{1}{(1+\lambda_s)\gamma}\right)^2 B\,\mathbb{E}(rx)$$

$$k^\star - k \approx -\frac{1}{B}\,\mathbb{E}(r^\star - r)$$

where $B > 0$ is a constant.

- Currency risk premia passes through to required return to capital and thus capital accumulation.
- Currency risk, or heterogenous loadings, jointly determines currency risk premia and capital-output ratios.

Alternative Intuition

Quantitative Challenge

Recall that $\mathbb{E}(rx_{NZL-JPN}) = 5.70\%$, under complete market and lognormal SDFs,

$$\mathbb{E}_t(rx_{t+1}) = -\frac{1}{2}(\text{var}_t(m^\star_{t+1}) - \text{var}_t(m_{t+1}))$$

But under standard CRRA preferences, $\text{var}_t(m_{t+1}) = \gamma^2 \, \text{var}_t(\Delta c_{t+1})$

- "Currency Premium Puzzle": *Difference* in variances of aggregate consumption growth is too small

Result #3: Quantitative Performance: Role of Habit

With habit, the variance of the log SDF is given by

$$\text{var}(m) = \text{var}(-\gamma s - \gamma c) = \gamma^2 (1 + \boldsymbol{\lambda_s})^2 \, \text{var}(\Delta c)$$

- Agents fear the state when consumption is close to the habit level.
- They have high "effective risk aversion" w.r.t consumption risk.

Result #3: Quantitative Performance: Role of Habit

With habit, the variance of the log SDF is given by

$$\text{var}(m) = \text{var}(-\gamma s - \gamma c) = \gamma^2 (1 + \boldsymbol{\lambda_s})^2 \, \text{var}(\Delta c)$$

- Agents fear the state when consumption is close to the habit level.
- They have high "effective risk aversion" w.r.t consumption risk.

Proposition 3

If countries share the same constant sensitivity parameter λ_s, currency risk premium is given by

$$\mathbb{E}(rx) = -\frac{1}{2}\gamma^2 (1 + \lambda_s)^2 (var(\Delta c^\star) - var(\Delta c))$$

Remark: with capital accumulation, risk-free rate is smooth even with large, constant λ_s (Chen (2017)).

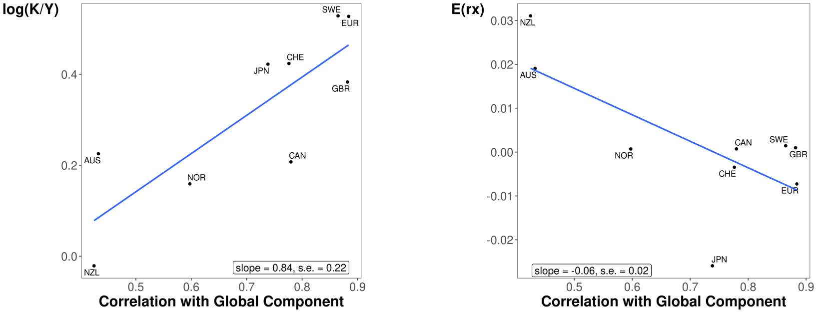
risk-free rate volatility | difference from Verdelhan (2010)

Summary of the Theoretical Results

In the simplified model

1. Currencies of high loading countries appreciate in global bad times and are thus safe.
2. **High-loading** country features **lower risk-free rate**, lower required return to capital and **accumulates more capital**.
3. Capital accumulation is negatively correlated with currency risk premium, as in the data.
4. Habit generates large currency risk premium as in the data;
5. Expected change in exchange rate is 0 and currency risk premia are driven by interest rate differences;

Evidence on Heter Loadings on a Global Shock



(a) Capital Output Ratio

(b) Currency Risk Premium

Countries that covary more with the world have low currency risk premium and accumulate more capital.

Robustness

Estimation by SMM: Data and Targets

- Quarterly GDP data (from OECD National Accounts Dataset) for countries issuing G10 currencies.
- Parameters to be estimated: loadings on the global shock β_z^i and volatility of country specific shocks σ_z^i
- Target moments: standard deviation of HP-filtered GDP for each country, as well as the correlations of HP-filtered GDP with its average across countries.

Objective Function:

$$\hat{\Theta} = \text{arg min}_{\Theta} \left(\frac{H(\Theta) - H_D}{H_D} \right)' \left(\frac{H(\Theta) - H_D}{H_D} \right)$$

Target Matching

Calibrated Parameters

Description	Value	Source
Preference and Production:		
Relative risk aversion [γ]	4	
Capital Share [α]	0.35	
Subjective discount factor [η]	0.995	Chen(2017)
Degree of home bias [ν]	0.98	Colacito et al. (2018)
Depreciation Rate [δ]	0.016	Chen (2017)
Elasticity of I/K wrt Tobin's Q [ξ]	0.7	Kaltenbrunner and Lochstoer (2010)
TFP:		
Mean of TFP growth(%) [μ]	0.45	Chen (2017)
Persistence of TFP growth ρ	0.98	Chen (2017)
Habit:		
Mean surplus consumption ratio(%) [$\bar{S}$]	7	Verdelhan (2010)
Persistence [ρ_s]	0.995	Verdelhan (2010)

Estimated Loadings

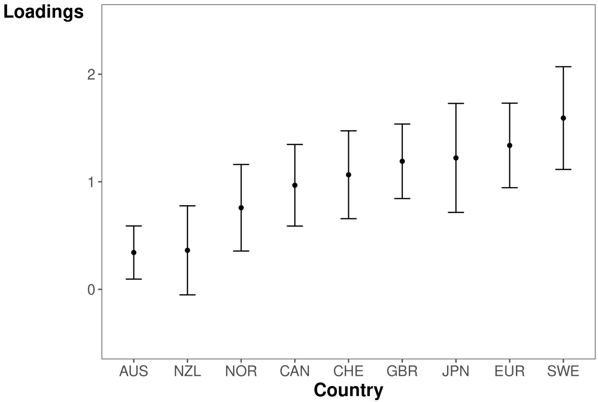
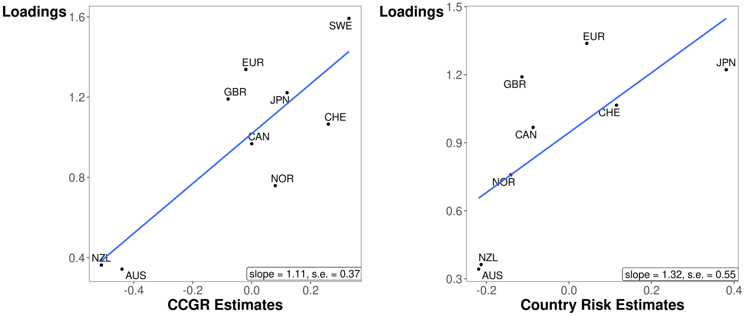
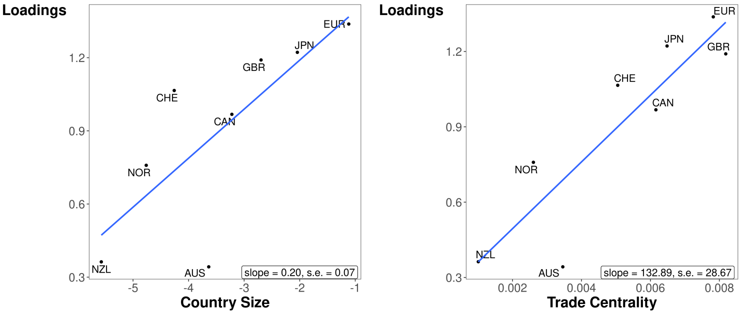


Table of β_z^i

Correlations with Existing Estimates

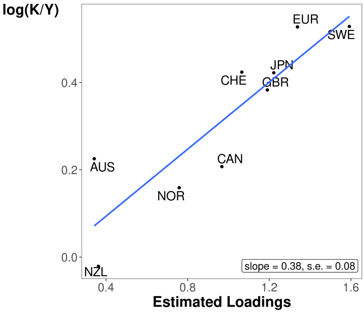


Correlations with Potential Drivers

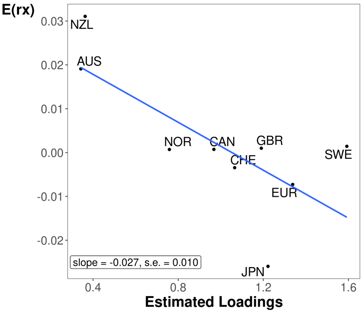


More

Estimated Loadings, K/Y and Currency Risk Premia



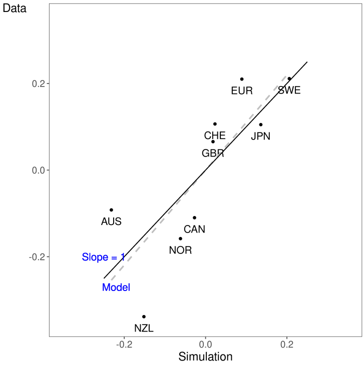
(a) Capital Output Ratio



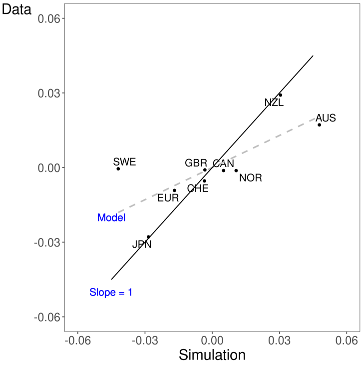
(b) Currency Risk Premium

- The R^2 for K/Y is 0.70 and for currency risk premia is 0.49.
- Loadings estimated **from GDP data alone** are highly correlated with currency risk premia and capital-output Ratios.

Simulated Data vs Empirical Data: K/Y



(a) Capital Output Ratio



(b) Currency Risk Premium

Interest Rate Differences

JPL-NZL Example

Use Japan as the base country:

	Diff in log(K/Y)	$\mathbb{E}(rx)$	$r_f^{NZL} - r_f^{JPN}$	$\mathbb{E}(\Delta ex)$
Data	-0.44	5.70%	5.08%	-0.62%
Model	-0.29	5.89%	6.06%	0.17%

- The model explains a large portion of the difference in capital-output ratios.
- The model matches currency risk premium very well.
- The model generates large difference in risk-free rates, with minimal unconditional movements in exchange rates.

Variance Decomposition: Average Performance

Write capital-output ratio in the data as

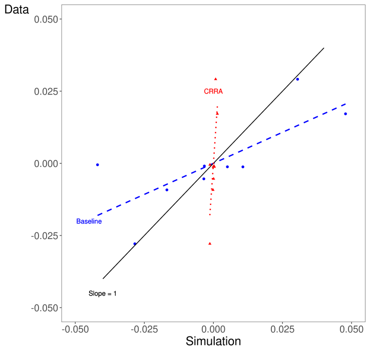
$$\kappa_D^i = \kappa_M^i + e^i$$

Taking variance on both side:

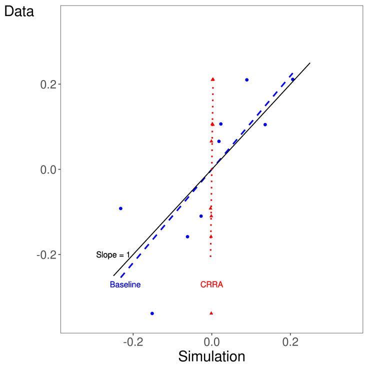
$$\underbrace{\text{var}(\kappa_D^i)}_{0.0345} = \underbrace{\text{var}(\kappa_M^i)}_{0.0189} + \underbrace{\text{var}(e^i)}_{0.0119} + \underbrace{2\,\text{cov}(\kappa_M^i, e^i)}_{0.0036}$$

$\frac{\text{var}(\kappa_M^i)}{\text{var}(\kappa_D^i)} = 54.76\%$: the model can account for 54.76% of the cross-country variations in capital-output ratios among countries issuing the G10 currencies!

Habit vs CRRA: Significant Quantitative Improvement



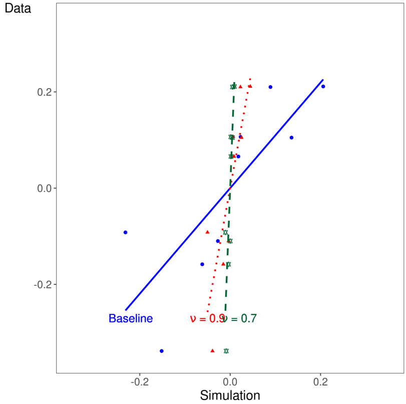
(a) Currency Risk Premium



(b) Capital-output Ratio

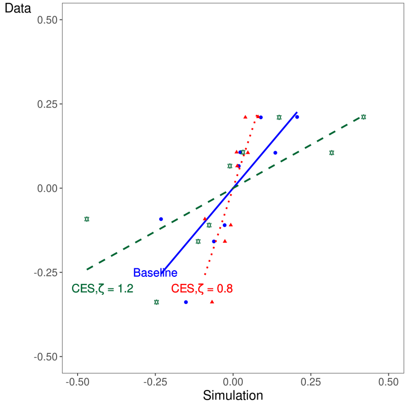
- Although CRRA fails quantitatively, the simulated moments are still highly correlated with the data. $R^2 : 0.58, 0.59$

Robustness: Home Bias



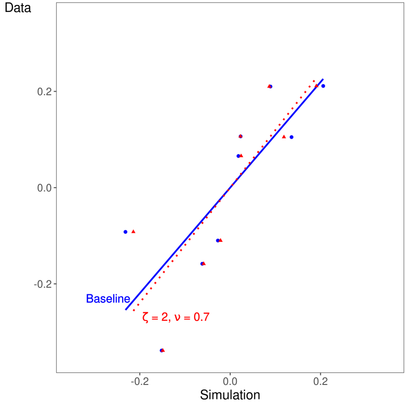
The model-generated differences in log(K/Y) is smaller when lower home bias ν, but still highly correlated.

Robustness: CES Aggregator



The model-generated differences in log(K/Y) is increasing in elasticity of substitution ζ.

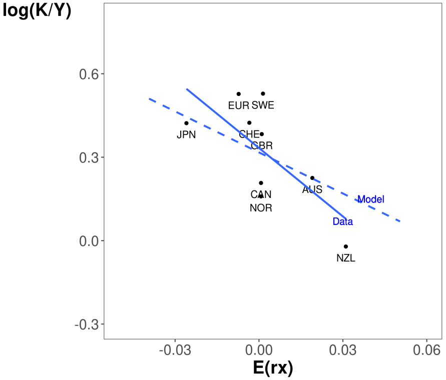
Robustness: High Elasticity with Low Home Bias



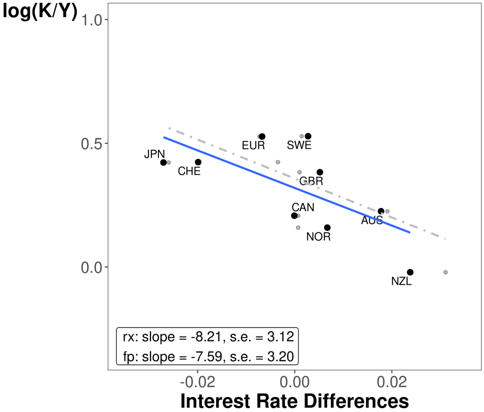
When a high elasticity is allowed ($\zeta = 2$), a lower home bias ($\nu = 0.7$) can be allowed for similar performance as the baseline.

Conclusion

- **High loading** ⇒ appreciation in glb downturns ⇒ safe currency ⇒ **lower rf/rx** ⇒ lower cost of K ⇒ **higher K/Y**
- External habit ⇒ large $\mathbb{E}(rx)$ with large rf differential ⇒ large K/Y differential.
  - A quantitative framework that can be instrumental in many related issues.



A1: Negative Correlation between Log K/Y and InRate Diff



back

A2: Deviation from Verdelhan (2010)

Under Verdehlan (2010):

- Countries are symmetric so no unconditional variance in variance of consumption growth, $E(rx) = 0$;
- Even if there are difference in $\text{var}(\Delta c)$, it would cancel out because the specific functional form of the sensitivity function.

$$(1 + \lambda(s))^2 = \frac{1}{\text{var}(\Delta c)} \frac{1 - \rho_s}{\gamma} (1 - 2(s - \bar{s}))$$

Currency Risk Premium

$$\begin{aligned}
\mathbb{E}(rx) &= -\frac{1}{2}\,\mathbb{E}(\text{var}(m^\star) - \text{var}(m)) \\
&= -\frac{1}{2}\gamma^2[(1 + \lambda(s^\star))^2 \,\text{var}(\Delta c^\star) - (1 + \lambda(s))^2 \,\text{var}(\Delta c)] \\
&= \mathbb{E}(s - \bar{s} - (s^\star - \bar{s}^\star)) = 0
\end{aligned}$$

back

A3: Change in Exchange Rate Under EZ

Under Epstein and Zin (1989) preference Colacito, Croce, Gavazzoni and Ready (2018), there is a hard-wired relationship between first and second moment of the log SDF.

$$\mathbb{E}(m_{t+1}) = \log(\delta) - \frac{1}{\psi}\mu - \frac{1}{2}(1-\gamma)\left(\frac{1}{\psi} - \gamma\right)\mathbb{E}(\text{var}_t(u_{t+1}))$$

$$\frac{1}{2}\mathbb{E}(\text{var}_t(m_{t+1})) = \frac{1}{2}\left(\frac{1}{\psi} - \gamma\right)^2 \mathbb{E}(\text{var}_t(u_{t+1}))$$

- high interest rate currency appreciate a lot.
- $\mathbb{E}(\Delta ex_{t+1}) = -\frac{\gamma-1}{\gamma-\frac{1}{\psi}}\mathbb{E}(rx_{t+1})$, most of the currency risk premium is accounted for by expected change in exchange rates, and risk-free rate difference is tiny.

back

A4: Simulated Data vs Empirical: Target Moments

Country	s.d. of GDP (%)		correlation	
	Data	Model	Data	Model
AUS	0.58	0.58	0.43	0.43
CAN	1.06	1.06	0.78	0.78
CHE	1.12	1.12	0.78	0.78
EUR	1.12	1.12	0.87	0.87
GBR	1.05	1.05	0.88	0.88
JPN	1.41	1.41	0.74	0.74
NOR	1.11	1.11	0.60	0.60
NZL	0.99	0.99	0.42	0.42
SWE	1.48	1.48	0.87	0.87

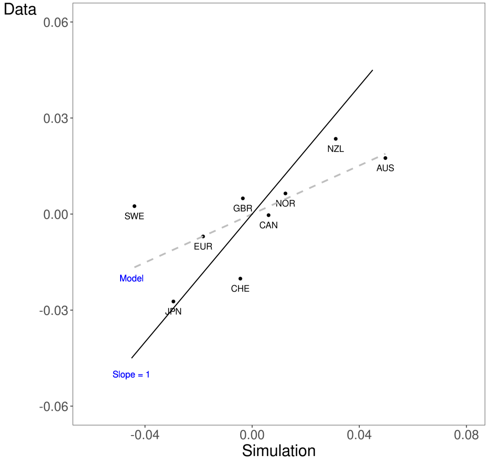
back

A5: Estimated Parameter Values

Country	β_z^i	$\sigma_z^i(\%)$
AUS	0.34	0.44
	(0.12)	(0.05)
CAN	0.97	0.57
	(0.19)	(0.08)
CHE	1.07	0.61
	(0.20)	(0.08)
EUR	1.34	0.46
	(0.20)	(0.07)
GBR	1.19	0.39
	(0.17)	(0.06)
JPN	1.22	0.83
	(0.25)	(0.10)
NOR	0.76	0.70
	(0.20)	(0.09)
NZL	0.36	0.77
	(0.21)	(0.09)
SWE	1.59	0.58
Global	1	0.64

back

A6: Simulated Data vs Empirical Data: Interest Rate Differences



back

A7: Capital Accumulation and Currency Risk Premium

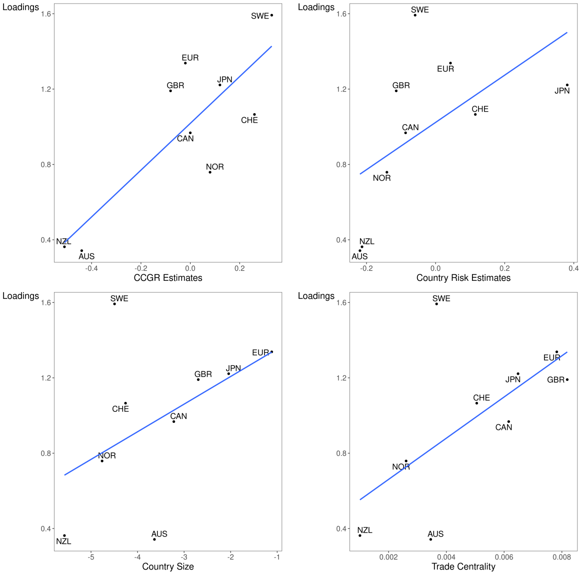
Cobb-Douglas production function implies:

$$\mathbb{E}_t(Y_{t+1}/K_{t+1}) = \frac{[\mathbb{E}_t[r_{t+1}]+\delta]\,\tau}{\alpha}$$

- Previous literature focuses on α, τ and δ.
- Relatively little attention on $\mathbb{E}_t[r_{t+1}] = r_{f,t} +$ risk premium
- Currency risk drives cross-country variation in $r_{f,t}$
- Should have implications for K/Y

back to motivation back to literature

A8: Correlations with other Estimates/Potential Drivers



Back

A9: Volatility of Interest Rate Differences: Model vs Data

Country	Data(%)	Model(%)
AUS	0.50	0.46
CAN	0.29	0.41
CHE	0.46	0.42
EUR	0.42	0.37
GBR	0.36	0.33
JPN	0.63	0.52
NOR	0.56	0.48
NZL	0.48	0.57
SWE	0.72	0.44

Model generated interest rates are stable: capital offers extra channel of intertemporal substitution and consumption smoothing.

back

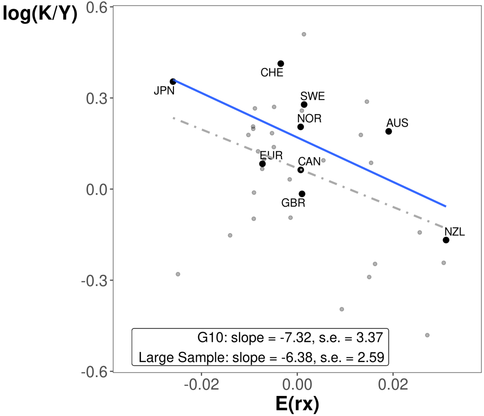
A10: Controlling for Institutions

	Dependent variable:							
	Capital-output Ratios Relative to the US							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathbb{E}(rx)$	-7.945^{*}	-8.742^{**}	-7.010	-7.722^{*}	-7.549^{*}	-10.662	-7.223	-8.193
	(3.405)	(3.319)	(4.340)	(3.609)	(3.300)	(5.617)	(4.071)	(4.399)
FDI	0.143							
	(0.397)							
FOI		-0.140						
		(0.195)						
CC			-0.077					
			(0.182)					
GE				-0.085				
				(0.245)				
PS					-0.150			
					(0.187)			
RQ						0.194		
						(0.359)		
RL							-0.107	
							(0.257)	
VA								-0.001
								(0.350)
Constant	0.226	0.635	0.476	0.477	0.492^{*}	0.031	0.515	0.334
	(0.300)	(0.426)	(0.339)	(0.420)	(0.204)	(0.561)	(0.441)	(0.491)
Observations	9	9	9	9	9	9	9	9
R^2	0.508	0.537	0.512	0.507	0.546	0.521	0.511	0.497
Adjusted R^2	0.344	0.382	0.349	0.343	0.395	0.361	0.348	0.330
Residual Std. Error (df = 6)	0.150	0.146	0.150	0.150	0.144	0.148	0.150	0.152
F Statistic (df = 2; 6)	3.098	3.476^{*}	3.148	3.088	3.610^{*}	3.259	3.140	2.968
Note:						$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$		

A11: Controlling for Institutions, Larger Sample back

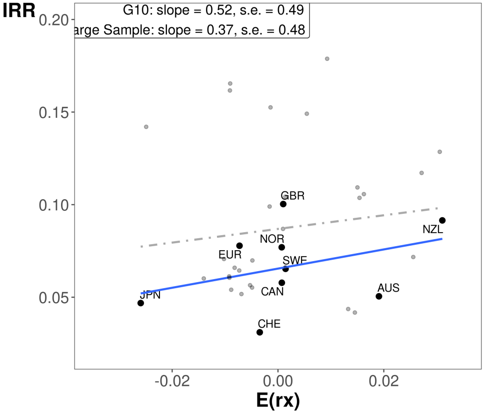
	Dependent variable:	
	Capital-output Ratios Relative to the US	
	(1)	(2)
$\mathbb{E}(rx)$	-3.276	-9.283^{**}
	(3.768)	(3.435)
FDI	0.139	0.050
	(0.393)	(0.436)
FOI	0.184^{***}	
	(0.066)	
CC	-0.816^{***}	-0.696^{***}
	(0.220)	(0.240)
GE	0.734^{**}	0.452
	(0.276)	(0.286)
PS	0.051	0.139
	(0.132)	(0.142)
RQ	0.059	0.346
	(0.257)	(0.262)
RL	0.033	0.012
	(0.268)	(0.299)
VA	0.071	0.063
	(0.071)	(0.079)
Constant	-0.177	0.043
	(0.191)	(0.194)
Observations	37	37
R^2	0.601	0.487
Adjusted R^2	0.468	0.341
Residual Std. Error	0.219 (df = 27)	0.243 (df = 28)
F Statistic	4.520^{***} (df = 9; 27)	3.323^{***} (df = 8; 28)
Note:		*p<0.1; **p<0.05; ***p<0.01

A12: Alternative Measure of Capital



back

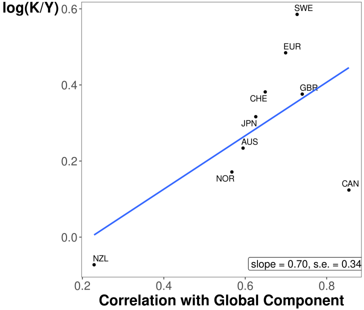
A13: Internal Rate of Return



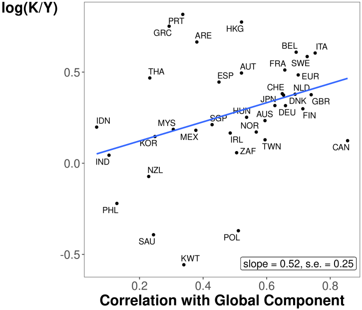
Chari and Rhee (2021) : IRR differs across countries;
Richers (2021) : Violation of UIP passes through to firm borrowing and ROA.

back

A14: Corr with Global Component and K/Y: Annual Data



(a) G10



(b) Larger Sample

back

A15: Social Planner Based Intuition

The Euler equation

$$1 = \mathbb{E}\left(MR\right)$$

where $M = \eta \frac{\Lambda_C}{\Lambda_{C,0}}$ is the SDF and

$$R = \frac{\Lambda_X}{\Lambda_C} \alpha \frac{Y}{K}$$

Substituting in the F.O.Cs and with log linearization

$$k \approx \frac{1}{2}\nu \left(1 - \frac{1}{(1+\lambda_s)\gamma}\right)^2 \mathrm{var}(m) + const$$

$$\mathbb{E}(r) \approx -\frac{1}{2}\nu \left(1 - \frac{1}{(1+\lambda_s)\gamma}\right)^2 B\, \mathrm{var}(m) + const$$

where

$$B = \frac{\gamma(1+\lambda_s)(1+\nu(1-\alpha))(1-\nu) + \nu^2(1-\alpha)}{\gamma(1+\lambda_s)(1+\nu)(1-\nu) + \nu^2}$$

back

A16: The Case of Euro

Table: Cross-country Dispersion of $\log(K/Y)$ Before and After Euro

	s.d.
Before	0.33
After	0.26

- Standard deviation is shrinking: K/Y is converging in Euro countries;
- Hassan (2013): returns on assets are lower after Euro is introduced.