Heterogeneous Impact of the Global Financial Cycle

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introduction

Countries have unequal exposure to global financial shocks

- emerging markets prone to sudden stops
- currencies and assets in some advanced economies appreciate in downturns
- stark differences in outward flows: retrenchment in advanced economies

Existing explanations:

- mostly rely on intrinsic advantages and focus on US vs ROW
- differences in leverage constraints, collateral advantage, risk aversion, bonds in utility

This paper: a model with ex ante identical countries, intermediaries, and segmented markets

key features

Key features to deliver heterogeneous exposure to global shocks:

- cross-country wealth distribution (arises endogenously)
- gross capital flows determined jointly with asset prices

Capital flight triggers retrenchment $\longrightarrow$ distribution of gross flows determines price responses

- foreign investors target poor countries in times of flight
- risk premia rise more in poor countries
- capital flight is driven by rich countries retrenching

explaining the data

Goal: see how much variation this model can explain with financial and output shocks

Financial shocks explain a great deal of variation in relative performance AE vs EM

- in total, model explains 50% of variation
- of this, 2/3 is due to financial shocks

Cyclical properties:

- output shocks generate procyclicality
- financial shocks induce countercyclical asset prices in AE

literature

Evidence of the global financial cycle and heterogeneous exposures:

- Miranda-Agrippino Rey 2020,2022, Miranda-Agrippino et al 2020, Barrot Serven 2018, Habib Venditti 2019, Cerutti et al 2019, Chari et al 2020, Eguren-Martin et al 2021, Gelos et al 2022, Kalemli-Ozkan 2019

This paper: analyze heterogeneity as an equilibrium feature in a model

Models of the global financial cycle and retrenchment:

- Caballero Simsek 2020, Jeanne Sandri 2023, Morelli et al 2023, Bai et al 2019, Dahlquist et al 2023, Gourinchas et al 2022, Davis van Wincoop 2021, 2023, Farboodi Kondor 2022, Kekre Lenel 2021, Sauzet 2023, Maggiori 2017

This paper: explain heterogeneity using retrenchment

outline

— model

— shock to risk-taking capacity of global intermediaries

— data and quantitative results

Model

countries

Countries $i \in [0, 1]$

- Lucas tree with price p_{it}, fixed supply of 1
- cumulative dividend up to t denoted by y_{it}
- flow dividend $dy_{it} = \nu dt + \sigma dZ_{it}$

problem of local agents

$$\max_{\{c_{it},\theta_{it}\}_{t\geq 0}} \mathbb{E}\left[\rho \int_0^\infty e^{-\rho t} \ln(c_{it}) dt\right]$$

$$dw_{it} = (r_t w_{it} - c_{it})dt + \theta_{it} w_{it} dR_{it}$$

- allocate share θ_{it} to tree
- share $1 - \theta_{it}$ to intermediary's debt, interest rate $r_t dt$

Excess returns dR_{it} are given by

$$dR_{it} = \frac{1}{p_{it}}(dy_{it} + dp_{it}) - r_t dt$$

special country

Special country

- Lucas tree with price $\hat{p}_t$, fixed supply of $\hat{q}$
- cumulative dividend up to t denoted by $\hat{y}_t$
- flow dividend $d\hat{y}_t = \nu dt$

Excess returns $d\hat{R}_t$ given by

$$d\hat{R}_t = \frac{1}{\hat{p}_t}(\nu dt + d\hat{p}_t) - r_t dt$$

intermediary's problem

$$\max_{\{\hat{c}_t, \hat{\boldsymbol{\theta}}_t, \hat{\theta}_t\}_{t\geq 0}} \mathbb{E}\left[\rho \int_0^\infty e^{-\rho t} \ln(\hat{c}_t) dt\right]$$

$$d\hat{w}_t = (r_t \hat{w}_t - \hat{c}_t)dt + \int (\hat{\theta}_{it} \hat{w}_t dR_{it}) di + \hat{\theta}_t \hat{w}_t d\hat{R}_t$$

- portfolio shares $\{\hat{\theta}_{it}\}$ allocated to all trees

Constraint on total amount of idiosyncratic risk:

foundation

$$\underbrace{\int_0^1 \mathbb{V}_t[\hat{\theta}_{it} \hat{w}_t dR_{it}] di}_{\text{total idiosyncratic risk}} \leq {\color{blue}\gamma_t} \hat{w}_t \underbrace{\int_0^1 \mathbb{E}_t[\hat{\theta}_{it} \hat{w}_t dR_{it}] di}_{\text{expected profit}} \qquad (1)$$

holdings

- tree holdings: $h_{it} = \dfrac{\theta_{it} w_{it}}{p_{it}}$ and $\hat{h}_{it} = \dfrac{\hat{\theta}_{it} \hat{w}_t}{p_{it}}$
- special tree holdings: $\hat{h}_t = \dfrac{\hat{\theta}_t \hat{w}_t}{\hat{p}_t}$
- bond holdings: $b_{it} = (1 - \theta_{it}) w_{it}$ and $\hat{b}_t = \left(1 - \hat{\theta}_t - \int \hat{\theta}_{it} di\right) \hat{w}_t$

equilibrium

Definition: processes for prices $\{p_{it}, \hat{p}_t, r_t\}$, quantities $\{c_{it}, \hat{c}_t, \hat{h}_{it}, \hat{h}_t, b_{it}, \hat{b}_t\}$, and wealth $\{w_{it}, \hat{w}_t\}$ such that all agents optimize and the following markets clear:

world map

$$
\begin{aligned}
1 &= \hat{h}_{it} + h_{it} \qquad \text{all } i \in [0,1] \\
\hat{q} &= \hat{h}_t \\
0 &= \hat{b}_t + \int_0^1 b_{it} di \\
(1+\hat{q})\nu &= \hat{c}_t + \int_0^1 c_{it} di
\end{aligned}
$$

main equation

Optimal portfolio choice: $\theta_{it} = \dfrac{\mu^R_{it}}{(\sigma^R_{it})^2}$ and $\hat{\theta}_{it} = \gamma_t \dfrac{\mu^R_{it}}{(\sigma^R_{it})^2}$

Market clearing implies $p_{it} = \theta_{it} w_{it} + \hat{\theta}_{it} \hat{w}_t$

With prices evolving as $dp_{it} = \mu^p_{it} dt + \sigma^p_{it} dZ_{it}$, returns are $\mu^R_{it} = \dfrac{\mu^p_{it} + \nu}{p_{it}} - r_t$ and $\sigma^R_{it} = \dfrac{\sigma_{it} + \sigma}{p_{it}}$

Putting all together

$$\mu^p_{it} + \nu - r_t p_{it} = \underbrace{(\sigma^p_{it} + \sigma)^2}_{\text{quantity of risk}} \cdot \underbrace{\frac{1}{w_{it} + \gamma_t \hat{w}_t}}_{\text{price of risk}}$$

characterizing equilibrium

Intermediary's risk-taking capacity is limited, cannot absorb all country-specific risk

- countries are exposed to idiosyncratic shocks
- non-degenerate wealth distribution

Solve for country-specific variables as functions of (w, t)

how to solve

- main variables of interest are prices $p(w, t)$ and wealth density $g(w, t)$
- prices and wealth driven by local shocks:

$$dw = \mu_w(w, t)dt + \sigma_w(w, t)dZ$$

$$dp = \mu_p(w, t)dt + \sigma_p(w, t)dZ$$

steady state: prices

Asset prices: solving the model

$$rp(w) = \nu - \underbrace{\frac{(\sigma_w(w)p'(w) + \sigma)^2}{w + \gamma\hat{w}}}_{\text{risk adjustment}} + \underbrace{\mu_w(w)p'(w) + \frac{\sigma_w(w)^2}{2}p''(w)}_{\text{growth term}}$$

Wealth distribution:

$$(\mu_w(w)g(w))' = \frac{1}{2}(\sigma_w(w)^2 g(w))$$

Interest rate:

$$r = \rho - \frac{\rho}{(1+\hat{q})\nu}\mathbb{E}\left[\frac{(\sigma_w(w)p'(w) + \sigma)^2}{w + \gamma\hat{w}}\right]$$

steady state: wealth dynamics

Drift and volatility of wealth:

$$\mu_w(w) = (r-\rho)w + \frac{\sigma_w(w)^2}{w}$$
$$\sigma_w(w) = \sigma \cdot \frac{w}{w + {\color{blue}\gamma}\hat{w} \underbrace{-p'(w)w}_{\text{feedback}}}$$

Property 1: $rp(w) \longrightarrow \nu$ as $w \longrightarrow \infty$

- risk adjustment disappears and growth terms disappear
- equilibrium selection: $p'(w)$ has a finite limit

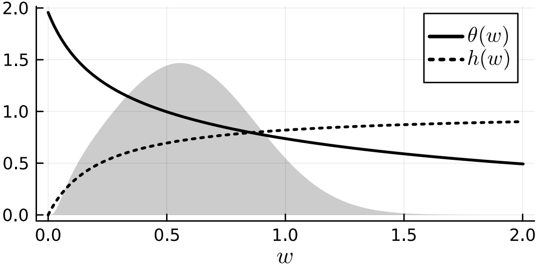
Property 2: $\sigma_w(w) \longrightarrow \sigma$ and $\mu_w(w)/w \longrightarrow r-\rho$ as $w \longrightarrow \infty$

- risk exposure does not scale with wealth
- rich countries enjoy safe payoffs and consume away their savings

steady state: holdings

Property 3: local agents own larger shares of assets in rich countries: $h(w) = \dfrac{w}{w + \gamma \hat{w}}$

Property 4: local agents in rich countries rely on foreign holdings more: $\theta(w) = \dfrac{p(w)}{w + \gamma \hat{w}}$



steady state: exorbitant privilege

Property 5: intermediary earns profits, special country gets "exorbitant privilege":

$$\hat{c} - \hat{q}\nu = r \cdot \underbrace{\left(\int p(w)\hat{h}(w)dG(w) + \hat{b} \right)}_{\text{net foreign assets}} + \underbrace{\int (\nu - rp(w))\hat{h}(w)dG(w)}_{\text{risky asset discount}} + \underbrace{\int \mu_p(w)\hat{h}(w)dG(w)}_{\text{trading profits}}$$

- average drift in prices is zero in the steady state: $\int \mu_p(w)\hat{h}(w)dG(w) = 0$
- intermediary skews its portfolios towards growing countries: $\int \mu_p(w)\hat{h}(w)dG(w) > 0$

benchmark: infinite risk-taking capacity

Consider the limit $\gamma \longrightarrow \infty$

- expected excess returns have to converge to zero
- local agents do not wish to hold any risk at zero premium
- intermediaries take over all risky assets, enjoy perfect diversification
- $r \longrightarrow \rho$ and $p(w) \longrightarrow \nu/\rho$
- local agents live off of the interest income, everyone's wealth is fixed in time

benchmark: ROW as a small open economy

Consider a double limit: $\hat{q} \longrightarrow \infty$, $\gamma \longrightarrow 0$, and $\gamma\hat{q} \longrightarrow \Gamma \cdot \rho/\nu$ for some $\Gamma > 0$

- as the special country's size diverges, $\hat{w} \longrightarrow \infty$ and $\gamma\hat{w} \longrightarrow \Gamma$
- intermediary holds a finite share of each risky asset
- as a whole, risky payoffs are a negligible part of its income, so $r = \rho$
- regular countries not fully insured, idiosyncratic shocks move them around the distribution
- the distribution itself is not a state variable

an approximation

Consider a second-order approximation around $\sigma = 0$

- the strength of precautionary motives relates to average price of risk:

$$r = \rho - \frac{\rho\sigma^2}{\nu(1+\hat{q})} \int \frac{1}{w + \gamma \hat{w}} dG(w) + o(\sigma^3)$$

- risky asset prices reflect risk premia and precautionary motives:

$$p(w) = \frac{\nu}{\rho} + \frac{\sigma^2}{\rho} \left(\underbrace{\frac{1}{1+\hat{q}} \int \frac{1}{w + \gamma \hat{w}} dG(w)}_{\text{precautionary motives}} - \underbrace{\frac{1}{w + \gamma \hat{w}}}_{\text{risk}} \right) + o(\sigma^3)$$

- risky countries are growing, safe countries consume:

$$d\log(w) = \left[\frac{1}{2(w + \gamma \hat{w})^2} - \frac{\rho}{\nu(1+\hat{q})} \int \frac{1}{w + \gamma \hat{w}} dG(w) \right] \sigma^2 dt + \frac{1}{w + \gamma \hat{w}} \sigma dZ + o_p(\sigma^2)$$

Shock to risk-taking capacity

shock to risk-taking capacity γ

Suppose $\gamma(t)$ falls

At steady-state prices

- intermediaries would decrease portfolio shares equally
- hold more in poor countries $\longrightarrow$ will want to sell more

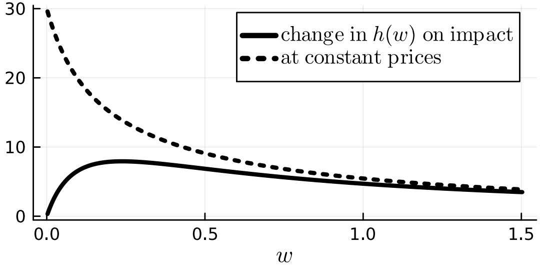
Local agents retrench:

- large volumes stabilize risk premia in rich countries
- agents in poor countries cannot absorb much without a sharp rise in risk premia

change in holdings on impact

Change in domestic holdings $h(w)$ on impact (in percent of total supply)

- counterfactual, at constant steady-state prices
- actual, in equilibrium



change in prices on impact

Price changes on impact: responses to interest rate $r(t)$ and to global factor $\varphi(t) = \gamma(t)\hat{w}(t)$:

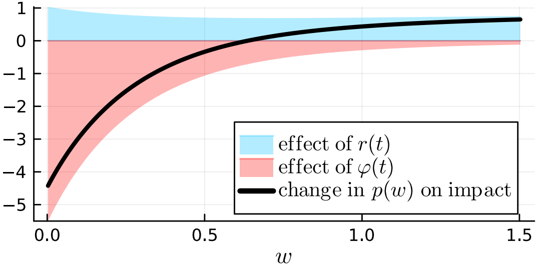
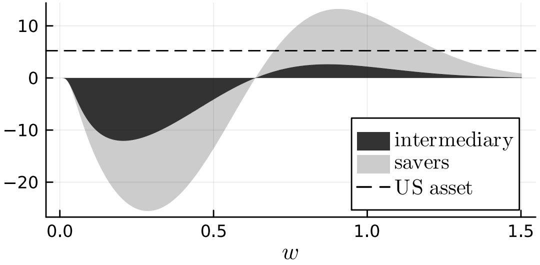


Figure: percentage changes in $p(w, t)$ on impact.

loss-sharing

Figure: gains and losses on impact in percent of global GDP, weighted by density



- intermediaries take losses on external position (exorbitant duty)
- wealth share still increases due to gains on US assets

Quantitative results

empirical model

Estimate parameters of aggregate shocks $(\mu_\gamma, \mu_\nu, \sigma_\gamma, \sigma_\nu)$:

$$d\gamma(t) = \mu_\gamma(\gamma - \gamma(t))dt + \sigma_\gamma \cdot dW(t) \tag{2}$$

$$d\nu(t) = \mu_\nu(\nu - \nu(t))dt + \sigma_\nu \cdot dW(t) \tag{3}$$

Simulate the model, compute moments of first-order deviations $\tilde{b}(t)$ and $\tilde{p}(t)$

- total external assets $b(t) = \int b(w,t)dG(w,t)$
- average risky asset price $p(t) = \int p(w,t)dG(w,t)$

results

estimation

Add output shocks alongside financial, estimate joint process

calibration

Targeted moments: aggregate equity index return $\tilde{p}_t$, outward flows $\tilde{b}_t$ (normalized by stock)

	$\text{std}(\tilde{p}_t)$	$\text{std}(\tilde{b}_t)$	$\text{corr}(\tilde{p}_t, \tilde{b}_t)$	$\text{corr}(\tilde{p}_t, \tilde{p}_{t-1})$	$\text{corr}(\tilde{b}_t, \tilde{b}_{t-1})$
data	0.048	0.049	0.738	0.785	0.828
model	0.048	0.049	0.740	0.779	0.839

Untargeted moments: AE vs EM

cyclicality

	$\text{std}(\tilde{b}_t^{AE})$	$\text{std}(\tilde{b}_t^{EM})$	$\text{std}(\tilde{p}_t^{AE})$	$\text{std}(\tilde{p}_t^{EM})$
data	0.045	0.035	0.042	0.059
model	0.074	0.027	0.030	0.048

quantitative results

Output and financial shocks responsible for different moments

- output shocks move global averages
- financial shocks move relative performance of AE vs EM

	data	full model	only γ	only ν
$\text{std}(\tilde{b}_t)$	0.049	0.049	0.024	0.044
$\text{std}(\tilde{p}_t)$	0.048	0.048	0.007	0.044
relative performance				
$\text{std}(\tilde{p}_t^{AE} - \tilde{p}_t^{EM})$	0.035	0.026	0.019	0.010

- high correlation between γ and $\nu \longrightarrow$ asking for endogenous link from prices to output

cyclicality of prices

- financial shocks generate countercyclical returns in AE, procyclical in EM
- real shocks make returns procyclical everywhere

Table: correlations of first-order responses with total outflows $\tilde{b}_t$

	full model	only γ	only ν
p_t^{AE}	0.52	-0.97	0.58
p_t^{EM}	0.69	0.93	0.48
relative performance			
$p_t^{AE} - p_t^{EM}$	-0.55	-0.95	-0.18

implications for wealth

conclusion and future work

Endogenizing output and capital stock

- how does variation in risk and risk premia affect capital allocation and growth?

Exchange rates

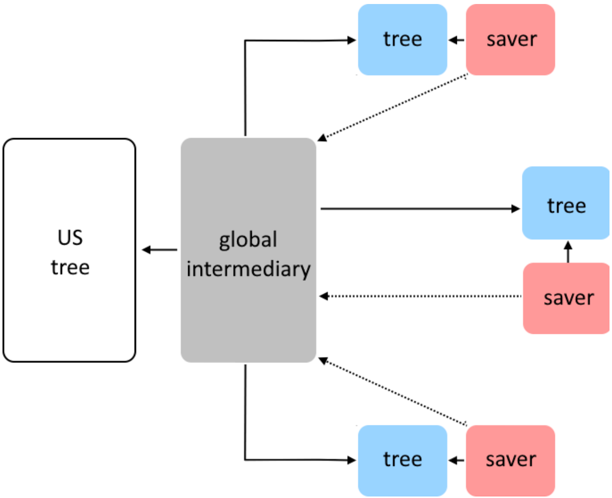
- can we jointly match properties of exchange rates and allocations?

Heterogeneous policy and aggregation

- how does individual monetary policy and capital flow policy aggregate?

Thank you for your attention

model map



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wealth dynamics

Drift and volatility of wealth defined as $dw = \mu_w(w)dt + \sigma_w(w)dZ$ back

- drift in wealth: savings, consumption, and risk compensation

$$\mu_w(w) = (r - \rho)w + \frac{\sigma_w(w)^2}{w} \tag{4}$$

- volatility of wealth: amplification term $-p'(w)w$ accounts for equilibrium feedback

$$\sigma_w(w) = \sigma \cdot \frac{w}{w + \gamma \hat{w} - p'(w)w} \tag{5}$$

outflows in AE and EM

- net acquisition of foreign assets (flows) f_{it}
- principal component F_t
- total foreign assets (stock) A_{it}
- position-adjusted flows $b_{it} = f_{it} / A_{i,t-1}$

Table: dependent variables expressed as percentage

	b_t^{AE}	b_t^{EM}	$b_t^{AE} - b_t^{EM}$
F_t	3.87	1.44	**2.43**
	(0.25)	(0.42)	(0.61)

measures of risk-taking capacity | global financial crisis | taper tantrum | trade wars | back

outflows and measures of risk-taking capacity

Table: Correlation between aggregate series and averages $\{b_t^{AE}, b_t^{EM}\}$

	b_t^{AE}	b_t^{EM}
outflow factor F_t	**0.86**	0.29
VIX (negative)	**0.38**	0.15
asset price factor, Miranda-Agrippino & Rey 2020	**0.32**	0.04
intermediary factor, He et al 2017	**0.21**	-0.16
treasury basis, Jiang et al 2021	**0.27**	0.00

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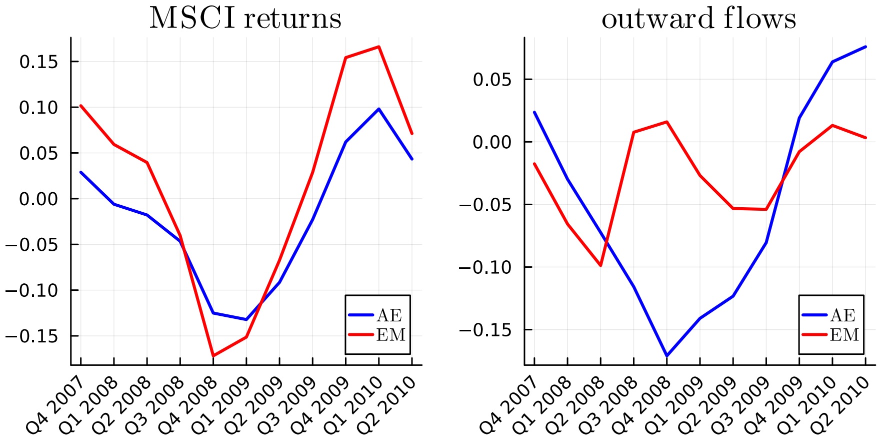
example: 2008



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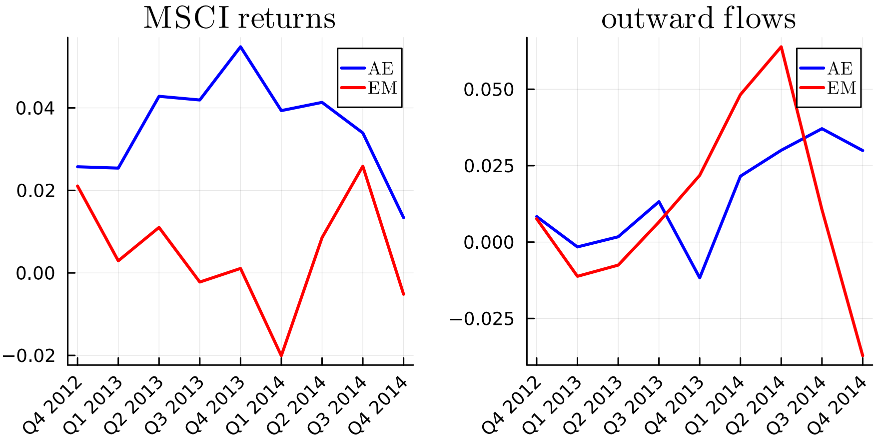
example: 2013



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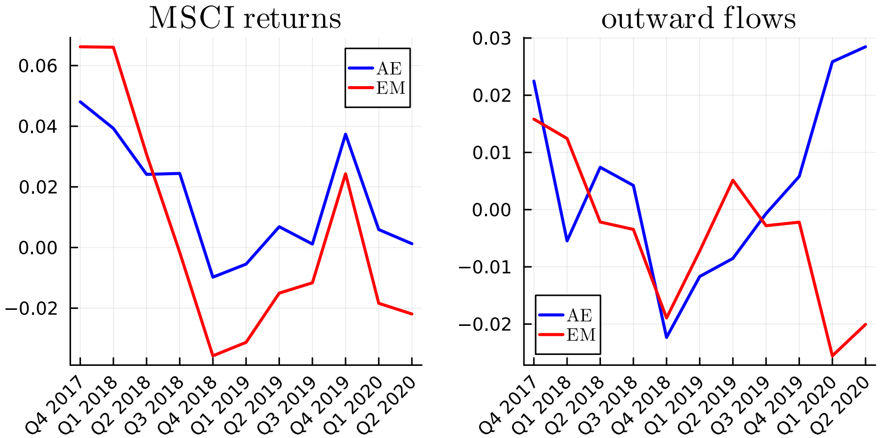
example: 2018



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intermediary's problem (ambiguity)

Consider misspecified processes $d\hat{Z}_{it} = dZ_{it} + \xi_{it} dt$ for idiosyncratic shocks:

$$dR_{it} = (\mu^R_{it} - \xi_{it}\sigma^R_{it})dt + \sigma^R_{it} d\hat{Z}_{it} \tag{6}$$

Minmax problem: first choose corrections $\boldsymbol{\xi}_t$, then portfolio and consumption

$$\max_{\{\hat{c}_t, b_t, \boldsymbol{\theta}_t\}_{t\geq 0}} \min_{\{\boldsymbol{\xi}_t\}_{t\geq 0}} \mathbb{E} \int_0^\infty e^{-\hat{\rho}t} \left(\hat{\rho} \ln(\hat{c}_t) + \frac{\gamma_t}{2} \int_0^1 \xi^2_{it} di \right) dt \tag{7}$$

Cost parameter γ_t governs risk-taking capacity:

back

$$\hat{\theta}_{it} = \gamma_t \frac{\mu^R_{it}}{(\sigma^R_{it})^2} \tag{8}$$

solving the full model

Expressions for risk premium turn into non-linear PDE for prices $p(w,t)$ equations

- use definition of returns to turn equilibrium conditions into PDE for prices
- PDE has unknown drift and volatility coefficients (μ_p, σ_p)
- use Itô's lemma to characterize (μ_p, σ_p) in terms of (μ_w, σ_w)
- use budget constraints to get (μ_w, σ_w)

At the end: asset prices $p(w,t)$ and wealth density $g(w,t)$ that solve a coupled system back

solving for prices and distributions

Given initial conditions, prices $p(w,t)$ and density $g(w,t)$ solve back

$$r(t)p(w,t) - \partial_t p(w,t) = y(w,t) + \mu_w(w,t)\partial_w p(w,t) + \frac{1}{2}\sigma_w(w,t)^2\partial_{ww}p(w,t) \tag{9}$$

$$\partial_t g(w,t) = -\partial_w[\mu_w(w,t)g(w,t)] + \frac{1}{2}\partial_{ww}[\sigma_w(w,t)^2 p(w,t)] \tag{10}$$

Risk-adjusted payoff $y(w,t)$:

$$y(w,t) = \nu(t) - \left(\frac{\sigma}{1-\epsilon(w,t)\theta(w,t)}\right)^2 \max\left\{\frac{1}{w+\varphi(t)}, \frac{1}{\varphi(t)}\left(1 - \frac{\bar{\theta}w}{p(w,t)}\right)\right\} \tag{11}$$

with wealth elasticity of price $\epsilon(w,t) = w/p(w,t) \cdot \partial_w p(w,t)$

calibration

	model	target	source
aggregates:			
US wealth share	32%	32%	Credit Suisse 2022
US output share	24%	23%	World Bank
average risk premium	2.6pp	2.5pp	Gourinchas Rey 2022
emerging market premium	2.2pp	2.3pp	Adler Garcia-Macia 2018
external assets to external liabilities:			
mean	1.07	1.08	IFS (IMF)
standard deviation	0.69	0.69	IFS (IMF)
q25	0.61	0.62	IFS (IMF)
q50	0.85	0.88	IFS (IMF)
q75	1.29	1.25	IFS (IMF)

parameter values back

parameters

parameter	value	meaning
regular countries		
ρ	0.0793	discount rate
λ	0.0177	emigration rate
ν	0.0600	output rate
σ	0.0647	output volatility
$\overline{\theta}$	0.7059	upper limit on risky asset share
special country		
$\hat{\rho}$	0.0844	discount rate
$\hat{\lambda}$	0.0384	emigration rate
$\hat{q}$	0.3096	asset stock
ζ	0.3824	country weight intercept
γ	0.6698	risk-taking capacity

back

estimation results

Estimate 5 parameters: persistence (μ_γ, μ_ν) and loadings $(\sigma_{\gamma 1}, \sigma_{\gamma 2}, \sigma_{\nu 2})$

$$\begin{pmatrix} d\gamma_t \\ d\nu_t \end{pmatrix} = \begin{pmatrix} \mu_\gamma & 0 \\ 0 & \mu_\nu \end{pmatrix} \begin{pmatrix} \overline{\gamma} - \gamma_t \\ \overline{\nu} - \nu_t \end{pmatrix} dt + \begin{pmatrix} \sigma_{\gamma 1} & \sigma_{\gamma 2} \\ 0 & \sigma_{\nu 2} \end{pmatrix} \begin{pmatrix} dW_1 \\ dW_2 \end{pmatrix} \tag{12}$$

Results:

μ_γ	μ_ν	$\sigma_{\gamma 1}$	$\sigma_{\gamma 2}$	$\sigma_{\nu 2}$
0.2445	0.7757	-0.1258	-0.0843	-0.0039
(0.0450)	(0.0356)	(0.0098)	(0.0056)	(0.00006)

back

untargeted moments: cyclicality

- cyclicality of outflows stronger in AE
- cyclicality of prices is stronger in EM
- relative performance negatively correlated with relative outflows

	$\text{corr}(\tilde{b}_t^{AE} - \tilde{b}_t^{EM}, \tilde{b}_t)$	$\text{corr}(\tilde{p}_t^{AE} - \tilde{p}_t^{EM}, \tilde{b}_t)$
data	0.67	-0.16
model	0.13	-0.55

back

cyclicality of wealth

Shocks to γ generate countercyclical wealth dynamics in AE, procyclical in EM

Table: Correlations of wealth with total outflows $\tilde{b}_t$

	full model	only γ	only ν
wealth			
$\hat{w}_t$	0.30	-0.95	0.11
w_t^{AE}	0.32	-0.89	0.97
w_t^{EM}	0.94	0.97	0.99

back