Heterogeneous Impact of the Global Financial Cycle

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May 18, 2024

motivation

Global cycle in capital flows and assets prices

- investors accumulate foreign assets in booms, sell in downturns (retrenchment)
- flows correlated with measures of global risk-taking capacity

Countries are unequally exposed to the cycle

- emerging markets especially strongly affected by downturns, prone to sudden stops
- outward investments tracks the cycle more closely in advanced economies

this paper

A heterogeneous-country model with global financial shocks

- gross capital flows and asset prices jointly determined
- cross-country wealth distribution
- heterogeneous responses to capital flight events

Mechanism to generate unequal exposure to capital flight: responses of local investors

- rise in risk premia concentrated in poor countries
- sales of foreign assets done by advanced economies
- risky assets in advanced economies appreciate in downturns

model

Global intermediaries + multiple countries

- countries issue risky assets, local agents hold these assets and save abroad
- intermediaries borrow from local agents and invest in all countries

Friction: market segmentation across countries

In equilibrium: heterogeneity in wealth, different exposure to foreign shocks

- rich countries: low risk premia, large external holdings
- poor countries: high risk premia, foreign investors hold large shares of local assets

mechanism and key results

Main experiment: negative shock to risk-bearing capacity of global intermediaries

- rich countries: local investors buy domestic assets from intermediaries
- poor countries: unable to absorb additional risk $\longrightarrow$ prices adjust instead of quantities

Equilibrium implications:

- assets issued in rich countries appreciate $\longrightarrow$ good substitutes for safe assets
- rich countries become richer
- rich countries provide insurance to poor ones

explaining the data

Global output shocks explain most of variation in average flows and prices

Financial shocks explain more 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:

- real shocks (output) explain procyclicality
- financial shocks induce countercyclical asset prices in AE

Correlation of wealth with global aggregates is 3 times lower 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, study risk-sharing

outline

— model

— shock to risk-taking capacity of global intermediaries

— data and quantitative results

regular 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

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

$$dw_{it} = (r_t w_{it} - c_{it})dt + \theta_{it} w_{it} dR_{it} \tag{1}$$

- 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

$$dR_{it} = \frac{1}{p_{it}}(dy_{it} + dp_{it}) - r_t dt \tag{2}$$

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

$$d\hat{R}_t = \frac{1}{\hat{p}_t}(\nu dt + d\hat{p}_t) - r_t dt \tag{3}$$

intermediary's problem

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

$$d\hat{w}_t = (r_t\hat{w}_t - \hat{c}_t)dt + \int(\hat{\theta}_{it}\hat{w}_t dR_{it})di + \hat{\theta}_t\hat{w}_t d\hat{R}_t \tag{4}$$

- portfolio shares $\{\hat{\theta}_{it}\}$ allocated to all trees, $\hat{\theta}_t$ to the US tree

Constraint on total amount of idiosyncratic risk:

foundation

$$\underbrace{\int_0^1 \mathbb{V}_t[\hat{\theta}_{it}\hat{w}_t dR_{it}]di}_{\text{total idiosyncratic risk}} \leq \gamma_t\hat{w}_t \underbrace{\int_0^1 \mathbb{E}_t[\hat{\theta}_{it}\hat{w}_t dR_{it}]di}_{\text{expected profit}} \tag{5}$$

holdings

- regular 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 infinite capacity benchmark

$$1 = \hat{h}_{it} + h_{it} \qquad \text{all } i \in [0,1] \tag{6}$$

$$\hat{q} = \hat{h}_t \tag{7}$$

$$0 = \hat{b}_t + \int_0^1 b_{it} di \tag{8}$$

$$(1+\hat{q})v = \hat{c}_t + \int_0^1 c_{it} di \tag{9}$$

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)

- 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

No arbitrage condition: $\hat{d}R = 0$ implies no risk premium, tree priced at fair value

solving the model

$$r\hat{p} = \nu$$

Regular countries:

$$rp(w) = \nu - \underbrace{\frac{(\sigma_w(w)p'(w) + \sigma)^2}{w + \gamma\hat{w}}}_{\text{risk adjustment}} + \underbrace{\mu_w(w)p'(w) + \frac{\sigma_w(w)^2}{2}p''(w)}_{\text{growth term}} \tag{10}$$

Property 1: as $w \longrightarrow \infty$, risk adjustment disappears and $rp(w) \longrightarrow \nu$

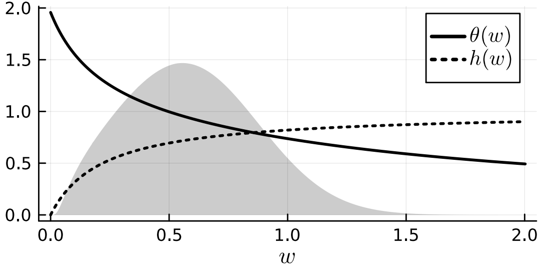
wealth dynamics

- $\sigma_w(w) \longrightarrow \sigma$, risk does not scale with wealth
- $\mu_w(w)/w \longrightarrow r - \rho$, agents consume away their savings

steady state: holdings

Property 2: local agents own larger shares of assets in rich countries: $h(w) = \dfrac{w}{w + \gamma \hat{w}}$

Property 3: local agents rely more on foreign holdings in rich countries: $\theta(w) = \dfrac{p(w)}{w + \gamma \hat{w}}$



steady state: exorbitant privilege

Property 4: intermediary earns profits, special country gets "exorbitant privilege"

Special country's trade deficit is

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

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

Rich countries use foreign holdings to buy domestic assets

- little movement in expected returns, sizeable trade volumes as local agents retrench

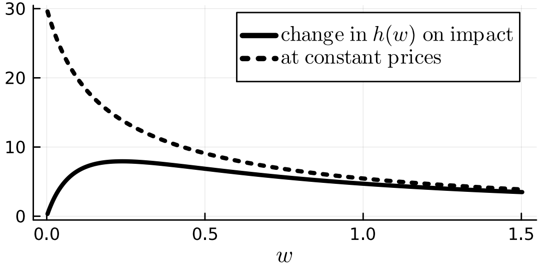
Poor countries cannot absorb much without a sharp rise in excess returns

- expected returns increase to convince intermediaries to sell less

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 $\varphi(t) = \gamma(t)\hat{w}(t)$:

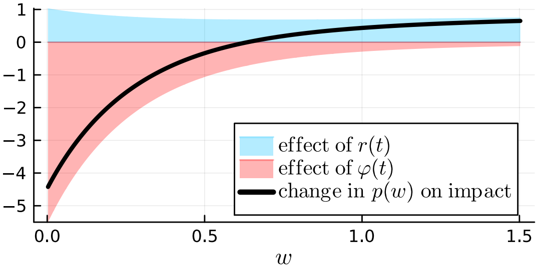
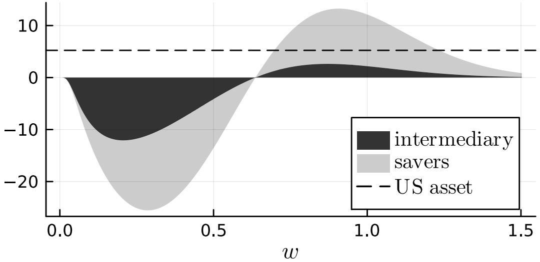


Figure: percentage changes in $p(w,t)$ on impact.

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

data

Facts about global downturns:

- AE investors sell more of their foreign assets (Miranda-Agrippino Rey 2022) evidence
- asset prices fall in EM (Kalemli-Ozkan 2019), rise in AE
- the US takes losses on its external position (Gourinchas Rey 2022)
- the US wealth share increases (Dahlquist et al 2023)

quantitative results

Add output shocks alongside financial, estimate joint process

- data point at a strong correlation $\longrightarrow$ asking for endogenous link from prices to output

Output and financial shocks responsible for different moments

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

Output and financial shocks induce different cyclicality

- output shocks induce procyclical behavior of prices everywhere
- financial shocks induce procyclical behavior in EM and countercyclical in AE

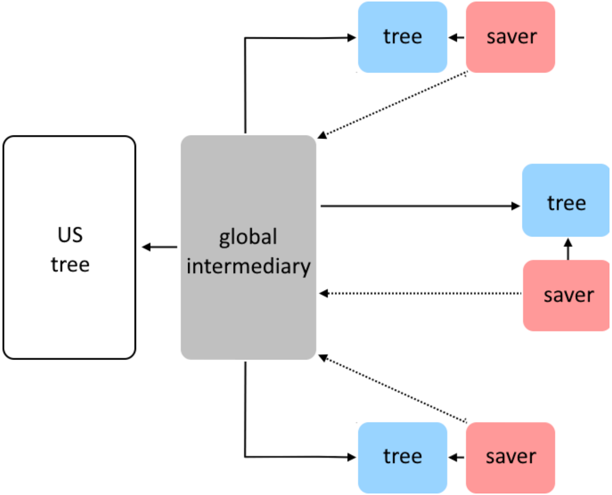
conclusion

Domestic demand in richer countries is more elastic due to size and portfolio constraints

- sudden stops lead to retrenchment that stabilizes prices
- assets issued by richer countries are endogenously safer
- wealth transfers: rich $\rightarrow$ dominant $\rightarrow$ poor
- wealth redistribution: regressive

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

$$\mu_w(w) = (r - \rho)w + \frac{\sigma_w(w)^2}{w} \tag{11}$$

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

$$\sigma_w(w) = \sigma \cdot \frac{w}{w + \gamma\hat{w} - p'(w)w} \tag{12}$$

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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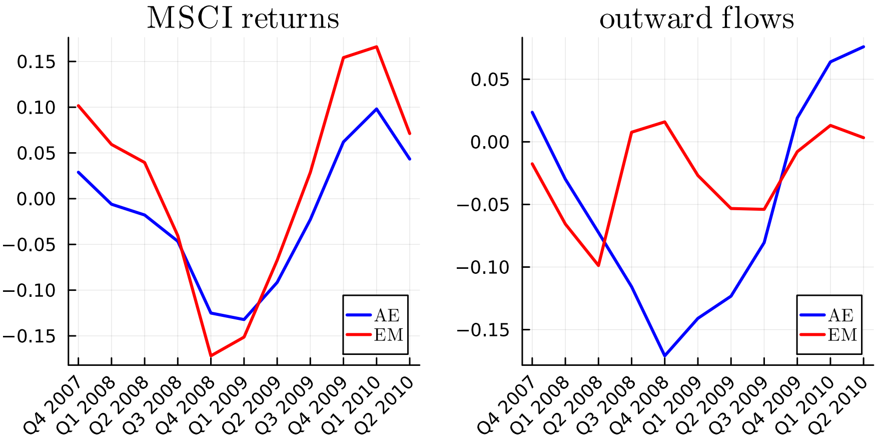
example: 2008



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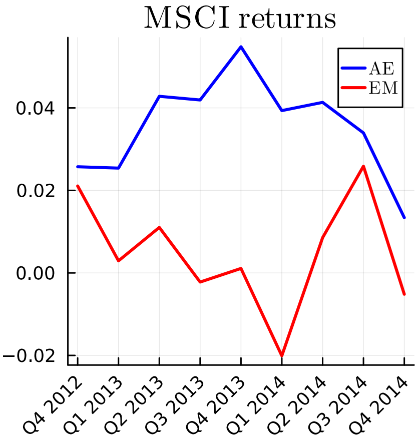
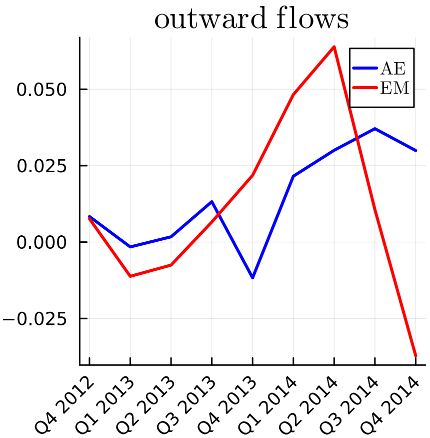
example: 2013





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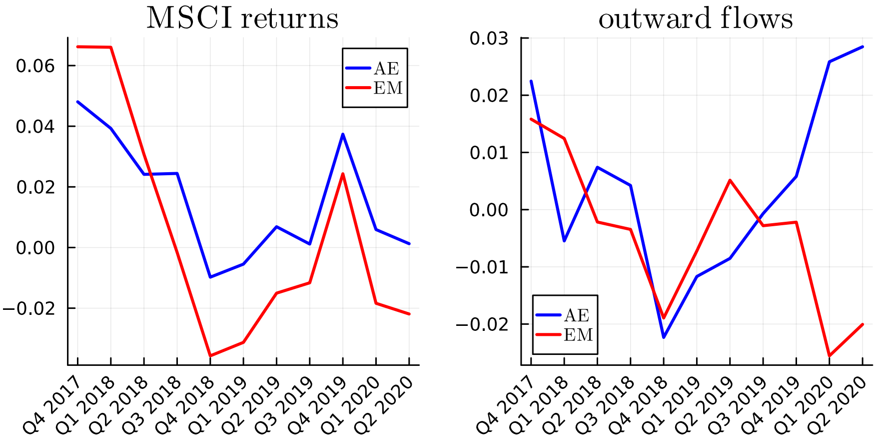
example: 2018



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intermediary's problem (ambiguity)

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

$$dR_{it} = (\mu_{it}^R - \xi_{it}\sigma_{it}^R)dt + \sigma_{it}^R d\hat{Z}_{it} \tag{13}$$

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

$$\max_{\{\hat{c}_t, b_t, \boldsymbol{\theta}_t\}_{t\geq 0}} \quad \min_{\{\boldsymbol{\xi}_t\}_{t\geq 0}} \mathbb{E} \int_0^\infty e^{-\hat{\rho}t} \left(\hat{\rho} \ln(\hat{c}_t) + \frac{\gamma_t}{2} \int_0^1 \xi_{it}^2 di \right) dt \tag{14}$$

Cost parameter γ_t governs risk-taking capacity:

back

$$\hat{\theta}_{it} = \gamma_t \frac{\mu_{it}^R}{(\sigma_{it}^R)^2} \tag{15}$$

infinite capacity benchmark

Suppose $\gamma = \infty$, no limit to risk-taking capacity

back

- $\mu_{it}^{R} = 0$: no expected excess returns
- $h_{it} = 0$ and $\hat{h}_{it} = 1$: intermediaries take over
- full insurance, everyone's wealth is constant
- dividends collected by intermediaries, countries get interest payments

solving the model

Investors choose mean-variance portfolio:

back

$$\theta(w,t) = \frac{\mu_R(w,t)}{\sigma_R(w,t)^2} \qquad \hat{\theta}(w,t) = \gamma(t)\frac{\mu_R(w,t)}{\sigma_R(w,t)^2}$$

Excess returns are defined as

$$\mu_R(w,t) = \frac{\mu_p(w,t)+\nu}{p(w,t)} - r(t) \qquad \sigma_R(w,t) = \frac{\sigma_p(w,t)+\sigma}{p(w,t)}$$

Using these facts and market clearing,

$$\underbrace{\mu_p(w,t)+\nu - r(t)p(w,t)}_{\text{risk premium}} = \underbrace{(\sigma_p(w,t)+\sigma)^2}_{\text{quantity of risk}} \cdot \frac{1}{w+\gamma(t)\hat{w}(t)} \tag{16}$$

solving for prices and distributions

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

back

$$r(t)p(w,t) - \partial_t p(w,t) = y(w,t) + \mu_w(w,t)\partial_w p(w,t) + \frac{1}{2}\sigma_w(w,t)^2\partial_{ww}p(w,t) \tag{17}$$

$$\partial_t g(w,t) = -\partial_w[\mu_w(w,t)g(w,t)] + \frac{1}{2}\partial_{ww}[\sigma_w(w,t)^2 p(w,t)] \tag{18}$$

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

$$y(w,t) = \nu(t) - \left(\frac{\sigma}{1-\epsilon(w,t)\theta(w,t)}\right)^2 \max\left\{\frac{1}{w+\varphi(t)}, \frac{1}{\varphi(t)}\left(1-\frac{\bar{\theta}w}{p(w,t)}\right)\right\} \tag{19}$$

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

solving for prices

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

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

estimation

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

$$d\gamma(t) = \mu_\gamma(\gamma - \gamma(t))dt + \sigma_\gamma \cdot dW(t) \tag{20}$$

$$d\nu(t) = \mu_\nu(\nu - \nu(t))dt + \sigma_\nu \cdot dW(t) \tag{21}$$

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 $p(t) = \int p(w,t)dG(w,t)$

moments

Data: quarterly returns on MSCI ex-US index for $\tilde{p}_t$, total outflows from IMF data for $\tilde{b}_t$

Table: targets

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

estimated parameters

untargeted moments

Associate AE to unconstrained countries

Gross outflows relative to assets are more volatile in AE:

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

Asset prices are less volatile in AE:

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

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

variance decomposition

- output shocks explain variation in averages
- financial shocks explain relative performance

Table: standard deviations of first-order responses

	data	full model	only γ	only ν
b_t	0.049	0.049	0.024	0.044
p_t	0.048	0.048	0.007	0.044
relative performance				
p_t^{AE} - p_t^{EM}	0.035	0.026	0.019	0.010

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

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 $(\sigma_{\gamma 1}, \sigma_{\gamma 2}, \sigma_{\nu 2})$

$$\begin{pmatrix} d\gamma_t \\ d\nu_t \end{pmatrix} = \begin{pmatrix} \mu_\gamma & 0 \\ 0 & \mu_\nu \end{pmatrix} \begin{pmatrix} \overline{\gamma} - \gamma_t \\ \overline{\nu} - \nu_t \end{pmatrix} dt + \begin{pmatrix} \sigma_{\gamma 1} & \sigma_{\gamma 2} \\ 0 & \sigma_{\nu 2} \end{pmatrix} \begin{pmatrix} dW_1 \\ dW_2 \end{pmatrix} \tag{22}$$

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)

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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