Heterogeneous Impact of the Global Financial Cycle

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motivation

Global shocks largely transmit through financial markets

Countries have unequal exposure

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

this paper

Model of global economy with financial shocks and segmented markets

Market segmentation leads to heterogeneity

- uninsured country risk, wealth distribution across countries
- price of country risk a decreasing function of local and global wealth
- sensitivity of country risk premia a decreasing function of local wealth

global shocks

Global shock: falling risk-taking capacity

- sudden stop targeting <u>poor</u> countries
- universal rise in risk premia, concentrated in <u>poor</u> countries
- large outflows and retrenchment, concentrated in <u>rich</u> countries
- falling global rate, rising asset prices in <u>rich</u> countries

Empirical patterns in cross-section:

- <u>prediction</u>: external assets related to sensitivity of returns and flows to global shocks
- stocks in high-asset economies <u>outperform</u> low-asset ones in global downturns
- retrenchment in high-asset economies is <u>stronger</u> in global downturns

literature

Evidence of the global financial cycle and heterogeneous exposures:

- Miranda-Agrippino Rey 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, Farboodi Kondor 2022, Jeanne Sandri 2023, Morelli et al 2023, Bai et al 2019, Dahlquist et al 2023, Gourinchas et al 2022, Davis van Wincoop 2023, Kekre Lenel 2021, Sauzet 2023

Models of the cross-section of currency returns:

- Hassan 2013, Verdalhan 2018, Richmond 2019 and many others

This paper: explain heterogeneity using gross flows + focus on country risk

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

$$dR_{it} = \frac{1}{p_{it}}(dy_{it} + dp_{it}) - r_t dt \equiv \mu_{it}^R dt + \sigma_{it}^R dZ_{it}$$

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

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

Houses the global intermediary

intermediary: trading desk i

Tree share $\hat{\theta}_{it}$, special tree share $\hat{\eta}_{it}$, risk-free rate, rebate to head office $d\tau_{it}$

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

Fear model misspecification for returns:

- misspecified models indexed by drift correction processes $\{h_{it}\}_{t\geq 0}$

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

- generate probability measures $\mathbb{Q}$, log likelihood ratio processes $\{m_{it}\}_{t\geq 0}$

$$\max_{\{\hat{c}_{it},\hat{\theta}_{it}\}_{t\geq 0}} \inf_{\mathbb{Q}} \mathbb{E}^{\mathbb{Q}}\left[\rho\int_0^\infty e^{-\rho t}\log(\hat{c}_{it})dt + \underbrace{\int_0^\infty e^{-\rho t}\frac{\gamma_t}{1-\gamma_t}dm_{it}}_{\text{entropy penalty}}\right]$$

- rebates $d\tau_{it}$ ensure $\hat{w}_{it} \equiv \hat{w}_t$, taken as given

equivalent problem discussion

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: $\hat{s}_{it} = \dfrac{\hat{\eta}_{it} \hat{w}_t}{\hat{p}_t}$
- bond holdings: $b_{it} = (1 - \theta_{it}) w_{it}$ and $\hat{b}_{it} = \left(1 - \hat{\eta}_{it} - \hat{\theta}_{it}\right) \hat{w}_t$

equilibrium

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

world map

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

main equation

Optimal portfolio choice: $\theta_{it} = \dfrac{\mu_{it}^R}{(\sigma_{it}^R)^2}$ and $\hat{\theta}_{it} = \gamma_t \dfrac{\mu_{it}^R}{(\sigma_{it}^R)^2}$

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

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

Putting all together

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

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 $g(w, t)$

characterizing prices · infinite risk-taking capacity benchmark · small open economy benchmark

steady state: wealth dynamics

Drift and volatility of wealth:

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

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

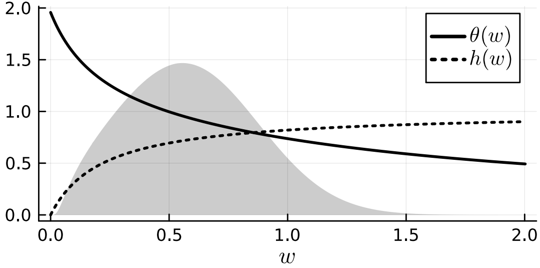
Property 2: $\sigma_w(w) \longrightarrow \sigma$ and $\mu_w(w)/w \longrightarrow r - \rho$ as $w \longrightarrow \infty$

- 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":

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

- 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: $\int \mu_p(w)\hat{h}(w)dG(w) > 0$

analytical solutions: prices

Consider a second-order approximation around $\sigma = 0$ (older terms are $o(\sigma^3)$, in fact) distribution

- define price of risk function $\boldsymbol{\pi}(w) = \dfrac{1}{w + \gamma \hat{w}}$
- let $\hat{\mathbb{E}}[\cdot]$ be taken at limiting distribution $\mathcal{G}(\cdot)$
- strength of precautionary motives relates to average price of risk:

$$r = \rho - \frac{\rho\sigma^2}{\nu} \cdot \frac{\hat{\mathbb{E}}[\boldsymbol{\pi}(w)]}{1+\hat{q}}$$

- asset prices reflect risk premia and precautionary motives:

$$p(w) = \frac{\nu}{\rho} + \frac{\sigma^2}{\rho}\left(\frac{\hat{\mathbb{E}}[\boldsymbol{\pi}(w)]}{1+\hat{q}} - \boldsymbol{\pi}(w)\right)$$
$$\hat{p} = \frac{\nu}{\rho} + \frac{\sigma^2}{\rho} \cdot \frac{\hat{\mathbb{E}}[\boldsymbol{\pi}(w)]}{1+\hat{q}}$$

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

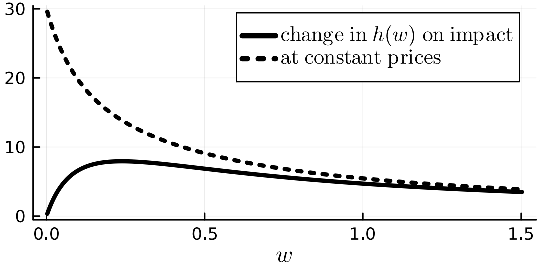
Local agents retrench:

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

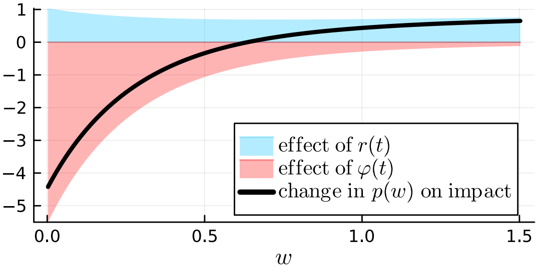


Figure: percentage changes in $p(w, t)$ on impact.

shocks to γ analytically

Consider a path of risk-taking capacity $\Delta\gamma(t) = \delta e^{-\mu t}$

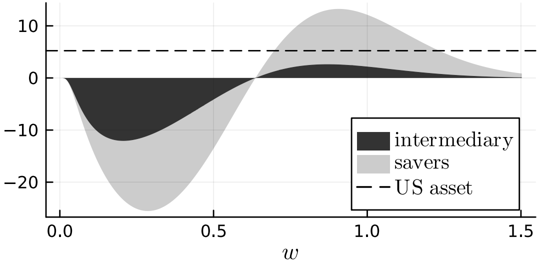
- take the first-order approximation: keep terms of order $O(\delta\sigma^2)$ and larger
- the deviation of the risky asset prices from the steady state is

$$\Delta p(w,t) = \delta e^{-\mu t} \cdot \frac{\sigma^2 \hat{w}}{\mu + \rho} \cdot \left[\boldsymbol{\pi}(w)^2 - \int \frac{\boldsymbol{\pi}(w)^2}{1+\hat{q}} d\mathcal{G}(w) \right]$$

- a threshold level of wealth $\underline{w}$ such that $\Delta p(w,t) < 0$ if $w > \underline{w}$ and $\Delta p(w,t) > 0$ if $w < \underline{w}$

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

Empirical results

cross-sectional regressions

Loadings $\{\beta_i^{(r,f)}\}_{i\in\mathcal{I}}$ from the factor regression with ouctome r_{it} and f_t

$$r_{it} = \alpha^{(r,f)} + \beta_i^{(r,f)} f_t + \epsilon_{it}^{(r,f)}$$

Project the loadings $\{\beta_i^{(r,f)}\}$ on cross-sectional variable x_i (external assets over GDP):

$$\beta_i^{(r,f)} = \gamma^{(r,f)} + \Gamma^{(r,f)} x_i + \varepsilon_i^{(r,f)}$$

- outcomes r_{it}: USD returns on stocks, exchange rate appreciation, outward flows (normalized by assets and by liabilities)
- factors f_t: first principal in outward flows, VIX, EBP, intermediary factor from He Kelly Manela 2017

return on equities

Table: cross-sectional regressions of loadings from r_{it}^{msci} on assets-to-GDP

	$f_t^{acq/asset}$	f_t^{vix}	f_t^{ebp}	f_t^{inter}
Γ	**0.00272**	**-0.00020**	-0.00368	**-0.05203**
	(0.00091)	(0.00007)	(0.00199)	(0.02443)
N	42	42	42	42
R^2	0.081	0.162	0.060	0.127

exchange rates

asset acquisition (normalized by liabilities)

Table: cross-sectional regressions of loadings from $r_{it}^{acq/liab}$ on assets-to-GDP

	$f_t^{acq/asset}$	f_t^{vix}	f_t^{ebp}	f_t^{inter}
Γ	**0.01674**	**-0.00031**	**-0.01952**	**-0.03049**
	(0.00399)	(0.00006)	(0.00377)	(0.01093)
N	57	57	57	57
R^2	0.203	0.164	0.208	0.028

acquisition to assets

conclusion

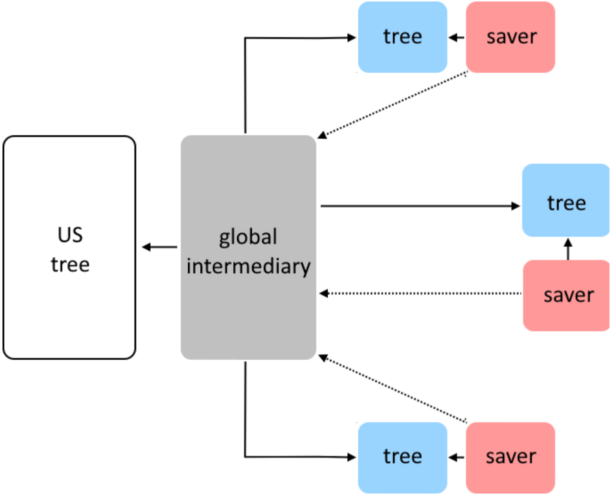
Segmented markets deliver heterogeneity in risk prices and capital flow elasticities

- economies with high external wealth have low country risk prices
- show high elasticity in times of global risk-taking shocks
- actively retrench and outperform in global downturns

Cross-sections of loadings of flows and returns in line with the mechanism

Thank you for your attention

model map



back

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

$$\mu_w(w) = (r-\rho)w + \frac{\sigma_w(w)^2}{w} \tag{1}$$

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

$$\sigma_w(w) = \sigma \cdot \frac{w}{w + \gamma\hat{w} - p'(w)w} \tag{2}$$

why robustness preferences

What robustness preferences do:

back

- long-lived agents with meaningful consumption-saving choice
- absence of hedging motives
- mean-variance portfolio with time-varying risk aversion

How: misspecified models for returns, not exogenous states

- important differences from Hansen Sargent (2001) and Duffie Epstein (1992)

Result: simple aggregation, tractable dynamics

- alternative interpretation as value-at-risk constraints

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

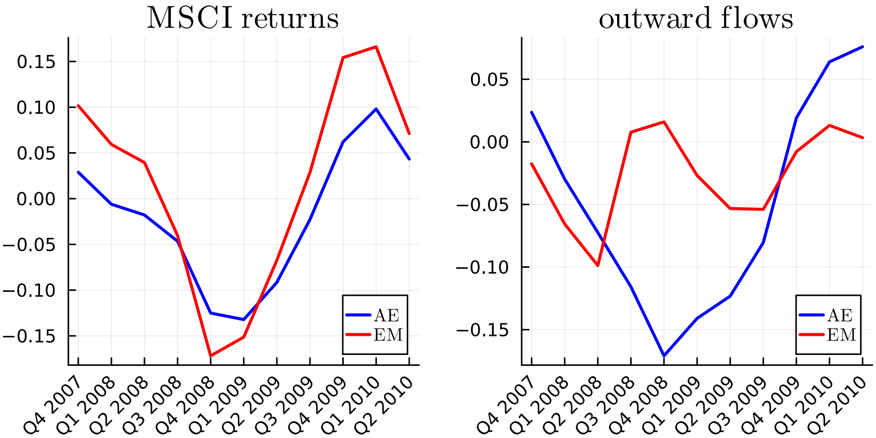
outflows and measures of risk-taking capacity

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

back

example: 2008



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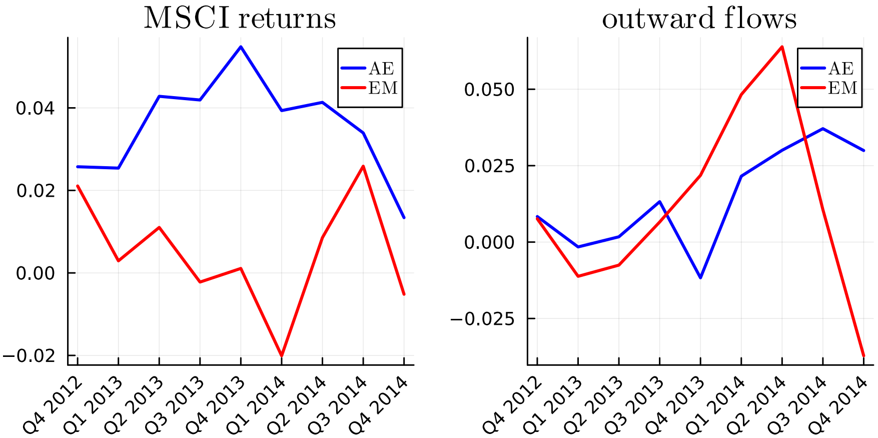
example: 2013



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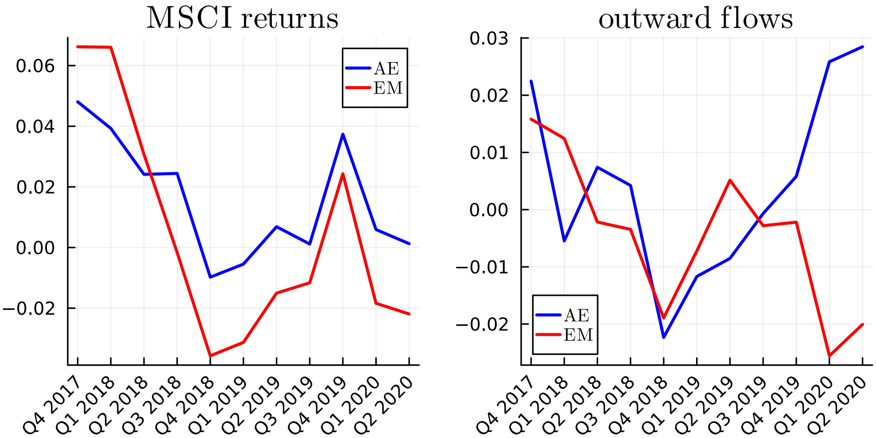
example: 2018



back

head offices's problem

Unified objective and budget constraint:

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

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

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

Constraint on total amount of idiosyncratic risk:

firm-wide misspecification back

$$\underbrace{\int_0^1 \mathbb{V}_t[\hat{\theta}_{it} \hat{w}_t dR_{it}] di}_{\text{total idiosyncratic risk}} \leq \gamma_t \hat{w}_t \underbrace{\int_0^1 \mathbb{E}_t[\hat{\theta}_{it} \hat{w}_t dR_{it}] di}_{\text{expected profit}} \tag{3}$$

intermediary's problem (firm-wide misspecification)

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

$$dR_{it} = (\mu^R_{it} - \xi_{it}\sigma^R_{it})dt + \sigma^R_{it} d\hat{Z}_{it} \tag{4}$$

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

$$\max_{\{\hat{c}_t, b_t, \boldsymbol{\theta}_t\}_{t\geq 0}} \min_{\{\boldsymbol{\xi}_t\}_{t\geq 0}} \mathbb{E} \int_0^\infty e^{-\hat{\rho} t} \left(\hat{\rho} \ln(\hat{c}_t) + \frac{\gamma_t}{2} \int_0^1 \xi^2_{it} di \right) dt \tag{5}$$

Cost parameter γ_t governs risk-taking capacity:

back

$$\hat{\theta}_{it} = \gamma_t \frac{\mu^R_{it}}{(\sigma^R_{it})^2} \tag{6}$$

steady state: prices

Asset prices:

solving the model back

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

Wealth distribution:

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

Interest rate:

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

benchmark: infinite risk-taking capacity

Consider the limit $\gamma \longrightarrow \infty$

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

back

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 $\Gamma > 0$

- $\hat{w} \longrightarrow \infty$ 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

back

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

$$r(t)p(w,t) - \partial_t p(w,t) = y(w,t) + \mu_w(w,t)\partial_w p(w,t) + \frac{1}{2}\sigma_w(w,t)^2\partial_{ww}p(w,t) \tag{7}$$

$$\partial_t g(w,t) = -\partial_w[\mu_w(w,t)g(w,t)] + \frac{1}{2}\partial_{ww}[\sigma_w(w,t)^2 p(w,t)] \tag{8}$$

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

$$y(w,t) = \nu(t) - \left(\frac{\sigma}{1-\epsilon(w,t)\theta(w,t)}\right)^2 \cdot \frac{1}{w+\varphi(t)} \tag{9}$$

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

analytical solutions: wealth distribution

Limiting steady-state distribution non-degenerate

back

- drift proportional to σ^2, volatility proportional to σ:

$$\frac{dw}{w} = \left(\boldsymbol{\pi}(w)^2 - \frac{\rho}{\nu} \cdot \frac{\hat{\mathbb{E}}[\boldsymbol{\pi}(w)]}{1+\hat{q}} \right) \sigma^2 dt + \boldsymbol{\pi}(w)\sigma dZ + o_p(\sigma^2)$$

- volatility approaches zero at infinity
- drift is negative for large w, positive for $w \longrightarrow 0$ if γ not too large
- risky countries grow, safe countries consume away

exchange rates

Table: cross-sectional regressions of loadings from r_{it}^{xr} on assets-to-GDP

	$f_t^{acq/asset}$	f_t^{vix}	f_t^{ebp}	f_t^{inter}
Γ	**-0.00085**	**0.00022**	0.00137	**0.05896**
	(0.00042)	(0.00007)	(0.00128)	(0.01779)
N	78	78	78	78
R^2	0.016	0.048	0.006	0.042

back

asset acquisition (normalized by assets)

Table: cross-sectional regressions of loadings from $r_{it}^{acq/asset}$ on assets-to-GDP

	$f_t^{acq/asset}$	f_t^{vix}	f_t^{ebp}	f_t^{inter}
Γ	**0.01221**	**-0.00036**	**-0.01670**	**-0.06927**
	(0.00622)	(0.00011)	(0.00681)	(0.03155)
N	58	58	58	58
R^2	0.038	0.102	0.054	0.051

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