Risk-sharing for the long-run
The gains from financial integration

Ric Colacito Max Croce

UNC-Chapel Hill

The question

What are the welfare benefits of financial integration?

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- Long standing question in international finance

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- One common finding

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What are the welfare benefits of financial integration?

- Long standing question in international finance
- One common finding
  → The benefits are smaller than 1% of lifetime consumption
- Related literature
  - Cole and Obstfeld (1991)
  - van Wincoop (1994)
  - Tesar (1995)
  - Gourinchas and Jeanne (2006)
  - ...

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  2. quantities

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  - Relative smoothness of exchange rates
  - Degree of volatility of SDF's

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  - Lack of correlation between consumption differentials and exchange rates
  - Negative UIP regression slope
  - At least some volatility of Net Exports

Background

- Bansal and Yaron (2004):
  1. Risk-sensitive agents
  2. Slowly moving predictive component of consumption growth

  can generate volatile stochastic discount factors.

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    1. Risk-sensitive agents
    2. Slowly moving predictive component of consumption growth

  can generate volatile stochastic discount factors.

- Colacito and Croce (2007):
    3. High int'l correlation of long-run risks

  can generate modestly volatile exchange rates.

This paper

Two additional ingredients:

4. Consumption home bias
5. General equilibrium approach

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This paper

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introduce a **time-varying distribution of consumption across countries**

This generates:

- incentive to trade (goods and assets)
- asymmetric movements between consumptions differentials and exchange rates
- time varying volatility

Roadmap of the talk

- Setup of the model
- Calibration
- Reconciling international prices and quantities
- What are the benefits of financial integration?
- In progress: predictability?

Preferences

- Agents have risk-sensitive preferences

$$U_t^i = (1-\delta)\log C_t^i + \delta\theta \log E_t \exp\left\{\frac{U_{t+1}^i}{\theta}\right\}, \qquad \forall i \in \{h,f\}$$

where $\theta = 1/(1-\gamma)$.

Preferences

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$$U_t^i = (1-\delta)\log C_t^i + \delta E_t[U_{t+1}^i], \qquad \forall i \in \{h, f\}$$

where $\theta = 1/(1-\gamma)$. If $\theta \to -\infty$: time additive case.

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- Preferences are defined over the consumption aggregate

$$C_t^h = \left(x_t^h\right)^{\alpha}\left(y_t^h\right)^{1-\alpha} \quad \text{and} \quad C_t^f = \left(x_t^f\right)^{1-\alpha}\left(y_t^f\right)^{\alpha}$$

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- Consumption home bias: $\alpha >> 0.5$.

Endowments

- Endowments' growth is *almost* i.i.d.

$$\begin{aligned} \Delta \log X_t &= \mu_x + z_{1,t-1} + \varepsilon_{x,t} \\ \Delta \log Y_t &= \mu_y + z_{2,t-1} + \varepsilon_{y,t} \end{aligned}$$

where $z_{1,t}$ and $z_{2,t}$ are small, predictable components

$$\begin{aligned} z_{1,t} &= \rho_1 z_{1,t-1} + \varepsilon_{1,t} \\ z_{2,t} &= \rho_2 z_{2,t-1} + \varepsilon_{2,t} \end{aligned}$$

Complete Markets

- Home country is endowed with X_t
- Foreign country is endowed with Y_t

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- Home country is endowed with X_t
- Foreign country is endowed with Y_t
- Two country specific budget constraints

$$x_t^h + p_t y_t^h + \int_{\zeta^{t+1}} Q^h\left(\zeta^{t+1}\right) A_{t+1}^h\left(\zeta^{t+1}\right) = X_t + A_t^h \qquad [Home]$$

$$x_t^f + p_t y_t^f + \int_{\zeta^{t+1}} Q^f\left(\zeta^{t+1}\right) A_{t+1}^f\left(\zeta^{t+1}\right) = p_t Y_t + A_t^f \qquad [Foreign]$$

- Market clearing: $A_t^h + A_t^f = 0$

Planner's problem

Efficient allocations are the solution to the planner's problem

$$
\begin{aligned}
\text{choose} \quad & \left\{x_t^h, x_t^f, y_t^h, y_t^f\right\}_{t=0}^{+\infty} \\
\text{to max} \quad & Q = \mu U_0^h + (1-\mu) U_0^f \\
\text{s.t.} \quad & x_t^h + x_t^f = X_t \\
& y_t^h + y_t^f = Y_t, \quad \forall t \geq 0
\end{aligned}
$$

$\rightarrow \mu$ and $1-\mu$ correspond to an initial distribution of assets

Allocations

Time Additive Preferences

Let $k = \frac{\alpha}{1-\alpha}$:

$$x_t^h = \frac{k}{1+k} X_t, \qquad x_t^f = \frac{1}{1+k} X_t$$
$$y_t^h = \frac{1}{k+1} Y_t, \qquad y_t^f = \frac{k}{k+1} Y_t$$

Allocations

Risk Sensitive Preferences

Let $k = \frac{\alpha}{1-\alpha}$:

$$x_t^h = \frac{kS_t}{1+kS_t}X_t, \qquad x_t^f = \frac{1}{1+kS_t}X_t$$

$$y_t^h = \frac{S_t}{k+S_t}Y_t, \qquad y_t^f = \frac{k}{k+S_t}Y_t$$

where

$$S_t = S_{t-1}\frac{\delta \exp\left\{\frac{U_t^h}{\theta}\right\}}{E_{t-1}\exp\left\{\frac{U_t^h}{\theta}\right\}} \Bigg/ \frac{\delta \exp\left\{\frac{U_t^f}{\theta}\right\}}{E_{t-1}\exp\left\{\frac{U_t^f}{\theta}\right\}}$$

Consumption growth

Time Additive Preferences

$$\Delta c_t^h = \alpha \Delta x_t + (1-\alpha)\Delta y_t$$
$$\Delta c_t^f = (1-\alpha)\Delta x_t + \alpha \Delta y_t$$

Consumption growth

Risk Sensitive Preferences

$$\Delta c_t^h = \Delta c_t^{h,TA} + \lambda_c^h s_{t-1} + \lambda_{cc}^h s_{t-1}^2 + \lambda_s^h (s_{t-1}) \varepsilon_t$$
$$\Delta c_t^f = \Delta c_t^{f,TA} + \lambda_c^f s_{t-1} + \lambda_{cc}^f s_{t-1}^2 + \lambda_s^f (s_{t-1}) \varepsilon_t$$

Consumption growth

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$$\Delta c_t^h = \Delta c_t^{h,TA} + \lambda_c^h s_{t-1} + \lambda_{cc}^h s_{t-1}^2 + v^h(s_{t-1}) g(\underbrace{\varepsilon_{1,t}}_{-}, \underbrace{\varepsilon_{2,t}}_{+}, \varepsilon_{x,t}, \varepsilon_{y,t})$$

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1. Contemporaneous response to long-run shocks

Consumption growth

Risk Sensitive Preferences

$$\Delta c_t^h = \Delta c_t^{h,TA} + \lambda_c^h s_{t-1} + \lambda_{cc}^h s_{t-1}^2 + \nu^h(s_{t-1}) g(\varepsilon_{1,t}, \varepsilon_{2,t}, \varepsilon_{x,t}, \varepsilon_{y,t})$$
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1. Contemporaneous response to long-run shocks
2. Endogenous stochastic volatility

Stochastic Discount Factors

- With Risk-sensitive preferences

$$
\begin{aligned}
m^i_{t+1} &= \log \frac{\partial U^i_{t+1}/\partial C^i_{t+1}}{\partial U^i_{t+1}/\partial C^i_t} \\
&= \log \delta - \Delta c^i_{t+1} + \log \frac{\exp\left\{U^i_{t+1}/\theta\right\}}{E_t \exp\left\{U^i_{t+1}/\theta\right\}}, \qquad \forall i \in \{h,f\}
\end{aligned}
$$

- With Time-additive preferences

$$
m^i_{t+1} = \log \delta - \Delta c^i_{t+1}, \qquad \forall i \in \{h,f\}
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Stochastic Discount Factors

- With Risk-sensitive preferences

$$m^h_{t+1} - E_t[m^h_{t+1}] = g^h(s_t \underbrace{\varepsilon^1_{t+1}}_{<<0}, s_t\varepsilon^2_{t+1}, s_t\varepsilon^x_{t+1}, s_t\varepsilon^y_{t+1})$$

$$m^f_{t+1} - E_t[m^f_{t+1}] = g^f(s_t\varepsilon^1_{t+1}, s_t \underbrace{\varepsilon^2_{t+1}}_{<<0}, s_t\varepsilon^x_{t+1}, s_t\varepsilon^y_{t+1})$$

- With Time-additive preferences

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- With Time-additive preferences

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Exchange Rates

- By no arbitrage

$$E_t\left[M^f_{t+1}R^f_{t+1}\right] = 1 = E_t\left[M^h_{t+1}\frac{e_{t+1}}{e_t}R^f_{t+1}\right]$$

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- Stochastic Discount Factors are highly volatile...
- they ought to be highly correlated as well!
- How?
- Long-Run risks are highly correlated

Net Export/Output

- Definition

$$\frac{NX_t^h}{X_t} = \frac{X_t^f - pY_t^h}{X_t}$$

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$$\frac{NX_t^h}{X_t} = \frac{X_t^f - pY_t^h}{X_t}$$

- With Time additive preferences

$$\frac{NX_t^h}{X_t} = 0$$

Net Export/Output

- Definition

$$\frac{NX_t^h}{X_t} = \frac{X_t^f - pY_t^h}{X_t}$$

- With Risk-Sensitive preferences

$$\frac{NX_t^h}{X_t} = \frac{1 - S_t}{1 + kS_t}$$

where

$$S_t = f(\varepsilon_t^1, \varepsilon_t^2, \varepsilon_t^x, \varepsilon_t^y)$$

Net Export/Output

- Definition

$$\frac{NX_t^h}{X_t} = \frac{X_t^f - pY_t^h}{X_t}$$

- With Risk-Sensitive preferences

$$\partial \frac{NX_t^h}{X_t} / \partial S_t < 0$$

where

$$S_t = f(\underbrace{\varepsilon_t^1}_{<<0}, \underbrace{\varepsilon_t^2}_{>>0}, \varepsilon_t^x, \varepsilon_t^y)$$

Calibration

μ	Mean Output growth	0.165%
σ	Std. dev. of idiosyncratic output growth	0.540%
σ_x	Std. dev. of long-run output growth	4%σ
α	Degree of consumption home bias	0.980
δ	Subjective discount factor	0.998
γ	Risk Aversion	7
ρ	Persistence of long-run risks	0.988
ρ_{12}	Correlation of long-run risks	.9
ρ_{xy}	Correlation of short-run risks	0

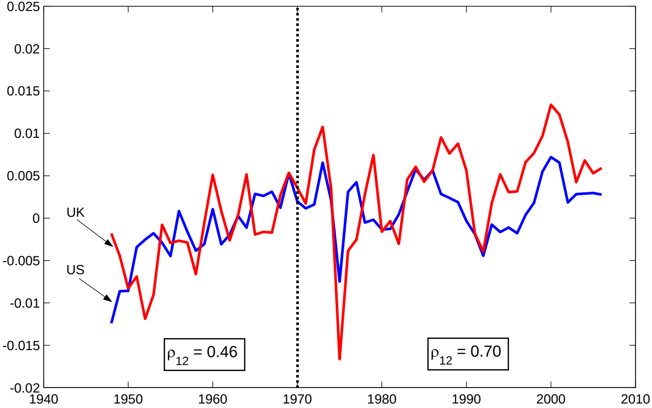
Correlation of Long-Run Risks: methodology

Methodology:

- Define GDP as sum of consumption and Net Export
- For each country: regress ΔGDP on lagged Δc, pd, cy
- Use projection as measure of long-run risks
- Apply to US and UK

Long-Run Risks

→ Using all NX



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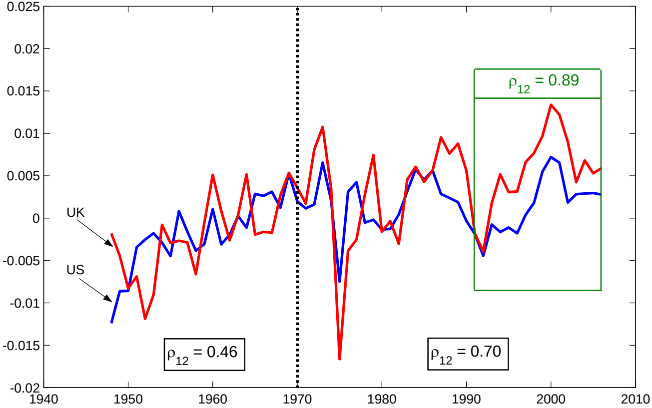

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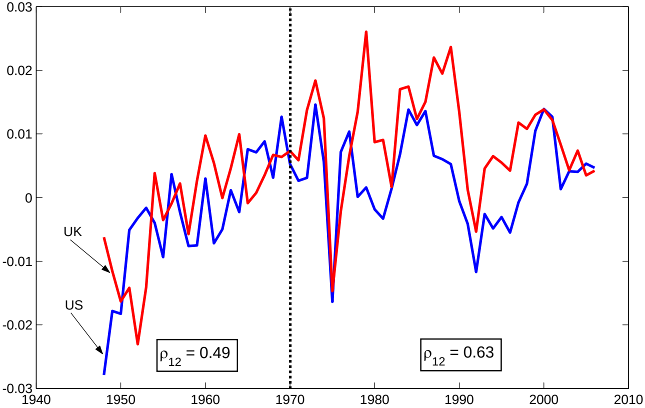

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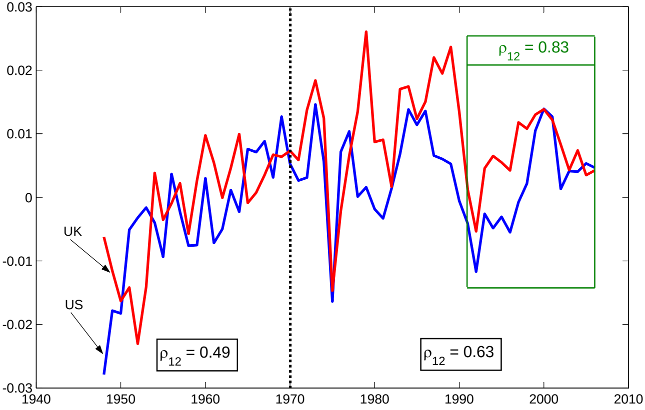

Results: quantities

	Model	Data	
		US	UK
$\sigma(\Delta y)$	1.92	1.17	2.57
$ACF_1(\Delta y)$	0.43	-0.01	0.05
$\sigma(\Delta c)$	1.78	1.14	2.27
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$\sigma(NX/Y)$	0.81	2.38	3.39
$ACF_1(NX/Y)$	0.85	0.81	0.69

Results: prices

	Model	Data US	Data UK
$\sigma(m)$	36%	$\geq$30%	

Results: prices

	Model	Data	
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β_{UIP}	-3.5	-0.98	

The benefits of Financial Integration

- A model with portfolio autarky
  $\rightarrow$ Welfare loss of a ban to trade of assets

The benefits of Financial Integration

- A model with portfolio autarky
  $\rightarrow$ Welfare loss of a ban to trade of assets
- Calibrate the model with autarky to 50's and 60's

Portfolio autarky

- Home country is endowed with X_t
- Foreign country is endowed with Y_t
- Two country specific budget constraints

$$\begin{aligned} x_t^h + p_t y_t^h &= X_t && [Home] \\ x_t^f + p_t y_t^f &= p_t Y_t && [Foreign] \end{aligned}$$

- Trade is balanced in every period

Equilibrium with portfolio autarky

- Consumption

$$\begin{aligned}\Delta c_t^{h,aut} &= \alpha \Delta x_t + (1-\alpha)\Delta y_t \\ \Delta c_t^{f,aut} &= (1-\alpha)\Delta x_t + \alpha \Delta y_t\end{aligned}$$

- Exchange rates

$$e_t = y_t - x_t$$

- Net Exports

$$\frac{NX_t^h}{X_t} = 0$$

What are the benefits of financial integration?

- Constant fraction of consumption that makes agents indifferent between
  - living in autarky
  - living in complete markets

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- What were the gains in the 50s-60s?

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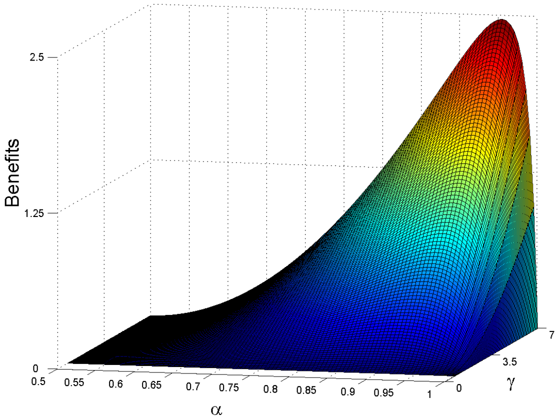
  - living in autarky
  - living in complete markets
- Benefits when:
  1. Long-run risks are shut down: 2.26%
  2. Long-run risks are turned on: 4.39%
- What were the gains in the 50s-60s?
  $\rightarrow corr(\varepsilon_t^1, \varepsilon_t^2) = 0.5$

Back in the day...

Without long-run risks



Back in the day...

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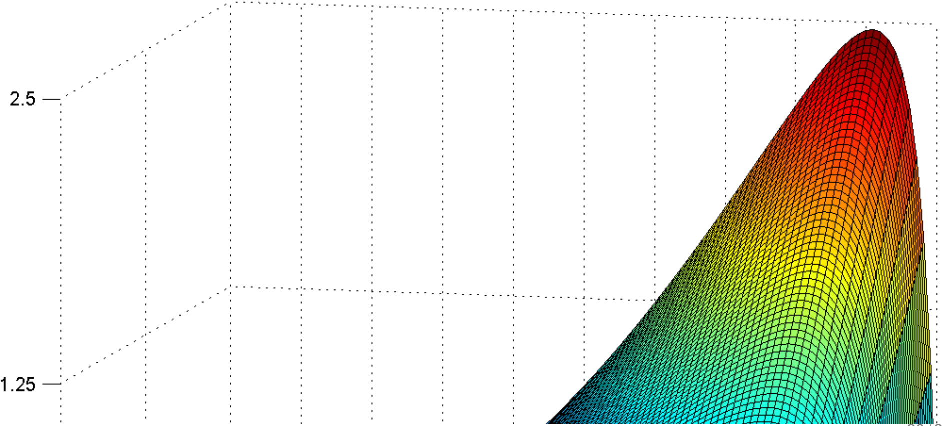

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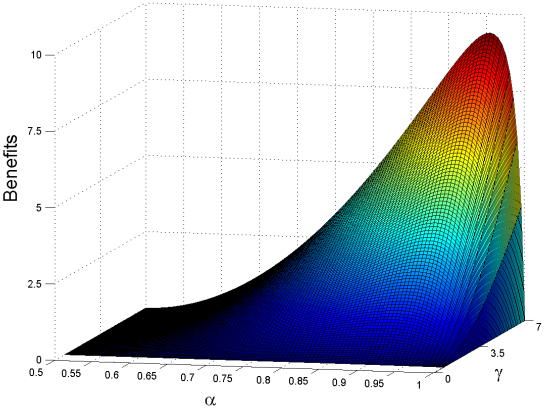

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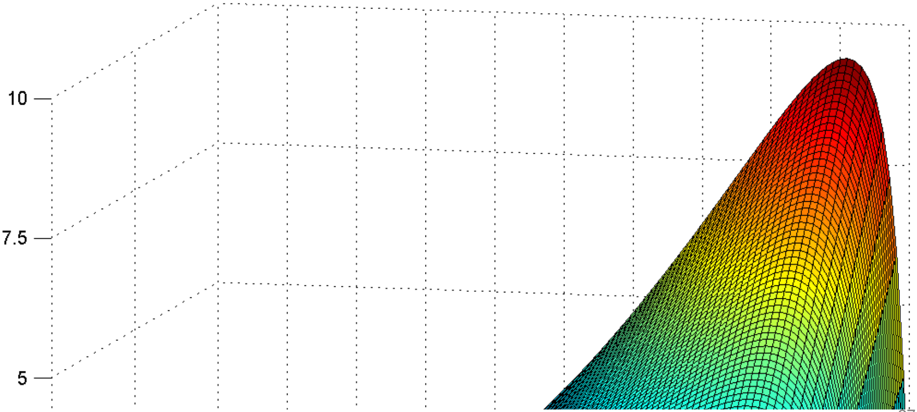

Portfolio autarky and the 50s-60s

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$\sigma(\Delta c)$	1.88	1.12	1.69
$ACF_1(\Delta c)$	0.43	0.36	0.20
$corr\left(\Delta y^h, \Delta y^f\right)$	-0.11	-0.38	
$corr\left(\Delta c^h, \Delta c^f\right)$	-0.07	0.02	
$\sigma(NX/Y)$	0	0.88	1.97
$ACF_1(NX/Y)$	-	0.42	0.13
$\sigma(m)$	38%	≥30%	
$\sigma(\Delta e)$	3.28	4.39	
$E\left(r^f\right)$	2.71	0.66	0.88
$\sigma\left(r^f\right)$	1.21	0.89	0.87
$corr\left(r_h^f, r_f^f\right)$	0.50	0.51	

Predictability?

s_t should forecast the cross-section of int'l excess returns

$$r^j_{c,t} = \beta_0 + \beta_1 s_{t-1} + \varepsilon_t, \quad \forall j = \{h, f\}$$

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Testable implications:

- forecastability through Net Exports
- forecastability through relative wealth-consumption ratios

Empirical questions:

- which returns?
- which Net Exports?
- how do we measure the wealth-consumption ratio?

Concluding Remarks

1. A general equilibrium model
2. Can account for
    - exchange rates dynamics
    - behavior of int'l returns
    - joint distribution of prices and quantities
3. Large welfare benefits
4. Forecastability of cross-section of int'l returns?

Stochastic Discount Factors

- With Risk-sensitive preferences

$$
\begin{aligned}
m^h_{t+1} - E_t[m^h_{t+1}] &= g^h(s_t \underbrace{\varepsilon^1_{t+1}}_{<<0}, s_t\varepsilon^2_{t+1}, s_t\varepsilon^x_{t+1}, s_t\varepsilon^y_{t+1}) \\
m^f_{t+1} - E_t[m^f_{t+1}] &= g^f(s_t\varepsilon^1_{t+1}, s_t \underbrace{\varepsilon^2_{t+1}}_{<<0}, s_t\varepsilon^x_{t+1}, s_t\varepsilon^y_{t+1})
\end{aligned}
$$

- With Time-additive preferences

$$
m^i_{t+1} = \log\delta - \Delta c^i_{t+1}, \qquad \forall i \in \{h, f\}
$$