Heterogeneity, financial markets, and macroeconomic fluctuations

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The core idea and research questions

- Households, institutions, countries differ in financial portfolios.
- Shocks affect asset prices and thus redistribute wealth.
- If those who gain wish to hold a different porfolio on the margin than those who lose, this will induce financial flows.
- This further changes asset prices and (maybe) real activity.

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- To what extent does this account for
  - *comovement* between asset prices, risk premia, real economy?
  - *amplification* of asset prices and risk premia vs. real economy?

Overview of papers covered today

- Will focus on transmission of *monetary shocks* today.
- Three papers (with Moritz Lenel):
  1. *Monetary policy, redistribution, and risk premia* (ECMA).
     Effects on equity premium and feedback to real economy.
  2. *The flight to safety and international risk sharing* (WP).
     Asymmetric effects in “Global Financial Cycle”.
  3. *Monetary policy, segmentation, and the term structure* (WP).
     Effects on term premium.
- Core ideas extend beyond monetary shocks.
  Will discuss this and other open questions at end.

Related literatures (not exhaustive)

- Asset pricing:
  - Heterogeneous agents and risk-sharing: Constantinides-Duffie (96), Garleanu-Panageas (15), Gourinchas-Rey-Govillot (17), Maggiori (17).
  - Asset demands and flows: Duffie (10), Chien-Cole-Lustig (12), He-Krishnamurthy (13), Vayanos-Vila (21), Gabaix-Koijen (22).
  - **Here**: production economies, wealth revaluation induces flows.
- Macroeconomics:
  - Financial accelerator: Bernanke-Gertler-Gilchrist (99).
  - "HANK" models: Kaplan-Moll-Violante (18), Auclert (19).
  - **Here**: risk premia (not agency/liquidity), *mpr*s not *mpc*s.
- Interactions: Alvarez-Atkeson-Kehoe (02,09), Brunnermeier-Sannikov (14), Gabaix-Maggiori (15), Caballero-Simsek (20), Itskhoki-Mukhin (21).

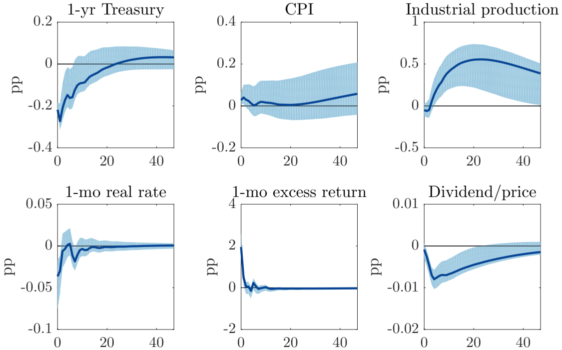
Plan

Evidence on monetary policy and asset prices

- Large and growing body of evidence that expansionary MP shocks raise the price of risky financial assets and lower future excess returns — i.e., expansionary MP lowers risk premia.
  - Equity premium: Bernanke-Kuttner (05), ...
  - External finance premium: Gertler-Karadi (15), ...
  - Term premium: Hanson-Stein (15), ...
  - Disproportionate effects of U.S. monetary shocks: Rey (13), ...
- Review selected empirical evidence from my work here.

Monetary policy and equity premium (1/2)

- Bernanke-Kuttner (05) meets Gertler-Karadi (15).
- Monthly VAR, 7/79-6/12.
- IV: Fed Funds futures surprises on FOMC days, 1/91-6/12.



Monetary policy and equity premium (2/2)

- Following Campbell-Shiller (88):

$$
\begin{aligned}
&(\text{real stock return})_t - \mathbb{E}_{t-1}[(\text{real stock return})_t] \\
&= (\mathbb{E}_t - \mathbb{E}_{t-1}) \sum_{j=0}^{\infty} \kappa^j \Delta(\text{dividends})_{t+j} \\
&\quad - (\mathbb{E}_t - \mathbb{E}_{t-1}) \sum_{j=1}^{\infty} \kappa^j (\text{real rate})_{t+j} - (\mathbb{E}_t - \mathbb{E}_{t-1}) \sum_{j=1}^{\infty} \kappa^j (\text{excess return})_{t+j}.
\end{aligned}
$$

	pp	share	90% CI
Real stock return	1.92		
Δ Dividends	0.64	33%	[-13%,71%]
− Future real rates	0.15	8%	[-6%,21%]
− Future excess returns	1.13	59%	[19%,108%]

Asymmetries in the Global Financial Cycle

- Replace S&P 500 with MSCI ACWI index.
- Estimate global equity index responses to U.S. monetary shock and Euro area monetary shock (from Altavilla et al (19)).

	U.S. monetary shock	Euro monetary shock
Share excess returns	58%	-22%
	[19%,100%]	[-105%,54%]

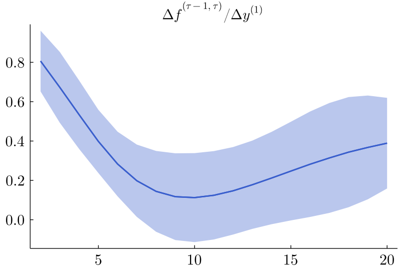
- U.S. easing lowers risk premia by more than easing abroad, a key element of "Global Financial Cycle" (Rey (13,16), ...).

Monetary policy and term premium

- Campbell-Shiller decompositions sensitive to VAR and κ.
- Following Hanson-Stein (15), real term structure is nice since

$$df_t^{(\tau-1,\tau)} = d\mathbb{E}_t r_{t+\tau-1} + d[\text{risk premium}]_t^{\tau}$$

and MP shocks (likely) have no effect on long-run real rates.



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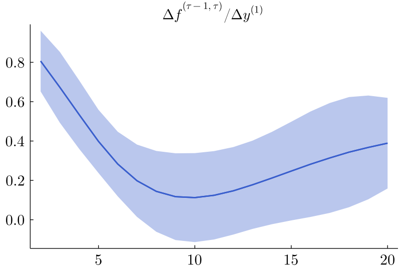

- Taking stock: (U.S.) MP easing lowers risk premia. Why?

Plan

Monetary policy, redistribution, and risk premia

- Environment:
  - standard New Keynesian model with capital and nom. bonds +
  - heterogeneous agents differing in risk tolerance.
- Findings:
  - Expansionary MP redistributes to relatively risk tolerant, who are levered, by devaluing debt, raising profits, and raising q.
  - Since these agents have a high

    $$\frac{\text{marginal propensity to save in capital}}{\text{marginal propensity to save}} \equiv mpr,$$

    this lowers risk premium on capital.
  - Conditional on safe rate, this stimulates x, c, and y.
  - Calibration to SCF rationalizes Campbell-Shiller decomposition after MP shock and amplifies stimulus by $1.3 - 1.4$ times.

Two-period model (1/2)

- Two-period model before quantifying in richer ∞-horizon.

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- Continuum of households with

$$\log v_0^i = (1-\beta)\log c_0^i - \bar{\theta}\frac{\ell_0^{1+1/\theta}}{1+1/\theta} + \beta \log\left(\mathbb{E}_0\left[\left(c_1^i\right)^{1-\gamma^i}\right]\right)^{\frac{1}{1-\gamma^i}}.$$

- Resource constraints:

$$P_0 c_0^i + B_0^i + Q_0 k_0^i \leq W_0 \ell_0 + (1+i_{-1})B_{-1}^i + (\Pi_0 + (1-\delta_0)Q_0)k_{-1}^i,$$
$$P_1 c_1^i \leq (1+i_0)B_0^i + \Pi_1 k_0^i.$$

- Workers supply identical ℓ_0 at rigid wages $W_0 = W_{-1}$.

Two-period model (2/2)

- Representative firm:

$$\Pi_0 k_{-1} = P_0 \ell_0^{1-\alpha} k_{-1}^{\alpha} - W_0 \ell_0 + Q_0 x_0 - P_0 \left(\frac{k_0}{k_{-1}} \right)^{\chi^x} x_0,$$

$$\Pi_1 k_0 = P_1 \exp\left(\epsilon_1^z\right) k_0^{\alpha}.$$

- Aggregate risk: $\epsilon_1^z \sim N\left(-\frac{1}{2}\sigma^2, \sigma^2\right)$.
- Monetary policy: $1 + i_0 = (1 + \bar{i}) \left(\frac{P_0}{P_{-1}}\right)^{\phi} \exp\left(\epsilon_0^m\right)$, $P_1 = P_0$.
- Market clearing: goods, labor, capital, bonds.

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- Market clearing: goods, labor, capital, bonds.

- How does ϵ_0^m affect risk premium on capital?
- What are implications for real transmission?

Micro-level optimization

- Optimal consumption and savings are

$$c_0^i = (1-\beta)\left[w_0\ell_0 + (1+i_{-1})\frac{B_{-1}^i}{P_0} + (\pi_0 + (1-\delta_0)q_0)k_{-1}^i\right],$$

$$a_0^i \equiv b_0^i + q_0k_0^i = \beta\left[w_0\ell_0 + (1+i_{-1})\frac{B_{-1}^i}{P_0} + (\pi_0 + (1-\delta_0)q_0)k_{-1}^i\right]$$

- Optimal portfolio share in capital $\omega_0^i \equiv q_0k_0^i/a_0^i$ implicitly defined by

$$\mathbb{E}_0\left(c_1^i\right)^{-\gamma^i}(\exp r_1^k - \exp r_1) = 0,$$

given

$$r_1^k \equiv \log \pi_1/q_0,$$
$$r_1 \equiv \log(1+i_0)(P_0/P_1) = \log(1+i_0).$$

Monetary policy and the risk premium (1/2)

- Second-order approximation of optimal portfolio choice condition around $r_1^k = r_1 \Rightarrow$

$$\mathbb{E}_0 r_1^k - r_1 + \frac{1}{2}\sigma^2 \approx \gamma^i \omega_0^i \sigma^2,$$

or equivalently

$$\omega_0^i \approx \frac{1}{\gamma^i} \frac{\mathbb{E}_0 r_1^k - r_1 + \frac{1}{2}\sigma^2}{\sigma^2}.$$

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- Asset market clearing requires

$$\int_0^1 a_0^i \omega_0^i di = q_0 k_0,$$

$$\int_0^1 a_0^i (1 - \omega_0^i) di = 0.$$

Monetary policy and the risk premium (2/2)

Proposition

The risk premium on capital is

$$\mathbb{E}_0 r_1^k - r_1 + \frac{1}{2}\sigma^2 \approx \gamma\sigma^2,$$

where $\gamma = \left(\int \frac{a_0^i}{\int a_0^{i'} di'} \frac{1}{\gamma^i} di\right)^{-1}$.

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$$\frac{d\left[\mathbb{E}_0 r_1^k - r_1\right]}{d\epsilon_0^m} = \gamma\sigma^2 \int \frac{d\left[a_0^i / \int a_0^{i'} di'\right]}{d\epsilon_0^m}(1 - \omega_0^i) di.$$

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- Policy affects the risk premium (only) by redistributing wealth.
- Redistribution to agents with high ω_0^i lowers risk premium.

Risk premium and the real economy (1/2)

- By definition of equilibrium profits,

$$\mathbb{E}_0 r_1^k = \mathbb{E}_0 \log \pi_1 - \log q_0 = (\alpha - 1) \log k_0 - \log q_0.$$

- By optimal investment,

$$\log q_0 = \chi^x (\log k_0 - \log k_{-1}).$$

- Combining,

$$d \left[\mathbb{E}_0 r_1^k - r_1 \right] = -(1 - \alpha + \chi^x)\, d \log k_0 - dr_1.$$

- Thus, fall in risk premium $\Leftrightarrow$ rise in capital accumulation, conditional on r_1.

Risk premium and the real economy (2/2)

- Rise in investment and q_0 stimulate agg consumption c_0:

$$c_0 = (1-\beta)\left[y_0 + (1-\delta_0)q_0 k_{-1}\right].$$

- ...and both the stimulus to investment and consumption stimulate output:

$$c_0 + (k_0 - (1-\delta_0)k_{-1}) = y_0.$$

- Appl'n of logic in Caballero-Farhi (18), Caballero-Simsek (20).

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  $n_0 \equiv \int n_0^i di$.
- On impact of a monetary shock:

$$d\left[n_0^i/n_0\right] = \frac{1}{n_0}\Bigg[-\frac{1+i_{-1}}{P_0}B_{-1}^i d\log P_0 + \left(k_{-1}^i - \frac{n_0^i}{n_0}k_{-1}\right)(d\pi_0 + (1-\delta_0)dq_0)\Bigg].$$

- à la Auclert [19], but what matters is covariance with ω_0^i.

Putting it all together

Proposition

Suppose agents differ in γ^i, their endowments are consistent with period 0 choices ($\omega^i_{-1} = \omega^i_0$), and they have same initial n^i_0. Then:

- *cut in nominal rate lowers risk premium, and*
- *stimulus to $\{k_0, c_0, y_0\}$ are larger than RANK starting from same aggregate allocation.*

- Risk tolerant agents borrow in nominal bonds to hold capital.
- Lower nominal rate redistribute to them via P_0, π_0, and q_0.
- As they rebalance to capital, risk premium falls + output rises.

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- In each case, relatively levered agents will invest more in capital given a marginal dollar in income.

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- But more generally, $mpr_0^i \neq \omega_0^i$. In limit as $\sigma \to 0$,

$$\overline{mpr}_0^i = \frac{\bar{\gamma}}{\gamma^i},$$

$$\bar{\omega}_0^i = \left(\frac{\bar{c}_1^i}{(1+\bar{r}_1)\bar{a}_0^i}\right)\frac{\bar{\gamma}}{\gamma^i} - \frac{\bar{w}_1}{(1+\bar{r}_1)\bar{a}_0^i}.$$

Monetary policy and the risk premium, redux

Proposition

Up to third order in $\{\sigma, \epsilon_1^z, \epsilon_0^m\}$,

$$\mathbb{E}_0 r_1^k - r_1 + \frac{1}{2}\sigma^2 = \bar{\gamma}\sigma^2 + \bar{\gamma}\int \overline{\frac{d\left[c_1^i / \int c_1^{i'} di'\right]}{d\epsilon_0^m}}(1 - \overline{mpr}_0^i)\epsilon_0^m \sigma^2 + o(||\cdot||^4).$$

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- Monetary easing lowers risk premium if it redistributes to agents with high *mpr*s.
- Decouples and clarifies roles of portfolios and *mpr*s:
  - Portfolios govern change in wealth due to MP shock.
  - *mpr*s describe how agents respond to change in wealth.

Extending the model to the infinite horizon

1. Labor supply with Rotemberg (82) wage adj. costs.
2. Three types $i \in \{a, b, c\}$, within which identical preferences.
   - Technical trick: trade ℓ endowment within types to aggregate.
3. Lower bound on capital $\underline{k}$.
4. Prod. shocks feature rare disaster with time-varying prob.
5. Global solution, given state variables

$$\Big\{ \underbrace{m_t, p_t}_{\text{exog.}}, \underbrace{k_{t-1}/(z_{t-1}\exp(\epsilon_t^z)), w_{t-1}/(z_{t-1}\exp(\epsilon_t^z)), s_t^a, s_t^c}_{\text{endog.}} \Big\}.$$

Brief interlude on computation

- Codes available at `https://github.com/KekreLenel`.
- General structure:
  1. Use FOCs and market clearing to solve for policies given guessed state transitions and policies tomorrow.
  2. Solve for state transitions implied by new policies.
  3. Update guesses and return to step 1.
- Key features for speed and accuracy:
  - Sparse Smolyak grids, Chebyshev interpolation, parallelization.
  - Decouple portfolio choice from consumption/savings:
    - Each iteration, solve for optimal portfolio choice and r which equilibrates bond market, given guessed total savings.
    - Over iterations, slowly update total savings and q consistent with consumption/savings decision and capital accumulation.

Micro moments from the SCF

- Decompose A^i into $\{Qk^i, B^i\}$ s.t. $B^i + Qk^i = A^i$.
- If household i holds \$1 equity in a firm with $\frac{\text{capital}}{\text{equity}} = lev^{firm}$, assign $\{Qk^i = lev^{firm}, B^i = 1 - lev^{firm}\}$.

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<table>
<tr><td></td><td></td><td colspan="2">$\frac{A^i}{W^i \ell^i}$</td></tr>
<tr><td></td><td></td><td>$>= p60$</td><td>$< p60$</td></tr>
<tr><td rowspan="2">$\frac{Qk^i}{A^i}$</td><td>$>= p90$</td><td>Group a
Share labor income: 3%
Share wealth: 18%
Aggregate Qk/A: 2.0</td><td rowspan="2">Group c
Share labor income: 83%
Share wealth: 23%
Aggregate Qk/A: 1.1</td></tr>
<tr><td>$< p90$</td><td>Group b
Share labor income: 14%
Share wealth: 58%
Aggregate Qk/A: 0.5</td></tr>
</table>

Projecting observables on group indicators

	$1\{hbus^i = 1\}$	$1\{age^i > 54, lf^i = 0\}$
$1\{i \in a\}$	0.37	0.37
	(0.03)	(0.03)
$1\{i \in b\}$	0.05	0.55
	(0.01)	(0.01)
Observations	6,229	6,229
Adj R^2	0.05	0.37

- Group *a* more likely to have private business wealth.
- Group *b* more likely to be retired.

Calibration: externally set parameters

	Description	Value	Notes
ψ	IES	0.8	
θ	Frisch elasticity	1	Chetty et al (11)
λ^a	measure of *a* households	4%	population in SCF
λ^b	measure of *b* households	36%	population in SCF
ϕ^a	labor *a* households	$3\%/\lambda^a$	labor income in SCF
ϕ^b	labor *b* households	$14\%/\lambda^b$	labor income in SCF
ξ	death probability	1%	
α	1 - labor share	0.33	
δ	depreciation rate	2.5%	
χ^W	Rotemberg wage adj. costs	150	$\approx \mathbb{P}(\text{adjust}) = 4 - 5$ qtrs
p	disaster probability	0.5%	Barro (06)
$\underline{\varphi}$	disaster shock	-15%	Nakamura et al (13)
ϕ	Taylor coeff. on inflation	1.5	Taylor (93)
σ^m	std. dev. MP shock	0.25%/4	
ρ^m	persistence MP shock	0	

Calibration: targets and parameters

	Description	Value	Moment	Target	Model
σ^z	std. dev. prod.	0.55%	$\sigma(\Delta \log c)$	0.5%	0.6%
χ^x	capital adj cost	3.5	$\sigma(\Delta \log x)$	2.1%	2.0%
β	discount factor	0.98	$4r_{+1}$	1.3%	1.5%
γ^b	RRA b	25.5	$4\left[r^e_{+1} - r_{+1}\right]$	7.3%	7.0%
σ^p	std. dev. log dis. prob.	0.47	$\sigma(4\mathbb{E}r_{+1})$	2.2%	2.2%
ρ^p	persist. log dis. prob.	0.8	$\rho(4\mathbb{E}r_{+1})$	0.79	0.75
γ^a	RRA a	10	k^a/a^a	2.0	2.3
$\underline{k}$	lower bound k^i	10	k^c/a^c	1.1	0.9
$\xi\bar{s}^a$	newborn endow. sh. a	0%	$\lambda^a a^a / \sum_i \lambda^i a^i$	18%	21%
$\xi\bar{s}^c$	newborn endow. sh. c	-.25%	$\lambda^c a^c / \sum_i \lambda^i a^i$	23%	23%
b^g	real value govt bonds	-2.7	$-\sum_i \lambda^i b^i / \sum_i \lambda^i a^i$	-10%	-10%

NIPA (Q3/79-Q2/12), VAR (7/79-6/12), SCF (2016). $D/E = 0.5$.

Labor disutilities set to achieve $\ell = 1$ and zero avg labor wedge for each agent.

Untargeted moments

Moment	Data	Model
$\sigma(\Delta \log y)$	0.8%	0.9%
$\sigma(\Delta \log \ell)$	0.8%	0.8%
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$\sum \lambda^i mpr^i$	≈0.2	0.3
mpr^a		1.9
mpr^b		0.7
mpr^c		0.0

- MPRs broadly consistent with available evidence.
  (Briggs-Cesarini-Lindqvist-Ostling (15), Fagereng-Holm-Natvik (21)).

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mpr^c		0.0
$\sum \lambda^i mpc^i$	≈0.2	0.02
mpr^a		0.02
mpr^b		0.02
mpr^c		0.02

- MPRs broadly consistent with available evidence.

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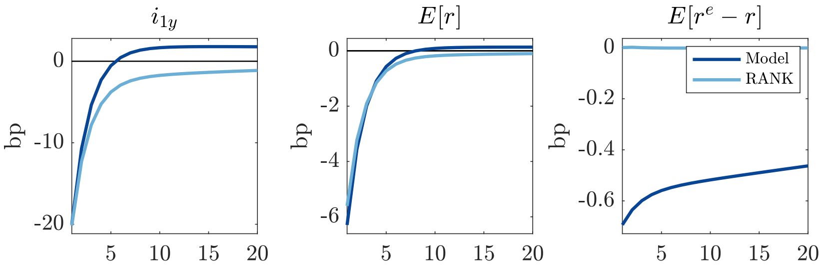
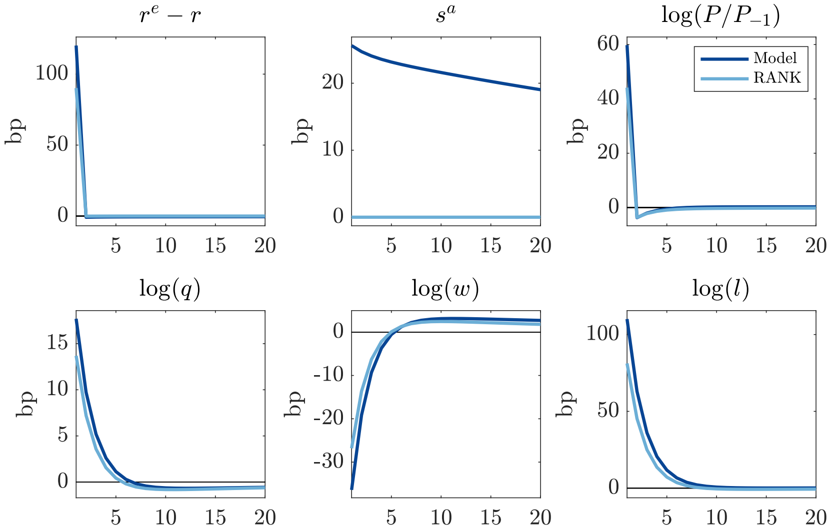
Expected returns after monetary policy shock



Redistribution to (high *mpr*) *a* households



Campbell-Shiller and implications for quantities

% Real stock return	Data [90% CI]	Model	RANK
Dividend growth news	33% [-13%,71%]	52%	65%
−Future real rate news	8% [-6%,21%]	16%	35%
−Future excess return news	59% [19%,108%]	32%	0%

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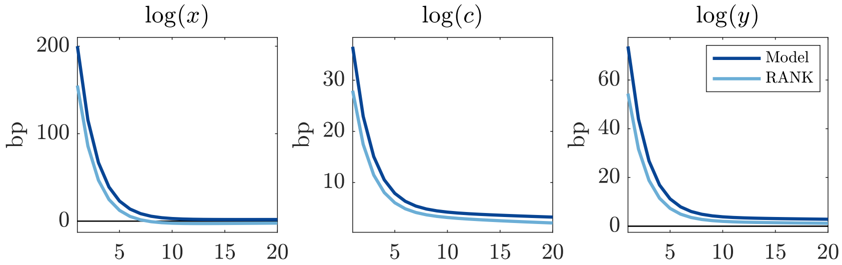

- Amplification of real stimulus by 1.3-1.4 × versus RANK.

Plan

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2. Evidence on monetary policy and asset prices
3. Monetary policy and the equity premium
4. Monetary asymmetries in the Global Financial Cycle
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The flight to safety and international risk sharing

- Two-country generalization of environment in previous paper.
- New mechanism: exchange rates also redistribute wealth.
- If USD appreciates in bad times, relatively risk tolerant will insure risk averse by borrowing in USD-denominated bonds.
- Implications:
  - U.S. MP easing depreciates USD $\Rightarrow$ redistribute *to* risk tol.
  - Foreign easing appreciates USD $\Rightarrow$ redistribute *from* risk tol.
- But why does USD appreciate in bad times (as in data)?
  - Flight to safe, dollar-denominated assets (Treasuries).
  - What most of paper is about.

Effects of monetary shocks in data and model

	Data	Model	Model, 2.5% adj.
U.S. monetary shock			
Share ex. return news	58%	4%	62%
	[19%,100%]		
Foreign monetary shock			
Share ex. return news	-22%	1%	-13%
	[-105%,54%]		

- Small fraction active traders amplifies effect because this implies little risk-bearing capital available to absorb flows. (Duffie (10), Chien-Cole-Lustig (12), Gabaix-Koijen (22), ...)

$\Rightarrow$ Both “income elasticities” *and* “price elasticities” matter.

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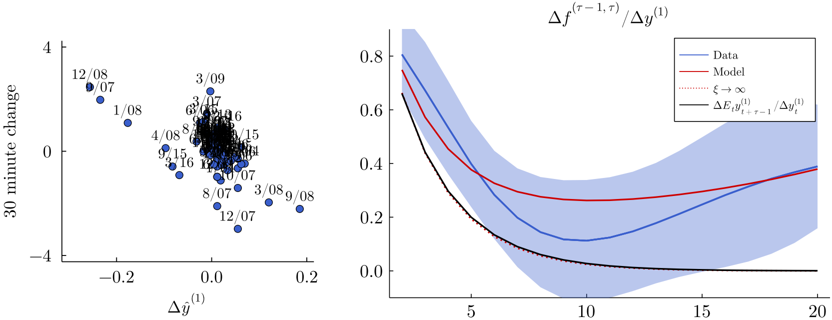
Monetary policy, segmentation, and the term structure

- Study effects of monetary policy on real term premia in *preferred habitat* environment à la Vayanos-Vila (21).
- Preferred habitat model has two useful features:
  - Trade in bonds between habitat investors and arbitrageurs.
  - Both heterogeneous *mpr*s *and* low "price elasticities".
- Key ideas:
  - Vayanos-Vila (21) counterfactually implies a monetary easing raises term premia, as habitat investors borrow more long term.
  - CARA prefs ⇒ wealth of arbs irrelevant for term premia.
  - Relaxing this, wealth revaluation of arbs accounts for decline in term premia provided arbs have positive duration.

Effects of monetary shock in data and model



- Arb duration disciplined by high-freq. resp. of dealer equities.
- Model-implied response of forward rates consistent with data.

Plan

Taking stock

- Households, institutions, countries differ in financial portfolios.
- Shocks affect asset prices and thus redistribute wealth.
- If those who gain wish to hold a different porfolio on the margin than those who lose, this will induce financial flows.
- This further changes asset prices and (maybe) real activity.

- Today: three papers with appl'n to monetary shocks.

Open questions

- Measurement:
  - How do agents allocate wealth *on margin*? (*mprs*, not *mpc*s)
  - How much can this account for flow response to macro shocks?
- Positive questions:
  - Beyond monetary shocks, how much can this account for business cycle comovement? Amplification?
- Normative questions:
  - Redistribution affects asset prices and real activity. How should this inform optimal stabilization policy?

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- Normative questions:
  - Redistribution affects asset prices and real activity. How should this inform optimal stabilization policy?
- Encourage you to explore these ideas, and excited to discuss!