Optimism, Net Worth Trap, and Asset Returns

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- Budding literature on the interactions between financial frictions and investors' beliefs (Krishnamurthy and Li, 2020; Maxted, 2023; Camous and Van der Ghote, 2023)
- Mostly the focus has been on diagnostic expectations or incomplete information on tail risk to explain pre-crisis frothy periods
- Empirical evidence from Bordalo et al (2023): "Overreaction of long term profit expectations emerges as a promising mechanism for reconciling Shiller's excess volatility puzzle with the business cycle"

What we do:

- Analyze the role of intermediary's (or expert's) **optimism** in the long-term growth prospects on (i) the amplification of boom-bust cycles; (ii) build-up to a financial crisis; (iii) creation of net worth trap, i.e., perennial crisis
- Build a tractable heterogeneous agent model with financial frictions where optimists hold dogmatic beliefs over long-run output growth
- Tie the model predictions to the empirical predictions by building an optimism measure from the Survey of Professional Forecasters (SPF)
- Study the cross-sectional asset pricing implications of the optimism factor

Literature review

Theory

Bird's-eye view of the model ▶▶ Model details

Continuous-time macro-finance model with financial friction: e.g., Brunnermeier and Sannikov (2014). The literature usually adapts:

- **Two types of agents**: experts and households. Experts are more efficient in capital utilization and formation (i.e., investment)
- **Single capital**, whose price process is risky and to be determined in equilibrium
- **Financial friction**: no risk sharing between the different types allowed. Only risk-free debt is issued between them

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Then the equilibrium usually features:

- In a normal (i.e., stochastic steady state), all capital is owned by experts
- When the economy transitions into a crisis due to some streak of negative shocks, experts' net worth share$\downarrow$, capital price$\downarrow$, market volatility$\uparrow$
- Risk premium$\uparrow$ helps experts recapitalize again, moving the economy out of the crisis (i.e., endogenous boom-bust cycles)

Bird's-eye view of the model ⏩ Model details

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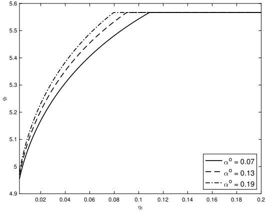
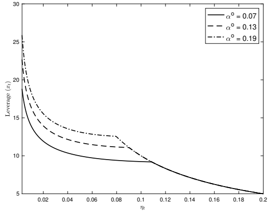
Now, we assume:

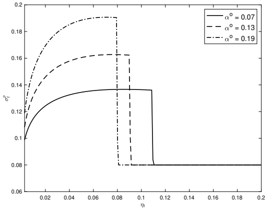
- The total factor productivity (TFP) of capital in generating output is growing with some constant rate. Optimistic experts believe it is higher



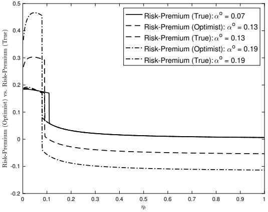
(a) Capital price q_t



(b) Leverage multiple x_t



(c) Endogenous volatility σ_t^p



(d) *Perceived-true* risk-premium

1. Dogmatic optimism $\longrightarrow$ risk amplification during a crisis Amplification channels
2. At the stochastic steady state: **frothy periods** due to higher perceived risk premium of optimists $\longrightarrow$ leverage$\uparrow$, true risk premium$\downarrow$ Additional figures

Ergodic distribution of the state variable η_t

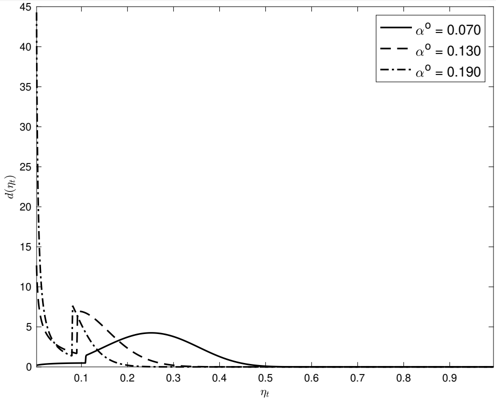


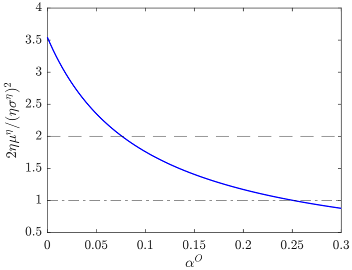
Figure: Stationary distribution of η_t and the net worth trap

- In the stochastic steady state, optimism of experts↑ $\longrightarrow$ leverage↑ and true risk premium↓: increasing the probability that a crisis occurs
- Once crisis hits, higher optimism of experts $\longrightarrow$ higher risk premium helping them to recapitalize faster
- Higher occupancy time in crisis on average

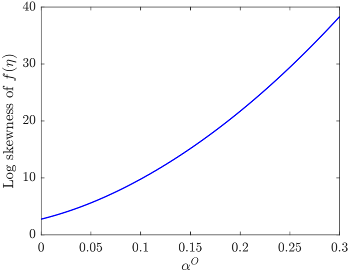
Wealth share dynamics

Around $\eta \sim 0$:

$$d(\eta) \sim \left(\frac{2\mu^{\eta}(0)}{(\sigma^{\eta})^2(0)} - 1 \right) \eta^{\frac{2\mu^{\eta}(0)}{(\sigma^{\eta})^2(0)} - 2} \tag{1}$$



(a) Tail analysis of stationary distribution

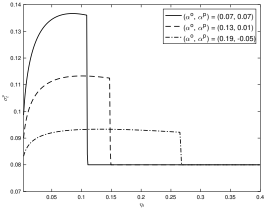


(b) Skewness of the distribution around $\eta \sim 0$

Proposition (Net Worth Trap)

$\exists \bar{\alpha}^O$ such that if $\alpha^O \geq \bar{\alpha}^O$, the economy is trapped at $\eta = 0$, and the probability of recapitalization for optimists goes to zero.

- The expectation error $\longrightarrow$ perennial crisis $\longrightarrow$ household welfare$\downarrow$ Welfare



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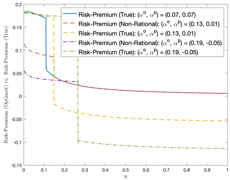
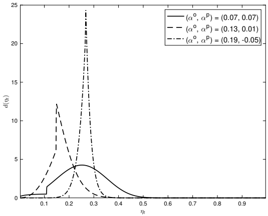
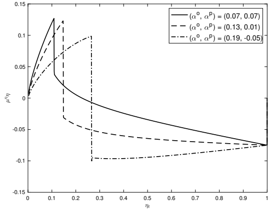


(b) *Perceived* and *true* risk-premium



(c) Stationary distribution of η_t



(d) Drift of η_t process $\mu^\eta(\eta_t) \cdot \eta_t$

- Stabilizing role of diagnostic expectations: e.g., Maxted (2023)

Empirical Analysis

- Empirical optimism is computed as

$$O_t = \frac{f_{75}}{|f_{50}|}$$

where f_k: $k\%$ percentile analyst forecast of quarter-on-quarter GDP growth rate for the $T+2^{\text{th}}$ quarter ahead at date T, from the Survey of Professional Forecasters (SPF)

- Define a factor $o_t = \Delta \log(O_t)$'s innovation

Run two-stage Fama-MacBeth with $f_t \equiv [\underbrace{M_t}_{\text{Market excess return}}, \underbrace{\eta_t}_{\text{HKM equity share}}, \underbrace{o_t}_{\text{Optimism}}]'$ with first stage:

$$R^e_{i,t} = a_i + \beta'_{i,t} f_t + v_{i,t}$$

and the second stage

$$\mathbb{E}[R^e_{i,t}] = \alpha_i + \hat{\beta}_{i,f} \lambda_f + \epsilon_i$$

Test assets

	Equities and Bonds		HKM + Momentum	
	Two-factor	Three-factor	Two-factor	Three-factor
Mean excess return	1.88	1.88	1.38	1.38
Std. excess return	0.84	0.84	1.32	1.32
Mean β_M	0.9	0.9	0.55	0.55
Std β_M	0.37	0.37	0.46	0.46
Mean β_η	0.08	0.08	0.07	0.0
Std β_η	0.11	0.11	0.13	0.13
Mean β_O	-	0.004	-	-0.01
Std β_O	-	0.03	-	0.04
Assets	95	95	129	129
Quarters	211	211	211	171
Controls	Yes	Yes	Yes	Yes

Table: Equity assets include 25 size and book-to-market portfolios, 25 size and momentum portfolios, 10 long-term reversal portfolios, and 25 profitability and investment portfolios. Bond portfolios include 10 maturity sorted portfolios from CRSP Fama bond portfolio dataset. HKM assets include 25 size and book-to-market portfolios, 10 U.S. Government bond portfolios, 10 U.S. corporate bond portfolios, 18 option portfolios, 20 CDS portfolios, and 12 foreign exchange portfolios taken from He et al. (2017). HKM+Momentum includes 25 size and momentum portfolios and 10 long-term reversal portfolios in addition to the listed HKM assets. The frequency is quarterly and time period is from 1970Q1 till 2022Q4.

	Equities and Bonds		HKM+Momentum	
	Two-factor	Three-factor	Two-factor	Three-factor
Market	0.01	0.01	0.02	0.02
t-stat Shanken	(1.17)	(1.20)	(1.59)	(1.50)
Intermediary	0.02	0.02	0.06	0.07
t-stat Shanken	(1.08)	(0.75)	(2.86)	(2.68)
Macro-optimism	-	0.1	-	0.08
t-stat Shanken	-	(2.88)	-	(2.06)
MAPE %	2.22	2.08	2.83	2.28
Adj. R2	0.22	0.32	0.45	0.61
Assets	95	95	129	129
Quarters	211	211	171	171

Table: Risk price estimates: the factors are market, intermediary capital ratio (HKM), and macro-optimism. The macro-optimism factor o_t is computed as innovation in the growth rate in O_t, the 75th percentile of GDP forecast scaled by median forecast by analysts. The forecast data is taken from The Survey of Professional Forecasters. The standard errors of risk price estimates are adjusted for generated regressor problem using Shanken correction. MAPE denotes the mean absolute pricing error in annualized terms.

		Macro-optimism			
		(1)	(2)	(3)	(3)-(1)
Intermediary	(1)	2.60	3.28	5.29	2.68
	(2)	6.53	3.95	7.51	0.97
	(3)	8.95	9.79	9.63	0.67
	(3)-(1)	6.35	6.51	4.34	-

Table: Average excess returns. The table reports the annualized mean excess return on equity and bond portfolios double-sorted on their exposures to the intermediary factor and the macro-optimism factor using the three-factor model. The data is at quarterly frequency from 1970Q1 till 2022Q4. The intermediary factor is from HKM2017, and the macro-optimism factor is computed from the growth rate of 75th percentile GDP projection, scaled by the median projection.

Cross-sectional fit | Cross-sectional fit: additional assets | Robustness

Empirical: run the following regression with monthly S&P500 excess return:

$$r^e_{t+h} = \alpha(h) + \beta_1(h) \times r^e_t + \underbrace{\beta_2(h)}_{\text{Excess conditional momentum}} \times r^e_t \times 1_{\text{Recession}} + \epsilon_{t+h}$$

Model-implied: simulate the model for 1,000 times for 5,000 years and run the following regression:

$$R^e_{t+h} = \alpha(h) + \beta_{1,\text{model}}(h) \times R^e_t + \underbrace{\beta_{2,\text{model}}(h)}_{\text{Excess conditional momentum}} \times R^e_t \times 1_{\text{Recession}} + \epsilon_{t+h}$$

with

$$R^e_t = \int_{t-\Delta}^{t} \left(\frac{d(q_u K_u) + (A(\psi_u) - \iota_u) K_u du}{q_u K_u} - r_{f,u} du \right) \tag{2}$$

Time series: conditional predictability

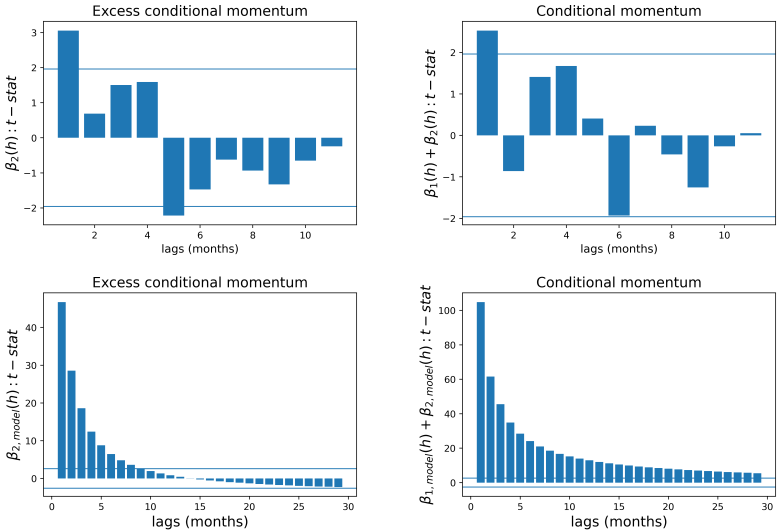


Figure: The data is at monthly frequency from 1945 till 2022.

Role of optimism

- **Model-implied optimism**: the component of leverage attributable to optimism

$$x_t^{\text{net}} = x_t - x_t^{\text{REE}}$$

where x_t^{REE}: leverage under the rational expectations

- **Optimism dummy**:

$$1_o = 1 \text{ if } O_t \geq O_{\text{median}} \text{ (empirics) or } x_t^{\text{net}} \geq x_{\text{median}}^{\text{net}} \text{ (theory)}$$

Run the following predictability regression:

$$r_{t+h}^e = \alpha(h) + \beta_1(h) \times r_t^e + \beta_2(h) \times r_t^e \times 1_{Recession} + \underbrace{\beta_3(h)}_{\text{Due to optimism}} \times r_t^e \times 1_{Recession} \times 1_o + \epsilon_{t+h}$$

Role of optimism

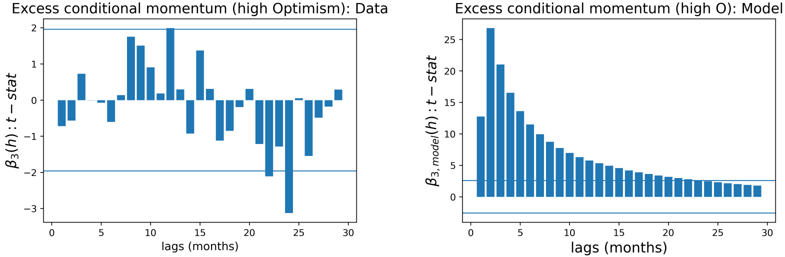


Figure: The left panel presents empirical autocorrelation coefficients from regressing the excess return on S&P500 on its lagged excess return. The data is at monthly frequency from 1945 till 2022. The macro-optimism factor is available at a quarterly frequency and hence interpolated to get monthly values. The left panel presents the conditional t-stats when the optimism is high ($\beta_3(h)$). The right panels presents the model-implied conditional t-stats when the optimism is high ($\beta_{3,model}(h)$).

Thank you very much!
(Appendix)

Basic framework based on Brunnermeier and Sannikov (2014)

- Macro-finance with financial frictions: He and Krishnamurthy (2013), Gertler et al. (2020)
- Heterogeneous beliefs, and deviations from the rational expectations: Harrison and Kreps (1978), Detemple and Murthy (1997), Basak and Croitoru (2000), Basak (2000), Gallmeyer and Hollifield (2008), Simsek (2013), Caballero and Simsek (2020), Krishnamurthy and Li (2020), Maxted (2023),[1] Camous and Van der Ghote (2023)
- Heterogeneous beliefs about risk-premium, financial markets, and the macroeconomy (e.g., inflation): Welch (2000), Coibion et al. (2020), Candia et al. (2021), Weber et al. (2022), Beutel and Weber (2022)[2]
- Long-run optimism and boom-bust cycles: Bordalo et al. (2023)
- Intermediary and capital-share based empirical asset pricing: He, Kelly, and Manela (2017), Lettau, Ludvigson, and Ma (2019)
- Momentum during crises: Cujean and Hesler (2017)

[1] Maxted (2023) incorporates diagnostic expectations into a model with intermediaries based on He and Krishnamurthy (2013).

[2] Beutel and Weber (2022) find that individuals are heterogeneous both at the information acquisition and processing stages, forming their own beliefs and choosing portfolios based on them.

The Model: Details

Go back

Single capital: owned by optimists and (rational) households

Optimists: produces $\underline{y_t^O = \gamma_t^O k_t^O}$, $\forall t \in [0, \infty)$ where

$$\frac{dk_t^O}{k_t^O} = \left(\Lambda^O(\boxed{\iota_t^O}) - \delta^O\right) dt, \quad \forall t \in [0, \infty)$$

Investment ratio
Their investment$= \iota_t^O y_t^O$

with technological growth:

$$\frac{d\gamma_t^O}{\gamma_t^O} = \boxed{\alpha} dt + \sigma \underbrace{dZ_t}_{\text{Brownian motion}}, \quad \forall t \in [0, \infty)$$

True (expected) growth

Households: produces $\underline{y_t^H = \gamma_t^H k_t^H}$, $\forall t \in [0, \infty)$ where

$$\frac{dk_t^H}{k_t^H} = \left(\Lambda^H(\boxed{\iota_t^H}) - \delta^H\right) dt, \quad \forall t \in [0, \infty)$$

Investment ratio
Their investment$= \iota_t^H y_t^H$

with the same technological growth:

$$\frac{d\gamma_t^H}{\gamma_t^H} = \boxed{\alpha} dt + \sigma \underbrace{dZ_t}_{\text{Brownian motion}}, \quad \forall t \in [0, \infty)$$

True (expected) growth

$\longrightarrow$ **Level difference**: $\gamma_t^H = l \cdot \gamma_t^O$, $\Lambda^H(\cdot) = l \cdot \Lambda^O(\cdot)$, with $l \leq 1$

- Efficiency in both production and capital formation$\downarrow$

Capital price process: (endogenous) p_t follows

$$\frac{dp_t}{p_t} = \mu_t^p dt + \boxed{\sigma_t^p} dZ_t$$

Endogenous volatility

Capital return process:

- Optimists' total return on capital:

$$dr_t^{Ok} = \underbrace{\frac{\gamma_t^O \cancel{k_t^O} - \iota_t^O \gamma_t^O \cancel{k_t^O}}{p_t \cancel{k_t^O}}}_{\text{Dividend yield}} dt + \underbrace{\left(\Lambda^O(\iota_t^O) - \delta^O + \mu_t^p\right) dt + \sigma_t^p dZ_t}_{\text{Capital gain}}$$

$$= \frac{1 - \iota_t^O}{\underbrace{q_t}_{\substack{\text{Price-earnings ratio} \\ \text{(optimists)}}}} dt + \left(\Lambda^O(\iota_t^O) - \delta^O + \mu_t^p\right) dt + \sigma_t^p dZ_t$$

- Households' total return on capital:

$$dr_t^{Hk} = \frac{\gamma_t^H \cancel{k_t^H} - \iota_t^H \gamma_t^H \cancel{k_t^H}}{p_t \cancel{k_t^H}} dt + \left(\Lambda^H(\iota_t^H) - \delta^H + \mu_t^p\right) dt + \sigma_t^p dZ_t$$

Optimists: dogmatically believe γ_t^O follows

$$\frac{d\gamma_t^O}{\gamma_t^O} = \boxed{\alpha^O} dt + \sigma \underbrace{dZ_t^O}_{\substack{\text{Optimists'} \\ \text{Brownian Motion}}}, \quad \forall t \in [0, \infty)$$

$$\alpha^O > \alpha$$

even if the true process is given as

$$\frac{d\gamma_t^O}{\gamma_t^O} = \alpha dt + \sigma \underbrace{dZ_t}_{\substack{\text{True} \\ \text{Brownian Motion}}}$$

with the following consistency (see e.g., Yan (2008)):

$$\underbrace{Z_t^O}_{\text{Optimists' BM}} = \underbrace{Z_t}_{\text{True BM}} - \frac{\alpha^O - \alpha}{\sigma} t$$

Note that:

- Optimists infer a true σ by calculating the process' quadratic variation

Perceived capital return process

- Optimists' total return on capital:

$$dr_t^{Ok} = \underbrace{\frac{\gamma_t^O \cancel{k_t^O} - \iota_t^O \gamma_t^O \cancel{k_t^O}}{p_t \cancel{k_t^O}}}_{\text{Dividend yield}} dt + \underbrace{\left(\Lambda^O(\iota_t^O) - \delta^O + \mu_t^p\right) dt + \sigma_t^p dZ_t}_{\text{Capital gain}}$$

$$= \frac{\gamma_t^O - \iota_t^O \gamma_t^O}{p_t} dt + \left(\Lambda^O(\iota_t^O) - \delta^O + \mu_t^p + \boxed{\frac{\alpha^O - \alpha}{\sigma}\sigma_t^p}\right) dt + \sigma_t^p dZ_t^O$$

Optimism premium

Observation (Belief heterogeneity in asset returns)

(Endogenous) volatility $\sigma_t^p \uparrow \longrightarrow$ the optimism premium in asset return$\uparrow$

Financial market: capital and risk-free (zero net-supplied)

Optimists: consumption-portfolio problem (price-taker) Solution

$$\max_{\iota_t^O, x_t \geq 0, c_t^O \geq 0} \boxed{\mathbb{E}_0^O} \left[\int_0^\infty e^{-\rho t} \log\left(c_t^O\right) dt \right]$$

Believes dZ_t^O is the true BM

subject to

$$dw_t^O = x_t w_t^O dr_t^{Ok} + (1 - x_t) r_t w_t^O dt - c_t^O dt, \quad \text{and} \quad \underbrace{w_t^O \geq 0}_{\text{Solvency constraint}}$$

Rational households: solve the similar problem with $\boxed{\mathbb{E}_0}$ $(\neq \mathbb{E}_0^O)$

Believes dZ_t is the true BM

Total capital $K_t = k_t^O + k_t^H$ evolves with

$$\frac{dK_t}{dt} = \underbrace{\left(\Lambda^O\left(\iota_t^O\right) - \delta^O\right)k_t^O}_{\text{From optimists}} + \underbrace{\left(\Lambda^H\left(\iota_t^H\right) - \delta^H\right)k_t^H}_{\text{From households}}, \quad \forall t \in [0,\infty)$$

Debt: zero net-supplied

$$\underbrace{\left(w_t^O - p_t k_t^O\right)}_{\substack{\text{Optimists'}\\ \text{lending}}} + \underbrace{\left(w_t^H - p_t k_t^H\right)}_{\substack{\text{Households'}\\ \text{lending}}} = 0$$

Good market equilibrium:

$$\underbrace{\frac{x_t^O w_t^O}{p_t}\left(\gamma_t^O - \iota_t^O \gamma_t^O\right)}_{\substack{\text{Optimists'}\\ \text{production}\\ \text{net of investment}}} + \underbrace{\frac{x_t^H w_t^H}{p_t}\left(\gamma_t^H - \iota_t^H \gamma_t^H\right)}_{\substack{\text{Households'}\\ \text{production}\\ \text{net of investment}}} = c_t^O + c_t^H$$

Markov equilibrium: optimists' wealth share η_t as state variable

Details Calibration Go back

The Model: Additional Slides

Optimists' optimal portfolio decision (e.g., Merton (1971))

$$x_t = \frac{\left(\frac{\gamma_t^O - \iota_t^O \gamma_t^O}{p_t} + \Lambda^O(\iota_t^O) - \delta^O + \mu_t^p + \boxed{\frac{\alpha^0 - \alpha}{\sigma}\sigma_t^p}\right) - r_t^*}{(\sigma_t^p)^2}$$

New term: from optimism

For $\alpha^O > \alpha$ (experts = optimists)

- Given the risk-free r_t^* and the endogenous volatility σ_t^p, optimism (i.e., $\alpha^O \uparrow$ from α) raises the optimists' leverage↑ and capital demand↑, i.e., booms
- Optimists bear 'too much' risk on their balance sheets $\longrightarrow$ crisis when dZ_t is negative enough (entering crisis more frequently, i.e., frothy periods)

$\sigma_t^p \uparrow \longrightarrow$ has two effects on leverage x_t:

- $\sigma_t^p \uparrow$ lowers x_t as the required risk-premium level↑
- $\sigma_t^p \uparrow$ raises x_t as it raises the degree of optimism on asset returns

Proportion of optimists' wealth as state variable, similarly to Brunnermeier and Sannikov (2014):

$$\eta_t \equiv \frac{W_t^O}{W_t^O + W_t^H} \underbrace{=}_{\text{Debt market equilibrium}} \frac{W_t^O}{p_t K_t}$$

which leads to:

$$x_t^O \leq \frac{1}{\eta_t}$$

- When it binds - 'normal' (all capital is owned by experts)
- When it does not bind - 'crisis' (less productive households must hold capital)

Under Markov equilibrium: normalized variables depend only on η_t

$$\longrightarrow q_t = q(\eta_t),\ x_t = x(\eta_t),\ \underbrace{\psi_t}_{\substack{\text{Capital share} \\ \text{(optimists)}}} = \psi(\eta_t)$$

Investment function

$$\Lambda^O(\iota_t^O) = \frac{1}{k}\left(\sqrt{1 + 2k\iota_t^O} - 1\right), \quad \forall t \in [0, \infty)$$

with

$$\Lambda^P(\iota_t) = l \cdot \Lambda^O(\iota_t), \quad \forall \iota_t \tag{3}$$

Parametrization: target 5% chance of crisis

	l	δ^O	δ^H	ρ	χ	σ	k	α	α^O set
Values	0.4	0	0	0.03	1	0.08	18	0.07	[0.07, 0.13, 0.19]

Table: Parameterization for $\alpha^O \geq \alpha$

Endogenous volatility: two channels

Go back

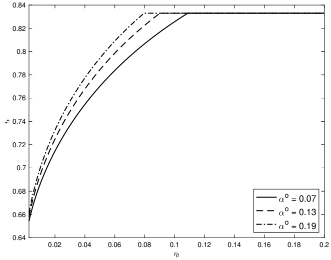
Capital price volatility σ_t^p is given by

$$\sigma_t^p \left(1 - (x_t - 1) \frac{\frac{dq(\eta_t)}{q(\eta_t)}}{\frac{d\eta_t}{\eta_t}} \right) \equiv \sigma_t^p \left(1 - (x_t - 1)\,\varepsilon_{q,\eta}\right) = \underbrace{\sigma}_{\text{Exogenous volatility}}$$

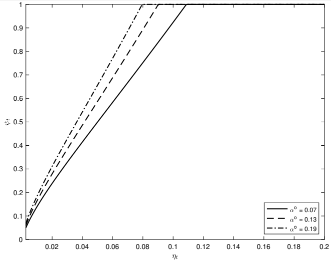
- $\varepsilon_{q,\eta}$ is the elasticity of the price-earnings ratio (i.e., normalized capital price) with respect to the experts' wealth share η_t
- 'Market illiquidity' effect: $\alpha^O \uparrow \longrightarrow \varepsilon_{q,\eta}\uparrow \longrightarrow \sigma_t^p \uparrow$
- 'Leverage' effect: $\alpha^O \uparrow \longrightarrow x_t \uparrow \longrightarrow \sigma_t^p \uparrow$

Additional figures

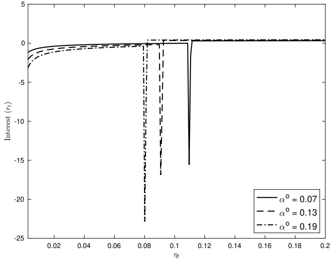
Go back



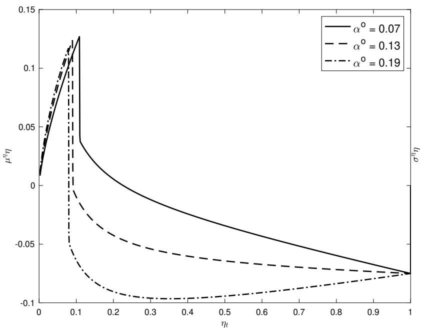
(a) Investment rate ι_t



(b) Capital share ψ_t



(c) Equilibrium interest rate r_t^*



(a) $\mu_\eta(\eta_t) \cdot \eta_t$ as a function of η_t (b) $\sigma^\eta(\eta_t) \cdot \eta_t$ as a function of η_t

Figure: Wealth share dynamics: drift and volatility

- $\alpha^O \uparrow \longrightarrow$ Wealth share drift $\mu_\eta(\eta_t) \cdot \eta_t \uparrow$ in a crisis: recapitalized faster
- $\alpha^O \uparrow \longrightarrow$ Wealth share drift $\mu_\eta(\eta_t) \cdot \eta_t \downarrow$ in normal: more likely to enter crises

Does optimism hurt the household's welfare?

Go back

$$\text{Welfare Loss} = \mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log c_t^H dt\right] - \mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log c_t^{H,REE} dt\right] \quad (4)$$

- $c_t^{H,REE}$: household's consumption in the rational expectations benchmark

Decomposition:

$$\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log c_t^H dt\right] = \underbrace{\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log(1-\eta_t) dt\right]}_{\text{Wealth effect}_+} + \underbrace{\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log(1-\iota_t) dt\right]}_{\text{Investment effect}_+}$$

$$+ \underbrace{\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log K_t dt\right]}_{\text{Capital effect}_-} + \underbrace{\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}\log A(\psi) dt\right]}_{\text{Misallocation effect}_-}$$

$$+ \underbrace{\text{t.i.e.}}_{\text{Terms independent of equilibria}}$$

- $A(\psi_t) = \psi_t + l(1-\psi_t)$: productivity-adjusted aggregate capital share

Go back

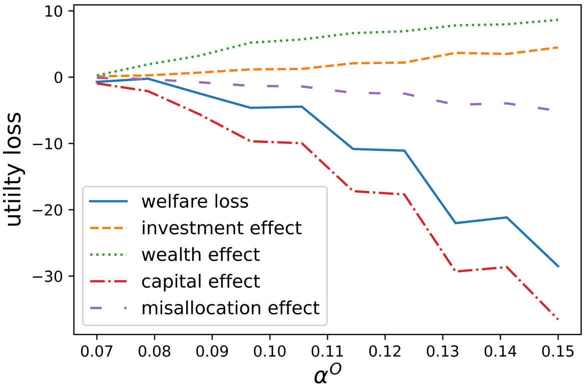


Figure: Decomposition of the rational household's welfare loss

- Overall, optimism $\alpha^O\uparrow \longrightarrow$ welfare of households$\downarrow$ (aggregate capital effects are the strongest)

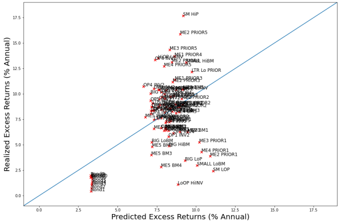
Empirical Analysis: Additional Slides

Test assets

- Test assets (1970Q1 - 2022Q4): 25 size and book-to-market portfolios; 25 size and momentum sorted portfolios; 10 long-term reversal portfolios; 25 profitability and investment portfolios; 10 maturity sorted US treasury bond portfolios from CRSP Fama bond dataset with maturities in 6 month intervals up to 5 years

- Other asset classes (1970Q1 - 2012Q4): 18 option portfolios; 20 CDS portfolios; 12 FX portfolios used in He, Kelly, and Manela (2017)

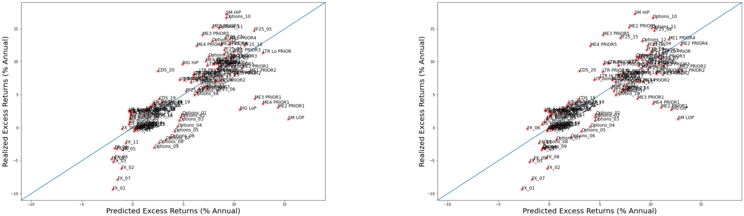
Go back



(a) Pricing error in two-factor model.

(b) Pricing error in three-factor model.

Figure: Pricing errors on equity and bond portfolios: Realized excess returns versus predicted excess returns using the two-factor model with market and intermediary factors. The data is at quarterly frequency and from 1970Q1 till 2022Q4.



(a) Pricing error in two-factor model

(b) Pricing error in three-factor model

Figure: Pricing errors on HKM+Momentum portfolios. Realized excess returns versus predicted excess returns using the two-factor model with the market and the intermediary factor in panel (11a), and the three-factor model with the market, intermediary, and macro-optimism factors in panel (11b).

	HKM		HKM+Momentum	
	Two-factor	Three-factor	Two-factor	Three-factor
Mean excess return	0.85	0.85	1.2	1.2
Std excess return	1.31	1.31	1.32	1.32
Mean β_M	0.46	0.46	0.62	0.62
Std β_M	0.46	0.46	0.48	0.48
Mean β_η	0.03	0.03	0.04	0.04
Std β_η	0.09	0.09	0.1	0.09
Mean β_O	-	-0.02	-	-0.03
Std β_O	-	0.04	-	0.06
Assets	94	94	129	129
Quarters	195	195	195	195
Controls	Yes	Yes	Yes	Yes

Table: Expected returns and risk exposures - Robustness check. HKM assets include 25 size and book-to-market portfolios, 10 U.S. Govt. bond portfolios, 10 U.S. corporate bond portfolios, 18 option portfolios, 20 CDS portfolios, and 12 foreign exchange portfolios taken from He et al. (2017). HKM+Momentum includes 25 size and momentum portfolios and 10 long-term reversal portfolios in addition to the HKM assets. The frequency is quarterly and time period is from 1970Q1 till 2012Q4. Controls include price-dividend ratio, cyclically adjusted earnings ratio (CAPE), cay, and capital share risk.

	HKM		HKM+Momentum	
	Two-factor	Three-factor	Two-factor	Three-factor
Market	0.02	0.01	0.02	0.02
	(1.6)	(1.32)	(1.83)	(1.36)
Intermediary	0.09	0.10	0.05	0.07
	(4.48)	(3.64)	(3.01)	(2.47)
Macro-optimism	-	0.06	-	0.09
	-	(1.68)	-	(2.89)
MAPE %	1.7	1.49	2.36	1.95
Adj. R2	0.82	0.86	0.60	0.74
Assets	94	94	129	129
Quarters	195	195	195	195

Table: Risk price estimates for HKM and HKM+Momentum portfolios - Robustness check. The standard errors of risk price estimates are adjusted for generated regressor problem using Shanken correction. MAPE denotes the mean absolute pricing error in annualized terms.