A Behavioral Foundation for the Investment Wedge

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What we do

Investment driven fluctuations remain hard to operationalize in DSGE models

- Exogenous “investment wedge” dynamics fit business-cycle patterns
- but poor co-movement of macro and financial aggregates

We provide a behavioral mechanism that endogenously generates an investment wedge

- Key idea: investment firms underestimate competitors’ investment
- $\Rightarrow$ misperceive future returns.
- investment wedge arises endogenously in response to other shocks

Contribution

Embed competition neglect (Greenwood & Hanson 2014) in a GE model

- Show the distortion is equivalent to a pure investment wedge.

Quantitatively, an RBC model augmented with competition neglect:

- produces boom–bust investment and stock-market dynamics;
- high valuations predict low future excess returns.

Roadmap

1. Investment goods firm's problem
2. Real Business Cycle model with Competition Neglect
3. Quantitative Implications

Physical Environment

- Many symmetric investment firms choose net investment $I_{f,t}$.
- Aggregate capital affects future marginal product / rental rate.
- **Strategic substitutes**: if everyone invests, future returns fall.

Firm's law of motion of capital:

$$K_{f,t+1} = K_{ft} + I_{ft}$$

Using symmetry, aggregate law of motion:

$$K_{t+1} = K_t + I_t$$

Example: linear return

Assume a linear market rental rate of capital

$$H_t = A_t - BK_t, \qquad B > 0$$

- Higher K_t depresses the marginal product of capital H_t.
- If firms neglect competitors' investment, they underpredict K_{t+1} and overpredict H_{t+1}.

Competition neglect: perceived aggregate investment

Let firm f perceive aggregate investment as a convex combination of own choice and a benchmark:

$$I_t^{\omega} = \omega_{ft} I_{ft} + (1 - \omega_{ft})\bar{I}$$

- $\omega_{ft} \in (0, 1)$: **competition neglect** (underweights others' responses).
- Mechanism: good news $\Rightarrow$ firm invests more, but fails to internalize others do too.

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In GE settings, we cast the friction as a fixed point problem.

- Standard RBC core:
  - Cobb–Douglas output
  - Household preferences and SDF
  - Capital accumulation
- New ingredient:
  - **Investment firms** form biased beliefs about future aggregate capital and hence returns.

State
(K_t, A_t)

Where CN lives
Investment block: beliefs about K_{t+1} and returns

Production and rental rate:

$$Y_t = K_t^{\alpha}(A_t N_t)^{1-\alpha}, \qquad H_t = \alpha \left(\frac{A_t N_t}{K_t}\right)^{1-\alpha}$$

Capital accumulation:

$$K_{t+1} = (1-\delta)K_t + I_t$$

Household SDF (CRRA):

$$M_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}$$

Competition neglect: perceived aggregate investment

For an investment firm f:

$$I_t^{\omega} = \omega_{ft} I_{f,t} + (1 - \omega_{ft})\bar{I}$$

- $\omega_{ft} = 1$: rational expectations about aggregate investment.
- $\omega_{ft} < 1$: underweights competitors $\Rightarrow$ perceives aggregate investment "closer to steady state".

At every t, firm f chooses its own CN degree ω_{ft} subject to a computation cost

$$\kappa \left(\omega_{ft} - \omega\right)^2 / 2, \quad \kappa > 0$$

Perceived aggregate capital path

Define perceived capital (formed at t about future dates):

$$K^{\omega}_{t+\tau|t} \;=\; K_t + \sum_{j=0}^{\tau-1} I^{\omega}_{t+j|t}$$

with accurate measurement of current aggregate state at beginning of period

$$K^{\omega}_{t|t} = K_t$$

- Firms observe current K_t but misforecast future K via misforecast of aggregate investment.
- This is the key channel that will generate sign-switching wedge dynamics.

Bounded rationality requirements for GE

Each boundedly rational firm receives two inputs

- $\mathcal{H}(K^{\omega}_{t|0}, A_t)$: rental rate, and $\mathcal{M}_0(K^{\omega}_{t|0}, A_t)$: discount factor
- firms evaluate future scenarios by plugging in their forecasts of future TFP A_t and perceived aggregate capital $K^{\omega}_{t|0}$

We require these informational inputs to be *consistent* in GE

- if the firm plugs in correct state variables, it would accurately predict actual returns
- firms' distortion is on the forecast of state variables

Distorted firm problem

Specifically, firm f chooses a path of attention levels ω_{ft} and investment I_{ft} to solve:

$$\max_{\{\omega_{ft}, I_{ft}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \mathcal{M}_0(K_{t|0}^{\omega}, A_t) \left\{ \mathcal{H}(K_{t|0}^{\omega}, A_t) K_{ft} - I_{ft} - \delta K_{ft} - \Phi(K_{ft}, I_{ft}) - \frac{\kappa}{2}(\omega_{ft} - \omega)^2 \right\} \quad (1)$$

subject to the individual capital accumulation equation. The choice of $0 \leq \omega_{ft} < 1$ drives firm's perceived law of motion of aggregate investment and capital.

The firms solves this problem separately for every period

Definition (Capital-Good Sector Equilibrium)

For a given sequence of realizations of the exogenous process $\{A_t\}$ and given mappings of the rental rate $\mathcal{H}(\cdot,\cdot)$ and the stochastic discount factor $\mathcal{M}_t(\cdot,\cdot)$, a symmetric competitive equilibrium in the capital-good sector is given by a sequence of state-contingent individual choices $\{\omega_{ft}, I_{ft}, K_{ft}\}$, perceived aggregate quantities $\{I_t^{\omega}, K_{t+\tau|t}^{\omega}\}$, for each firm f and each future date $t+\tau$, $\tau \geq 0$; and by a sequence of aggregate allocations $\{I_t, K_t\}$; such that, at each date $t \in \{0, \ldots, \infty\}$, (a) the individual choices of neglect and investment solve the individual firms' problem, (b) the aggregate capital good market clears, and, (c) capital-goods producers' choices are symmetric.

Definition (General Equilibrium)

A symmetric competitive general equilibrium with CN is a sequence of state-contingent allocations $\{C_t, N_t, Y_t, \omega_{ft}, I_{ft}, K_{ft+1}, I_t, K_{t+1}\}$, prices $\{W_t, H_t, r_t\}$, and perceived aggregate quantities $\{I^{\omega}_{t+\tau}, K^{\omega}_{t+\tau|t}\}$, for each firm f and each future date $t+\tau$, $\tau \geq 0$ such that, at each date t, (a) the choices of consumption, and hours solve the household's problem, (b) the choices of labor demand and production solve the problem of final-good producers, (c) the choices of neglect and investment solve the individual capital-goods producers' problem, (d) firm's choices are symmetric, (e) the mappings $\mathcal{H}(\cdot,\cdot)$, and $\mathcal{M}_t(\cdot,\cdot)$ satisfy consistency:

$$\mathcal{H}(K_t, A_t) = H_t \tag{2}$$

$$\mathcal{M}_t(K_{t+1}, A_{t+1}) = M_{t,t+1} \tag{3}$$

and, (f) prices clear goods, labor, and bond markets.

Where the fixed point comes from

- Firms' Euler equation needs mappings for prices and SDF:

$$H_t = \mathcal{H}(K_t, A_t), \qquad M_{t,t+1} = \mathcal{M}_t(K_{t+1}, A_{t+1})$$

- But in GE, those mappings are themselves implied by household decisions and market clearing.
- So we solve for a consistent set of linear (or nonlinear) decision rules.

We log-linearize the model and find a solution

Solution

The solution to the real business cycle CN model takes the form of policy functions for aggregate endogenous variables $\{\hat{n}_t, \hat{k}_{t+1}, \hat{l}_t, \hat{c}_t, \hat{r}_t\}$:

$$\hat{x}_t = \psi_{xk}\hat{k}_t + \psi_{xa}\hat{a}_t \tag{4}$$

The perceived aggregate capital stock is given by the following law of motion:

$$\hat{k}^{\omega}_{t+\tau+1|t} = (1 + \omega\frac{\psi_{lk}}{K})\hat{k}^{\omega}_{t+\tau|t} + \omega\frac{\psi_{la}}{K}\mathbb{E}_t\hat{a}_{t+\tau} \tag{5}$$

with $\hat{k}^{\omega}_{t|t} = \hat{k}_t$ at each time t.

The dynamics of output, consumption, investment, capital stock, real interest rate in the prototype model with wedges are observationally equivalent to that of CN when

1. the investment wedge is given by:

$$\tau_{It} = \nu_k K \hat{k}_t + \nu_a K \hat{a}_t \tag{6}$$

2. the labor wedge, efficiency wedge, and government wedge are set to zero in all periods.

Corollary (ARMA (2,1) Representation of the Investment Wedge)
The investment wedge admits the following ARMA(2,1) representation:

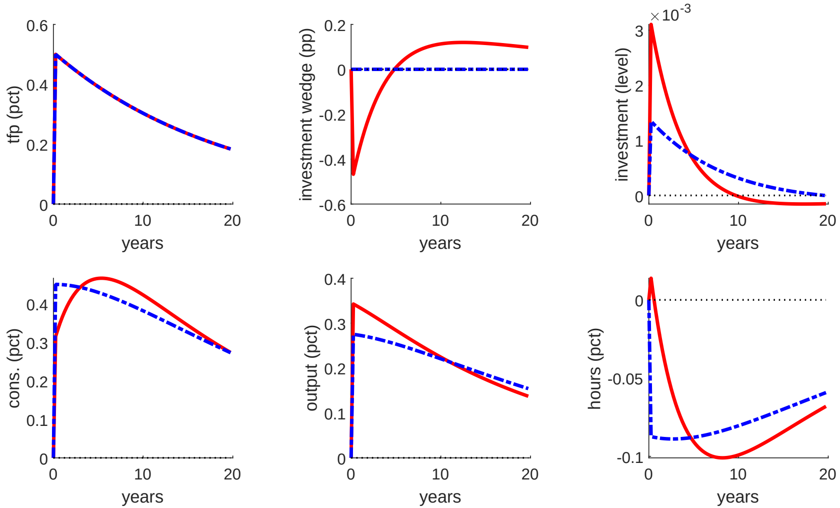
$$\tau_{It} = (1 + \psi_{Ik} + \rho_a)\tau_{It-1} - (1 + \psi_{Ik})\rho_a \tau_{It-2} + \nu_a K \epsilon_t + [\nu_k \psi_{Ia} - \nu_a(1 + \psi_{Ik})]K \epsilon_{t-1}$$

Dynamics of τ_{It-1} and τ_{It-2} can give rise to boom-bust dynamics in investment

Calibration

Parameter		Value
β	Time preference	0.99
γ	Inverse EIS $= 1/\gamma$	1
χ	Labor disutility parameter	1.0324
φ	Inverse Frisch elasticity $= (1-N)/N/\varphi$	1
μ	Mean growth rate	$0.02/4$
δ	Capital depreciation rate	.025
α	Capital share in value added	$1/3$
ϕ	Capital adjustment costs	20
ρ_a	Serial correlation productivity shock	$0.95^{1/4}$
σ_a	Standard deviation productivity shock	0.005
ω	Steady-state awareness	0.1

Impulse responses: real quantities



Impulse responses of real variables to a +1 s.d. productivity shock. Red (solid): with competition neglect. Blue (dashed): frictionless model. Deviations from balanced-growth path.

Financial variables

the cum-dividend value of an individual firm as

$$V_t = D_t + \mathbb{E}_t M_{t+1|t} V_{t+1} \tag{7}$$

stock return

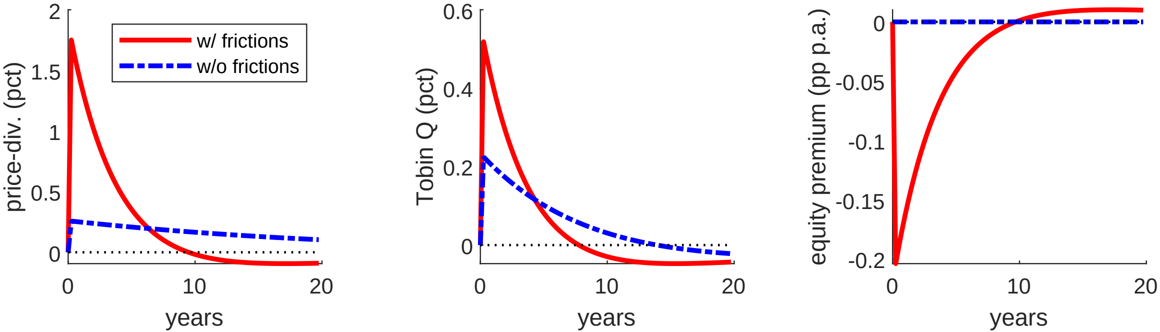
$$R_{st+1} = \frac{V_{t+1}}{V_t - D_t} \tag{8}$$

stock return approx equal to return on capital

$$R_{st+1} \approx R_{kt+1} = \frac{H_{t+1} - \delta + \phi \left(\frac{I_{t+1}}{K_{t+1}} - \frac{I}{K} \right) \frac{I_{t+1}}{K_{t+1}} - \frac{\phi}{2} \left(\frac{I_{t+1}}{K_{t+1}} - \frac{I}{K} \right)^2 + Q_{t+1}}{Q_t}$$

the risk-free rate $r_t = -\log \mathbb{E}_t M_{t+1}$ and the equity premium $\mathbb{E}_t(r_{st+1} - r_t)$

Impulse responses: financial variables



Impulse responses of financial variables to a $+1$ s.d. productivity shock. Red (solid): with competition neglect. Blue (dashed): frictionless model.

Variables are in deviations from balanced-growth path.

excess return predictability tied to investment wedge dynamics

$$\mathbb{E}_t[r_{st+1} - r_t] = \tau_{xt} - \beta \mathbb{E}_t[\tau_{xt+1}] \tag{9}$$

Why not an exogenous AR(1) investment wedge?

- Exogenous wedge typically cannot generate sign-switching boom–bust underinvestment phase.
- RBC–CN delivers richer dynamics because distortion acts through an endogenous state (capital).
- behavioral distortion also gives rise to time-varying equity premia

Conclusion

- Behavioral competition neglect in the investment block $\Rightarrow$ endogenous, time-varying investment wedge.
- The resulting wedge can switch sign, generating boom–bust investment dynamics.
- Delivers realistic return predictability and variance decomposition without adding financial frictions.

Key takeaway

A small, disciplined expectation bias in GE is enough to generate both macro and asset-pricing patterns.