Incomplete Information and Investment Inaction

ASSA 2025: International Society for Inventory Research Session

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- Both frictions are important, but studied individually. Do they interact?

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3. **Empirical Analysis:**
   - Test predictions using Japanese administrative data
   - Firms with worse information behave as predicted by model

Theory

Firms' Problem

- Atomistic firms face simple investment problem
- Produce using capital K and stochastic productivity A by

$$F(A, K) = A^{1-\alpha} K^{\alpha}$$

- Log productivity a follows a random walk:

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- Investment I is irreversible. Conditional on investing, profits are

$$\pi = A^{1-\alpha} K^{\alpha} - \psi I$$

- The law of motion for capital is

$$dK = I - \delta K dt$$

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- Effect of incomplete information? *It determines the inaction region*

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- Relevant state variables: log capital k and *nowcast* $\hat{a} \equiv \mathbb{E}[a|\Omega]$
- $\hat{a}$ follows a random walk with the same properties as a

▸ Nowcast Behavior

Solving the Firm's Problem: Inaction Boundary

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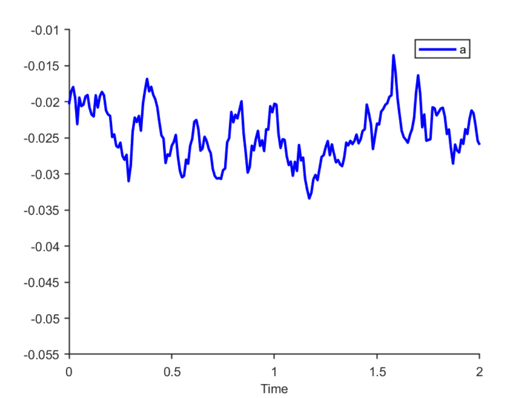
- Firm maximizes *expected value function* $\hat{V}(\exp(\hat{x})) = \mathbb{E}[V(exp(x))|\exp(\hat{x})]$
- We show that the optimum is characterized by usual value-matching and super contact conditions, except applied to $\hat{V}$:

$$\hat{V}'(\exp(\hat{b})) = \psi \qquad \lim_{\exp(\hat{x})\to\infty} \hat{V}'(\exp(\hat{x})) = 0$$

$$\hat{V}''(\exp(\hat{b})) = 0 \qquad \lim_{\exp(\hat{x})\to\infty} \hat{V}''(\exp(\hat{x})) = 0$$

▸ Exact Expression ▸ Normalized HJB

Example of a Typical Firm's Behavior



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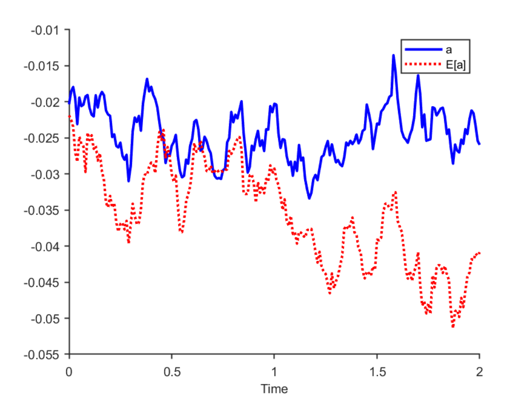

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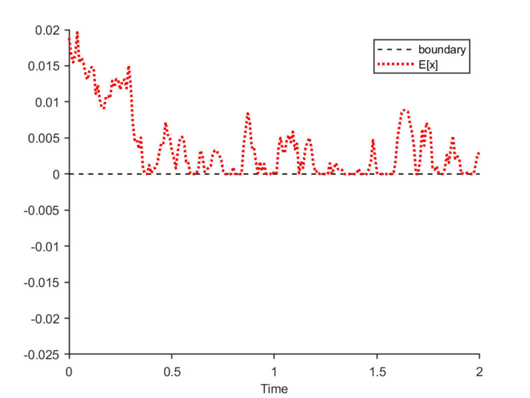

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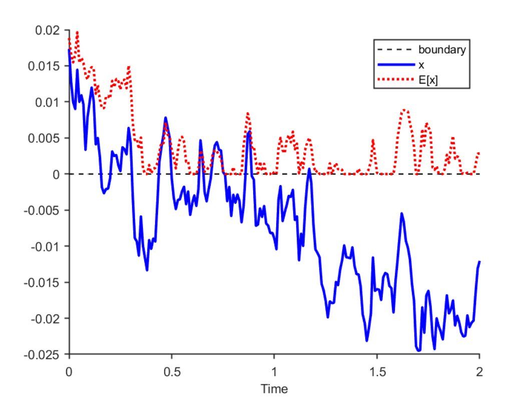

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- Actual norm. capital x follows $x = k - a = \hat{x} - \hat{a} + a$

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$$\frac{d}{dW^a_{t-h}}\mathbb{E}[a_t|\Omega_t] = \begin{cases} \gamma = \frac{\sigma_a^2}{\sigma_a^2+\sigma_n^2} < 1 & 0 \leq h < \tau \\ 1 & h \geq \tau \end{cases}$$

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Predictions for later: worse information associated with

- **Lower inaction rate**, conditional on firm size
- **Lower sensitivity of investment to productivity shocks**

▸ Boundary Properties ▸ Inelastic Forecasts

(Macro) Investment Behavior Under Incomplete Information

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4. Information friction **attenuates** aggregate responses to productivity shocks

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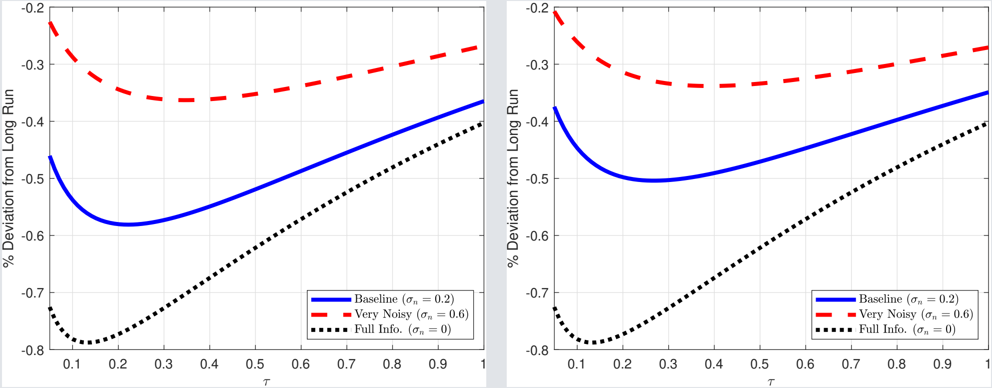
Aggregate Response of $\hat{x} = k - \hat{a}$ to a Productivity Shock



Quick Revelation $\tau = 1$ Slow Revelation $\tau = 4$

Information friction **attenuates aggregate response**

▸ Distribution Dynamics

Testing Theoretical Predictions

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    - Merged dataset contains firms with at least 1 billion JPY in registered capital

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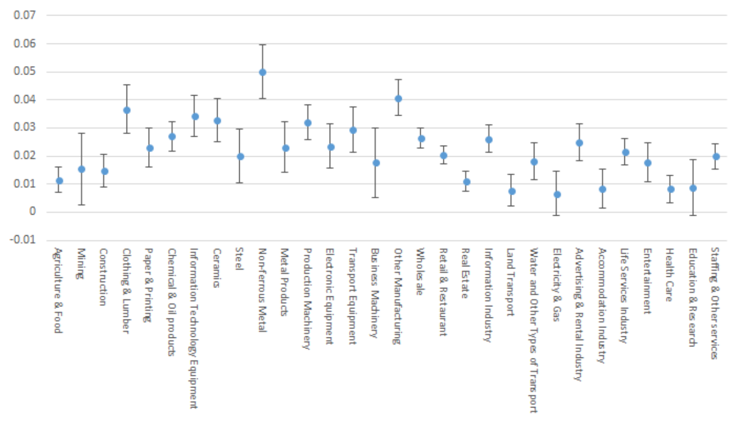
- Positive $\xi_s \implies$ forecast *underreaction*

Attenuation Coefficients across Industries



- Positive & statistically significant coefficients. Larger for manufacturing industries

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$$\mathbb{1}(\text{inaction})_{it} = \alpha\xi_s + \Gamma z_{it} + \gamma_t + \epsilon_{it}$$

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- α is the coefficient of interest
- We calibrate & simulate our model and do a similar analysis for comparison.

▸ Calibration

Empirical Exercise 1: Information Frictions & Inv. Inaction

	Data			Model	
	investment inaction $= 1$			*investment inaction* $= 1$	
ξ_s	**-0.076****	**-0.079*****	**-0.0544****	-0.085	-0.087
	(0.028)	(0.026)	(0.025)		
$a_{i,t}$	0.039	0.059*	0.104***	-0.028	-0.035
	(0.034)	(0.031)	(0.038)		
$k_{i,t-1}$		-0.050***	-0.049***		-0.007
		(0.009)	(0.008)		
$m_{i,t}$			-0.026		
			(0.021)		
Time FE	Yes	Yes	Yes	Yes	Yes
N	99027	99027	86294		
adj. R^2	0.038	0.069	0.063	0.052	0.053

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- More severe information frictions $\Rightarrow$ more inaction
- 1 SD in ξ_s $\Rightarrow$ 5.44 p.p. (15%) less inaction

Empirical Exercise 2: Information Frictions & Inv. Sensitivity

- Do we see lower investment sensitivity to productivity shocks in industries with stronger information frictions?

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- We estimate

$$\mathbb{1}(\text{inaction})_{it} = \beta(w_{it} \times \xi_s) + \gamma w_{it} + \Gamma z_{it} + \gamma_s + \gamma_t + \epsilon_{it}$$

  - w_{it} : productivity shock (random walk or AR(1))
  - z_{it}: firm-level controls
  - γ_s is the firm fixed effect
  - γ_t is the time (semi year) fixed effect
  - Standardize ξ_s

Empirical Exercise 2: Information Frictions & Inv. Sensitivity

	Data				Model
	inaction (random walk)		inaction (AR(1))		inaction
$\xi_s \times w_{i,t}$	**0.009***	**0.010****	**0.010****	**0.009***	0.136
	(0.005)	(0.005)	(0.005)	(0.005)	
w_{it}	-0.003	0.003	-0.005	0.002	-0.212
	(0.009)	(0.009)	(0.009)	(0.009)	
a_{it-1}	-0.028**	-0.015	-0.029**	-0.016	-0.022
	(0.012)	(0.012)	(0.011)	(0.011)	
Firm FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
Industry-year FE	N	Y	N	Y	-
N	84656	84656	84313	84313	
adj. R^2	0.446	0.451	0.446	0.451	0.240

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Firm FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
Industry-year FE	N	Y	N	Y	-
N	84656	84656	84313	84313	
adj. R^2	0.446	0.451	0.446	0.451	0.240

- *Dampened* inaction responses to prod. shocks in industries with higher ξ

▸ Empirical Exercise 3 ▸ Robustness

Conclusions

- We show that information and investment frictions interact in rich ways
- Parsimonious model delivers testable predictions, consistent with the data
- Information frictions are easily incorporated into continuous time inaction models (there are many applications beyond investment)
- An alternative structure for investment frictions:
  - Old paradigm: convex fixed costs to get inaction, + convex adjustment costs to get attenuation
  - New paradigm: *irreversibility* to get inaction, + *information frictions* to get attenuation
  - Plenty of micro evidence!

Appendix

Selected Literature

1. **Partial Irreversibility: Theory** Pindyck (1991), Bertola and Caballero (1994), Abel and Eberly (1996), Veracierto (2002), Stokey (2008), Ottonello (2017), and Baley and Blanco (2022)

2. **Incomplete Information and Inaction in Continuous Time**
    - Price-setting: Alvarez, Lippi, and Paciello (2011) Alvarez, Lippi, and Paciello (2016), Baley and Blanco (2019)
    - Attention fixed costs and investment: Verona (2014)

3. **Firms in the Data: Systematic Errors in Expectations** Massenot and Pettinicchi (2018), Born et al. (2022), Andrade et al (2022) Chen et al (2023), Chen, Hattori, and Luo (2023)

How Do Firms Nowcast?

Proposition (1)

For a firm with information set $\Omega(t)$, productivity is conditionally distributed

$$a(t)|\Omega(t) \sim N\left(a(t-\tau) + \gamma\left(s(t) - s(t-\tau)\right), \nu\right)$$

where

$$\gamma \equiv \frac{\sigma_a^2}{\sigma_a^2 + \sigma_n^2} \qquad \nu \equiv \frac{\tau\sigma_a^2\sigma_n^2}{\sigma_a^2 + \sigma_n^2}$$

How Do Nowcasts Behave?

Proposition (2)

A firm's expected productivity $\hat{a} \equiv \mathbb{E}[a|\Omega]$ *and nowcast error* u *follow the diffusions*

$$d\hat{a} = \sigma_a dW^{\hat{a}} \qquad du = \sigma_u dW^u$$

where

$$dW_t^{\hat{a}} = (1-\gamma)dW_{t-\tau}^A + \gamma dW_t^A + \gamma \frac{\sigma_n}{\sigma_a}(dW_t^n - dW_{t-\tau}^n)$$

$$dW_t^u = (1-\gamma)\frac{\sigma_a}{\sigma_u}(dW_t^A - dW_{t-\tau}^A) + \gamma \frac{\sigma_n}{\sigma_u}(dW_t^n - dW_{t-\tau}^n)$$

$$\sigma_u^2 = 2\frac{\sigma_n^2 \sigma_a^2}{\sigma_a^2 + \sigma_n^2}$$

Back

Boundary Solution

The critical value $\hat{b}$ depends on: the variance of nowcast errors ν, the capital share α, the cost of investment ψ, as well as ϱ and m defined as:

$$\varrho \equiv \frac{\mu - \sqrt{\mu^2 + 2\sigma_a^2 r}}{\sigma_a^2} \qquad m \equiv \frac{1}{r + \mu\alpha - \frac{\sigma_a^2}{2}\alpha^2}$$

Proposition (4)

The critical value of expected normalized capital is

$$\hat{b} = \frac{1}{1-\alpha} \log\left(\frac{m\alpha}{\psi}\left(e^{\nu\frac{(1-\alpha)^2}{2}} - \frac{1-\alpha}{1-\varrho} e^{\nu\left(\frac{(2-\alpha)^2}{2} - \frac{(2-\varrho)^2}{2} + \frac{(1-\varrho)^2}{2}\right)}\right)\right)$$

▸ Back

Solving the Firm's Problem: Normalization

- Standard approach: define log normalized capital

$$x \equiv k - a$$

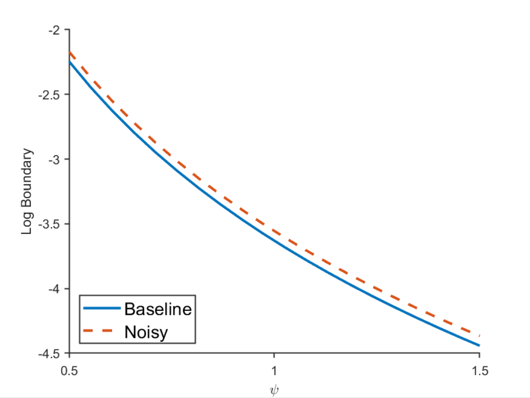
- HJB is simpler in one dimension:

$$rv(x) = e^{\alpha x} - \mu v'(x) + \frac{\sigma_a^2}{2} v''(x)$$

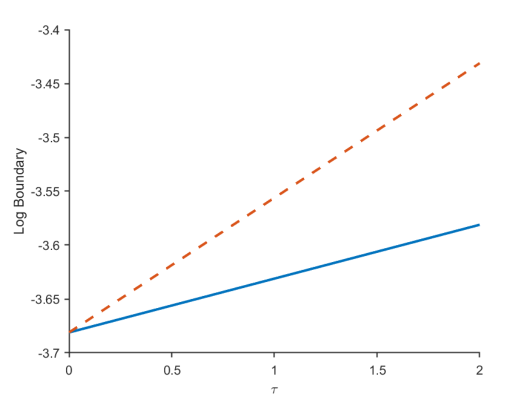
where $\mu \equiv \delta + \frac{\sigma_a^2}{2}$

▸ Back

How the Boundary $\hat{b}$ Depends on the Information Friction

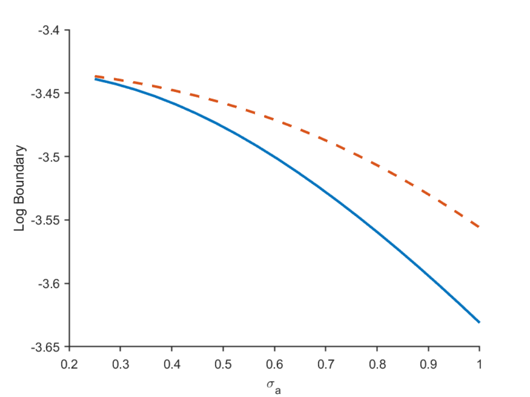


Investment Cost ψ



Revelation Delay τ

How the Boundary $\hat{b}$ Depends on "Uncertainty"



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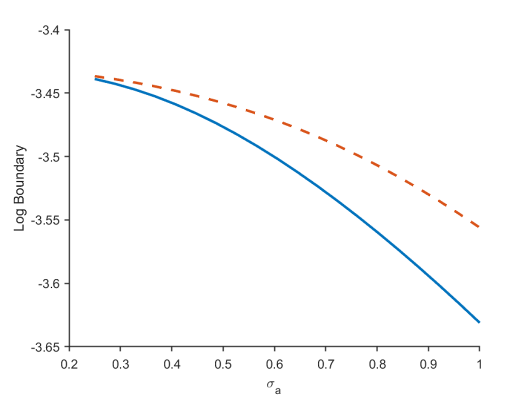

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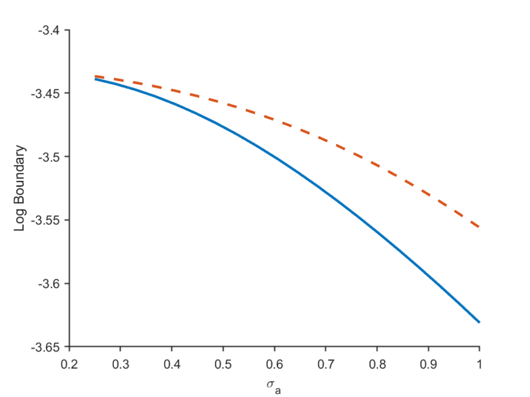

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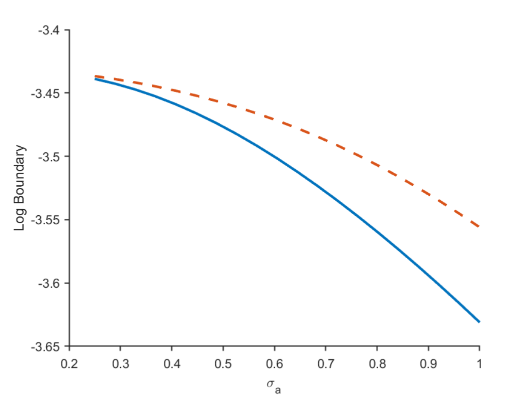

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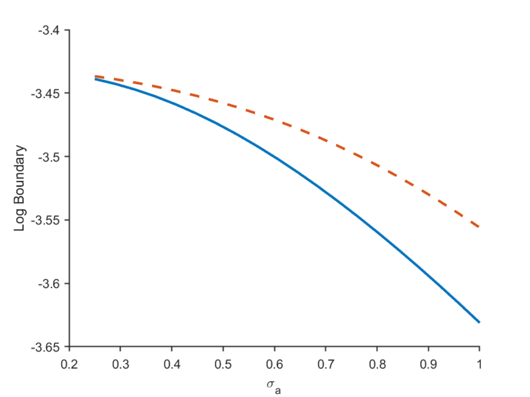

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Information Friction's Micro Effects: Inelastic Forecasts

- Recall from Proposition (1):

$$\hat{a}(t) = a(t-\tau) + \gamma(s(t) - s(t-\tau))$$

where $\gamma = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_n^2} < 1$ and $s = a + n$

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- Increased noise lowers the elasticity of forecasts to productivity γ:

$$\frac{d}{dW_{t-h}^a}\mathbb{E}[a_t|\Omega_t] = \begin{cases} \gamma & 0 \leq h < \tau \\ 1 & h \geq \tau \end{cases}$$

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- Prediction for later: worse information reduces γ

Back

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  - Their expected normalized capital $\hat{x}$ enters at the critical value $\hat{b}$

The Stationary Distribution of Expected Normalized Capital

- The Kolmogorov Forward equation (KFE) for the distribution of expected normalized capital $h(\hat{x}, t)$:

$$\partial_t h(\hat{x}, t) = \delta \partial_{\hat{x}} h(\hat{x}, t) + \frac{\sigma_a^2}{2} \partial_{\hat{x}}^2 h(\hat{x}, t) - \eta h(\hat{x}, t)$$

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- Boundary condition: $h(\hat{x})$ must integrate to one over $[\hat{b}, \infty)$
- The stationary distribution of expected normalized capital $h(\hat{x})$ for $\hat{x} \geq \hat{b}$ is

$$h(\hat{x}) = \rho e^{-\rho(\hat{x} - \hat{b})}$$

where $\rho \equiv \frac{\delta}{\sigma_a^2} + \sqrt{\frac{\delta^2}{\sigma_a^4} + 2\frac{\eta}{\sigma_a^2}}$ (which is *unaffected* by the info. friction)

Back

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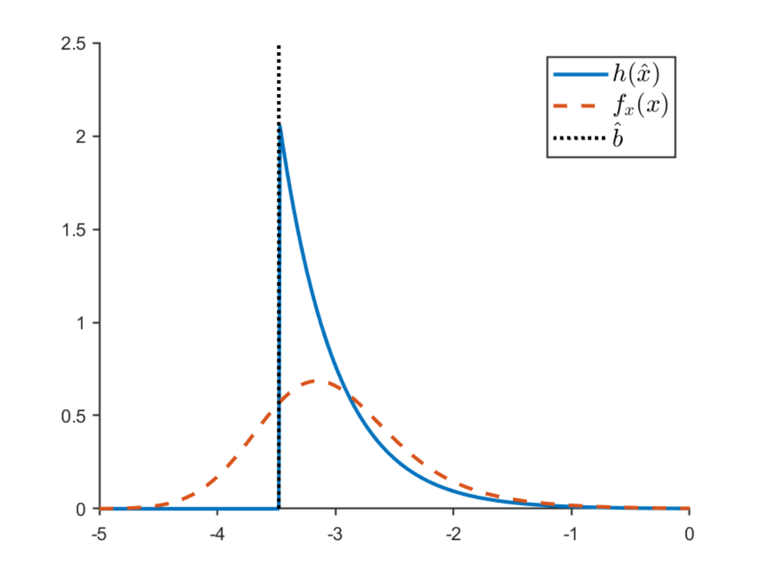
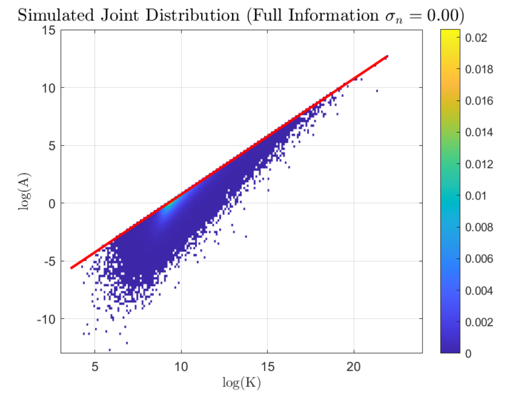
- Error variance ν smooths out the distribution

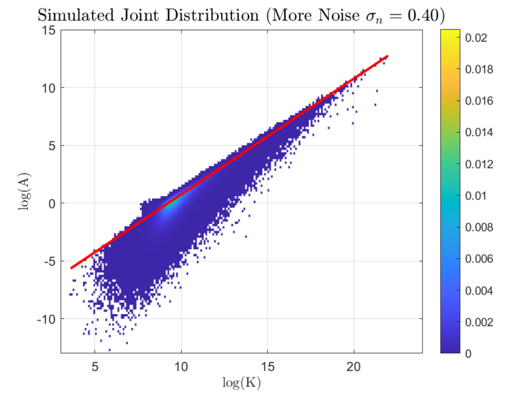
Stationary Distribution: Expected & Realized Normalized Capital



Joint Distribution for Capital and Productivity



Full Information $\sigma_n = 0$



Noisy Information $\sigma_n = 0.4$

Back

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- Recall: information frictions only affect $h(\hat{x})$ by shifting the distribution boundary
- $\implies$ noise does not affect $Var[\hat{x}]$, but does increase $Var[u]$, and thus misallocation.

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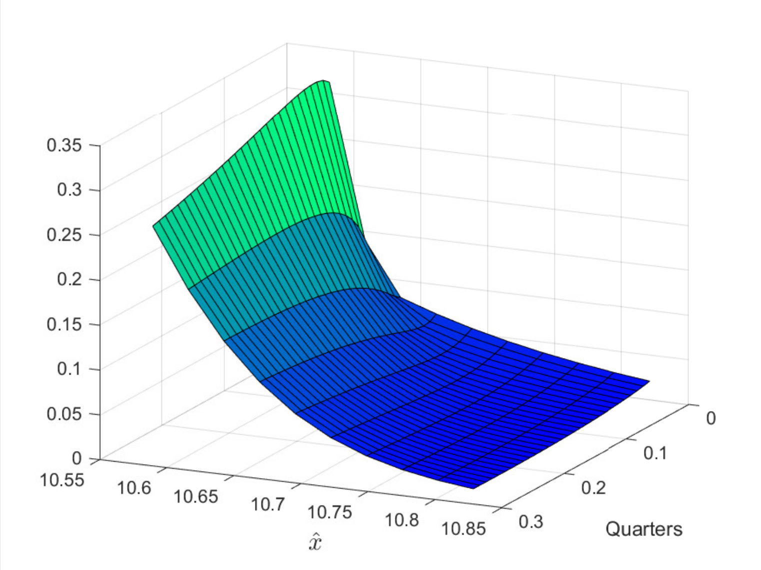
- Greater noise ($\sigma_n \uparrow$) or delay ($\tau \uparrow$) increase both the nowcast error variance ν and boundary $\hat{b}$

Dynamic Effects of Aggregate Productivity

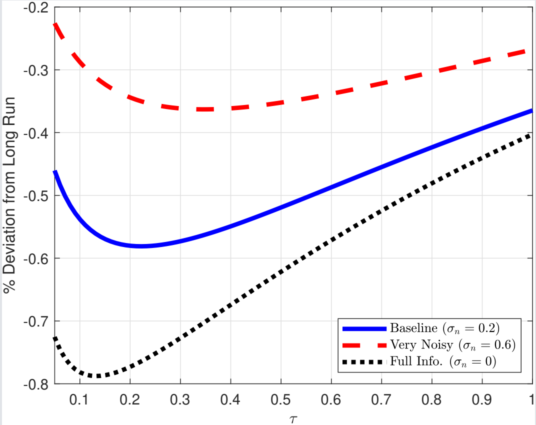
- What happens if all firms receive a productivity increase da?
- Expected productivity $\hat{a}$ increases by γda (less than one-for-one!)
- Expected normalized capital $\hat{x} = k - \hat{a}$ decreases by γda
- ... so the entire distribution shifts left, with a mass point at the boundary $\hat{b}$.
- Then, the distribution evolves per the KFE.

Distribution Across Time

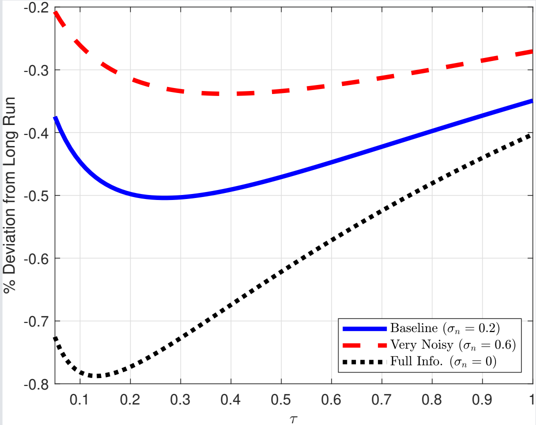


Back

Worse Information Attenuates the Aggregate Response



Quick Revelation $\tau = 1$



Slow Revelation $\tau = 4$

Empirical Evidence: Summary

- There is substantial heterogeneity in degree of information frictions across industries
- Information frictions reduce firm-level investment inaction
- Information frictions attenuate the firm-level investment response to firm-level productivity shocks

Datasets

- Two firm-level administrative data sets (2004-2018) from Japan:
  1. Business Outlook Survey (BOS)
     - Contains forecasts of sales, profit (semi-year frequency: Apr. to Sep. and Oct. to next Mar.) and firms' investment and investment plans (quarterly frequency).

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  2. Financial Statements Statistics of Corporations (FSS)
     - Contains financial statement information in balance sheet and profit and loss account at quarterly frequency (e.g., various assets, debt, equity, various types of capital etc.)
- Basic features:
  - FSS: roughly 21,000 per quarter; BOS: roughly 11,000 per quarter
  - Cover all large firms and a representative and rotating sample of small and medium-sized firms
  - Both datasets have time-invariant common firm IDs for large firms → a merged dataset with firms that have at least 1 billion JPY in terms of

Empirical Test of Our Model

- Variables Used in Empirical Analysis
    - Forecast error (FE) = log realized value (e.g., sales) - log forecasted value

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  - Group firms into 30 industries: construction, metal, transportation equipment, wholesale etc.
  - Labor productivity $=$ sales per worker
- Information friction estimated as forecast error response to productivity shocks.

Summary of the Datasets

Table 1: Sample Comparison (Quarterly)

Moments	Merged dataset	Entire Sample (FSS)
The number of obs. (non-missing sales)	392,158	1,260,836
Average employment	1040.58	491.61
Average sales (million JPY)	19991.75	8541.77
Average fixed capital stock	59919.34	24842.79

Notes: Notes: The time span is 2004-2018 (15 years and 60 quarters)

Summary Statistics of Merged Dataset (Semi-Year): Untrimmed Forecast Errors

Variable	Obs.	mean	median	standard deviation	min.	max.
log FE of sales	119,335	-.0106	-.0005	0.199	-8.472	5.759
percentage FE of sales	119,359	.0198	-.0005	1.556	1	316

Time span: 2004-2018 (29 semi-years). Forecast is made at the beginning of each semi-year.

Back

Model Calibration

Parameter	Interpretation	Value	Reference
r	Real interest rate	0.01	Annual rate of 4%
α	Capital share	0.67	Decreasing return to scale of 2/3
ψ	Investment cost	1.00	Normalization
δ	Depreciation rate	0.0136	Target average I/K in Japanese data
η	Exit risk	0.02	Annual exit rate of 8% in Japanese data
σ_A	S.D. of productivity process	0.20	Investment dynamics in Japanese data
σ_n	S.D. of noise process	0.20	Investment dynamics in Japanese data
τ	Revelation delay	1	Arbitrary

Standard deviations chosen to target investment moments

Investment Moments (Quarterly)

Moments	Data	Baseline Model	Full Info. ($\sigma_n = 0$)
Aggregate Investment Rate	1.36%	1.36%	1.36%
Investment Rate Mean	2.10%	2.63%	2.84%
Investment Rate S.D.	7.1%	7.1%	8.7%
Investment Rate Autocorrelation	0.70	0.51	0.25
Investment Inaction Rate	57.8%	79.7%	82.9%
Investment Spike Rate	1.4%	4.5%	5.4%

Back

Investment Inaction - TFP

Go back

	investment inaction = 1		
ξ_s	-0.0445*	-0.0401	-0.0461**
	(0.0245)	(0.0242)	(0.0231)
$a_{i,t}$	-0.0377	-0.00736	-0.0289
	(0.0683)	(0.0698)	(0.0386)
$k_{i,t-1}$		-0.0367***	-0.0421***
		(0.00836)	(0.00903)
$m_{i,t}$			0.0481*
			(0.0245)
Year $\times$ quarter fixed effects	Yes	Yes	Yes
N	84987	84987	84987
adj. R^2	0.016	0.033	0.051

The degree of information friction is estimated at the industry level.
Standard errors are clustered at the industry level. * 0.10 ** 0.05 *** 0.01
Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Robustness checks

- Alternative productivity measure: TFP using proxy estimator from Olley and Pakes (1996)
- Exercise 1: using TFP results
- Exercise 2:
    - using TFP: results
    - Investment rate (consistent with our prediction, but marginally insignificant p value: 1.1-1.3): results

Sensitivity Analysis - TFP ▸ Go back

	(1)	(2)	(3)	(4)
	inv. inaction $= 1$		*inv. rate* (*inv. inaction* $\neq 1$)	
$\xi_s \times w_{i,t}$	0.00581*	0.00600*	0.000342	0.000204
	(0.00340)	(0.00339)	(0.00105)	(0.00105)
$a_{i,t-1}$	-0.112***	-0.103***	0.0235***	0.0208***
	(0.0132)	(0.0134)	(0.00516)	(0.00527)
$w_{i,t}$	-0.0404***	-0.0350***	0.0117***	0.00976***
	(0.00848)	(0.00854)	(0.00282)	(0.00284)
$m_{i,t}$	-0.00566	-0.00418	0.00476***	0.00360*
	(0.00634)	(0.00637)	(0.00184)	(0.00193)
$k_{i,t-1}$		0.0727***		-0.0408***
		(0.00873)		(0.00498)
Firm FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
N	80508	80508	54747	54747
adj. R^2	0.445	0.447	0.303	0.312

Sensitivity Analysis - Labor Productivity

Go back

	(1)	(2)	(3)	(4)
	$inv.\ inaction = 1$		$inv.\ rate\ (inv.\ inaction \neq 1)$	
$\xi_s \times w_{i,t}$	0.00848*	0.00885*	-0.0400	-0.0408
	(0.00466)	(0.00465)	(0.0386)	(0.0388)
$w_{i,t}$	0.00213	-0.00344	0.0170	0.0325
	(0.00931)	(0.00931)	(0.0179)	(0.0279)
$a_{i,t}$	-0.0204*	-0.0281**	-0.0259	-0.00409
	(0.0119)	(0.0120)	(0.0299)	(0.0158)
$m_{i,t}$	-0.00891	-0.00523	0.00593	-0.00534
	(0.00551)	(0.00552)	(0.00411)	(0.00795)
$k_{i,t-1}$		0.0771***		-0.152
		(0.00857)		(0.103)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	84656	84656	57143	57143
adj. R^2	0.444	0.446	0.045	0.059

Degree of information friction is estimated at the industry level.

Standard errors are clustered at the firm level. * 0.10 ** 0.05 *** 0.01

Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Sensitivity Analysis - Labor Productivity, Industry-Year FE

Go back

Table 2: Incomplete Information and Investment Sensitivity: industry-year FEs

	(1)	(2)	(3)	(4)
	inv. inaction = 1		*inv. rate* (*inv. inaction* ≠ 1)	
$\xi_s \times w_{i,t}$	0.00991**	0.01000**	-0.0424	-0.0424
	(0.00473)	(0.00472)	(0.0406)	(0.0401)
$a_{i,t-1}$	-0.00857	-0.0146	-0.0313	-0.0127
	(0.0120)	(0.0119)	(0.0326)	(0.0202)
$w_{i,t}$	0.00735	0.00302	0.0146	0.0276
	(0.00930)	(0.00919)	(0.0170)	(0.0253)
$m_{i,t}$	-0.00879*	-0.00633	0.00705	-0.00133
	(0.00524)	(0.00514)	(0.00443)	(0.00585)
$k_{i,t-1}$		0.0824***		-0.168
		(0.00823)		(0.114)
Industry-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time (semi-year) FE	Yes	Yes	Yes	Yes
N	84656	84656	57137	57137
adj. R^2	0.448	0.451	0.044	0.059

Degree of information friction is estimated at the industry level.

Standard errors are clustered at the firm level. * 0.10 ** 0.05 *** 0.01

Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Sensitivity Analysis - Labor Productivity AR(1) ▸ Go back

	(1)	(2)	(3)	(4)
	$inv.\ inaction = 1$		$inv.\ rate\ (inv.\ inaction \neq 1)$	
$\xi_s \times w_{i,t}$	0.00952*	0.00976**	-0.0408	-0.0414
	(0.00500)	(0.00499)	(0.0396)	(0.0396)
$a_{i,t-1}$	-0.0218*	-0.0288**	-0.0266	-0.00653
	(0.0112)	(0.0113)	(0.0305)	(0.0173)
$w_{i,t}$	0.000772	-0.00456	0.0182	0.0334
	(0.00934)	(0.00935)	(0.0189)	(0.0287)
$m_{i,t}$	-0.00890	-0.00536	0.00548	-0.00552
	(0.00547)	(0.00549)	(0.00403)	(0.00807)
$k_{i,t-1}$		0.0764***		-0.153
		(0.00861)		(0.103)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	84313	84313	56911	56911
adj. R^2	0.444	0.446	0.045	0.059

Degree of information friction is estimated at the industry level.

Standard errors are clustered at the firm level. * 0.10 ** 0.05 *** 0.01

Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Sensitivity Analysis - Labor Productivity AR(1) ▸ Go back

	(1)	(2)	(3)	(4)
	inv. inaction = 1		*inv. rate* (*inv. inaction* ≠ 1)	
$\xi_s \times w_{i,t}$	0.00905*	0.00922*	-0.0416	-0.0419
	(0.00498)	(0.00496)	(0.0402)	(0.0399)
$a_{i,t-1}$	-0.0104	-0.0158	-0.0324	-0.0157
	(0.0114)	(0.0113)	(0.0334)	(0.0222)
$w_{i,t}$	0.00561	0.00161	0.0148	0.0270
	(0.00931)	(0.00921)	(0.0173)	(0.0250)
$m_{i,t}$	-0.00863	-0.00631	0.00704	-0.000940
	(0.00525)	(0.00515)	(0.00442)	(0.00566)
$k_{i,t-1}$		0.0818***		-0.169
		(0.00827)		(0.114)
Industry-year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time (semi-year) fixed effects	Yes	Yes	Yes	Yes
N	84313	84313	56906	56906
adj. R^2	0.449	0.451	0.043	0.059

Degree of information friction is estimated at the industry level.

Standard errors are clustered at the firm level. * 0.10 ** 0.05 *** 0.01

Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Empirical Exercise 3: Information Frictions & Volatility

- Do we see dampened effect of higher volatility on investment inaction in regions where information frictions are more severe?
- We estimate

$$\mathbb{1}(\text{inaction})_{it} = \beta(vol_r \times \xi_s) + \gamma_1 \xi_s + \gamma_2 vol_r + \Gamma z_{i,t} + \bar{sg}_r + \gamma_t + \epsilon_{it}$$

  - w_{it} : $a_{it} - a_{it-1}$
  - z_{it}: lagged (log) capital stock k_{it-1}, (log) labor productivity a_{it}, and intermediate goods per worker m_{it}
  - $\bar{sg}_r$ and vol_r are mean and volatility of firm-level sales growth in region r
  - γ_t is the semi year (i.e., time) fixed effects
  - Standardize ξ_s, $\bar{sg}_r$ and vol_r

Empirical Exercise 3: Information Frictions & Volatility ▸ full result

	Data	Model
	inaction	
$vol_r \times \xi_s$	-0.00549**	-0.009
	(0.00253)	(0.001)
ξ_s	-0.0551**	-0.145
	(0.0231)	(0.001)
vol_r	0.00612	0.041
	(0.00524)	(0.000)
Time FE	Y	Y
N	85920	4178503
adj. R^2	0.067	0.016

- Higher volatility of productivity leads to *dampened* increase in investment inaction when information friction is more severe

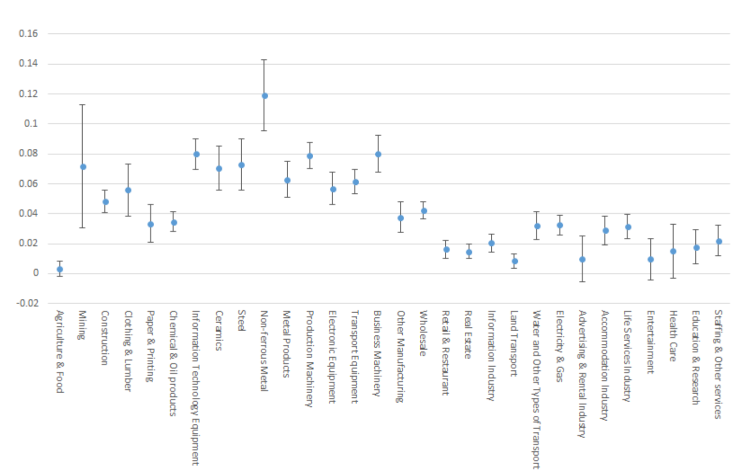
Information Frictions & Volatility: Go back

Table 3: Investment Inaction and Region-level Volatility

	inv. inaction = 1		
$vol_r \times \xi_s$	-0.0113**	-0.00927**	-0.00549**
	(0.00434)	(0.00368)	(0.00253)
ξ_s	-0.0769***	-0.0796***	-0.0551**
	(0.0260)	(0.0238)	(0.0231)
vol_r	0.00684	0.00636	0.00612
	(0.00513)	(0.00529)	(0.00524)
$s\bar{g}_r$	-0.0199**	-0.0318***	-0.0365***
	(0.00873)	(0.0107)	(0.00817)
$a_{i,t}$	0.0375	0.0565**	0.101***
	(0.0291)	(0.0264)	(0.0320)
$k_{i,t-1}$		-0.0512***	-0.0507***
		(0.00748)	(0.00727)
$m_{i,t}$			-0.0249
			(0.0195)
Time FE	Yes	Yes	Yes
N	98515	98515	85920
adj. R^2	0.039	0.072	0.067

Degree of information friction is estimated at the industry level.
Standard errors are clustered at the firm level. * 0.10 ** 0.05 *** 0.01
Top and bottom 1% productivity obs. are trimmed out (i.e., outliers).

Attenuation Coefficients across Industries - TFP



- Positive & statistically significant coefficients

Partial Irreversibility

- If firms invest, they do so at cost $\Psi(I)$:

$$\Psi(I) = \begin{cases} \psi_+ I & I \geq 0 \\ \psi_- I & I < 0 \end{cases}$$

  with $\psi_+ > \psi_- > 0$
- Instantaneous profit is $\pi = A^{1-\alpha}K^{\alpha} - \Psi(I)$
- Optimal firm behavior: for a range of capital values, firms choose to neither invest nor divest. Usual HJB in the inaction region.
- Solving the firm's problem comes down to finding the optimal choice of $\hat{B}_L$ and $\hat{B}_U$

Proposition

Under incomplete information, the boundary conditions consist of two value-matching conditions:

$$\hat{V}'(\hat{B}_L) = \psi_+ \qquad \hat{V}'(\hat{B}_U) = \psi_-$$

and two super contact conditions:

$$\hat{V}''(\hat{B}_L) = 0 \qquad \hat{V}''(\hat{B}_U) = 0$$

Partial Irreversibility

Proposition

The critical values of expected normalized capital are

$$\hat{b}_L = b_L^{FI} + \frac{\alpha^2 \nu}{2(1-\alpha)} \qquad \hat{b}_H = b_H^{FI} + \frac{\alpha^2 \nu}{2(1-\alpha)}$$

where b_L^{FI} *and* b_H^{FI} *denote the full information solutions such that* $\nu = 0$*.*