Information, Misallocation and Aggregate Productivity

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July 11, 2014

Contribution

- **Fantastic paper!**
- Original results on important and under-researched topic
- **Main result**:
  - informational frictions = important source of misallocation, TFP losses
  - In India, $\approx 80\%$ of cond. variation of a_{it} is unknown to firms at time they make investment decisions (vs. $\approx 40\%$ in US)
- Extremely clever strategy for identifying information quality
  - use correlations of productivity, investment with **stock returns**
  - scaling trick

Plan

1. Revisit main mechanism
2. Revisit identification of informational frictions
3. Comments

Refresher: Information Economics

- Perhaps not super familiar to growth crowd
- Everything just **Bayes' law** for normal random variables
- a_{it} unknown but prior and signal
  - prior: $a_{it} \sim \mathcal{N}(\bar{a}, \sigma_a^2)$
  - signal: $s_{it} = a_{it} + e_{it}$, $e_{it} \sim \mathcal{N}(0, \sigma_e^2)$
- Posterior distribution?

$$\mathbb{E}_{it} a_{it} = \mathbb{E}[a_{it} | \mathcal{I}_{it}] = \phi_1 \bar{a} + \phi_2 s_{it} \quad \phi_1 = \frac{\mathbb{V}}{\sigma_a^2}, \quad \phi_2 = \frac{\mathbb{V}}{\sigma_e^2}$$

$$\mathbb{V} = Var(a_{it} | \mathcal{I}_{it}) = \left(\frac{1}{\sigma_a^2} + \frac{1}{\sigma_e^2} \right)^{-1}$$

- Importantly, $\mathbb{E}_{it} a_{it}$ is a **random variable**

$$\mathbb{E}[\mathbb{E}_{it} a_{it}] = \bar{a},$$

$$Var(\mathbb{E}_{it} a_{it}) = \phi_2^2 (\sigma_a^2 + \sigma_e^2) = ... = \sigma_a^2 - \mathbb{V}$$

$$Var(\mathbb{E}_{it} a_{it} - a_{it}) = ... = \mathbb{V}$$

Application to Misallocation

- FOC of firms

$$\alpha \mathbb{E}_{it}[A_{it}] K_{it}^{\alpha-1} = R$$

- Hsieh and Klenow (2009) would identify a wedge τ_{it}

$$\alpha(1-\tau_{it}) A_{it} K_{it}^{\alpha-1} = R, \quad \tau_{it} = \frac{A_{it} - \mathbb{E}_{it}[A_{it}]}{A_{it}}$$

- From formulas on previous slide:

$$Var(\log(1-\tau_{it})) = Var(\mathbb{E}_{it} a_{it} - a_{it}) = \mathbb{V}$$

- everything else just log-normal formulas from Hsieh-Klenow

Identification

- Paper's most important formula (iid case):

$$\frac{\rho_{pk}}{\rho_{pa}} = \frac{1}{\sqrt{1 - \frac{\mathbb{V}}{\sigma_\mu^2}}} \qquad \nearrow \text{in} \mathbb{V}$$

  - ρ_{pk} = corr(stock return, investment)
  - ρ_{pa} = corr(stock return, productivity)

- Q: Why is $\rho_{pk} \nearrow$ in $\mathbb{V}$?

- A: Two steps

  1. $\sigma_k^2 = \textit{constant} \times (\sigma_\mu^2 - \mathbb{V}) \searrow$ in $\mathbb{V}$
     - no information $\mathbb{V} = \sigma_\mu^2$: everyone expects $a_{it} = \bar{a} \Rightarrow \sigma_k^2 = 0$
     - perfect information $\mathbb{V} = 0$: $\sigma_k^2 \propto \sigma_\mu^2$
  2. $\rho_{pk} = \frac{\sigma_{pk}}{\sigma_p \sigma_k} \searrow$ in σ_k^2
     - investment more dispersed $\Rightarrow$ less correlated with stock prices

Comment 1: How general is: $\rho_{pk} \nearrow$ in $\mathbb{V}$?

- $\Leftrightarrow$ How general is "bad information $\Rightarrow$ low dispersion in investment" ($\sigma_k^2 \searrow$ in $\mathbb{V}$)?

- For instance, what if heterogeneous priors?

$$a_{it} \sim \mathcal{N}\left(\bar{a}_i, \sigma_a^2\right), \quad Var(\bar{a}_i) > 0$$

- No longer true that no information $\Rightarrow \sigma_k^2 = 0$
- Conjecture: σ_k^2 becomes U-shaped function of $\mathbb{V}$, $\rho_{pk} \cap$ in $\mathbb{V}$

Why Correlations?

- Naive identification: use **production-side variances**

$$\frac{\sigma_a}{\sigma_k} = \frac{1-\alpha}{\sqrt{1-\frac{\mathbb{V}}{\sigma_\mu^2}}}$$

- Joel, Hugo, Venky point out problem: var's may be affected by other distortions, e.g. $k_{it} = \frac{1+\gamma}{1-\alpha}\mathbb{E}_{it}[a_{it}]$, with γ **unknown**

$$\frac{\sigma_a}{\sigma_k} = \frac{1-\alpha}{1+\gamma}\frac{1}{\sqrt{1-\frac{\mathbb{V}}{\sigma_\mu^2}}}$$

- Clever trick: **scale by price covariances**:

$$\sigma_{pk} = \frac{1+\gamma}{1-\alpha}\sigma_{pa} \quad \Rightarrow \quad \frac{\sigma_{pk}}{\sigma_{pa}}\frac{\sigma_a}{\sigma_k} = \frac{1}{\sqrt{1-\frac{\mathbb{V}}{\sigma_\mu^2}}} \qquad \left(= \frac{\rho_{pk}}{\rho_{pa}}\right)$$

Does this clever trick solve all problems?

- Will argue: **No**.
- To see why, reconsider naive identification

$$\frac{\sigma_a}{\sigma_k} = \frac{1-\alpha}{\sqrt{1-\frac{\mathbb{V}}{\sigma_\mu^2}}} \qquad (*)$$

- $\mathbb{V}$ overestimated if σ_a "too high" or σ_k "too low"...

  ... and some sources of bias cannot be solved by scaling trick

- Paper discusses "σ_k problem": uncorrelated distortions
  - but means σ_k too high $\Rightarrow$ **under**-estimate uncertainty $\mathbb{V}$
- I'll discuss "σ_a problem" next: **measurement error** in a_{it}
- **Comment 2: price correlations are just rescaled production-side variances. Doesn't solve all problems.**

Comment 3: Measurement Error

- Suppose measure $\hat{a}_{it} = a_{it} + \varepsilon_{it}$, $\varepsilon_{it} \sim \mathcal{N}(0, \sigma_\varepsilon^2)$
- Can show: in iid case, Joel, Hugo and Venky would measure

$$\hat{\mathbb{V}} = \mathbb{V} + \sigma_\varepsilon^2 > \mathbb{V}$$

$$\frac{\hat{\mathbb{V}}}{\hat{\sigma}_\mu^2} = \frac{\mathbb{V} + \sigma_\varepsilon^2}{\sigma_\mu^2 + \sigma_\varepsilon^2} > \frac{\mathbb{V}}{\sigma_\mu^2}$$

- Measurement error in k_{it} would have opposite effect
- How important can this be? From paper's Table 2:

	σ_μ
US	0.46
China	0.53
India	0.55

- **What if gap between σ_μ's due to measurement error?**

Comment 3: Measurement Error

	$\mathbb{V}$	$\frac{\mathbb{V}}{\sigma_\mu^2}$	$\frac{\mathbb{V}}{\sigma_{mrpk}^2}$	$a^* - a$
Case 2 ($\alpha = 0.62$)				
US	0.08	0.41	0.22	0.04
China	0.10 (0.16)	0.50 (0.63)	0.25 (0.34)	0.04 (0.07)
India	0.14 (0.22)	0.70 (0.77)	0.37 (0.48)	0.06 (0.10)
Case 1 ($\alpha = 0.83$)				
US	0.13	0.63	0.35	0.40
China	0.11 (0.18)	0.52 (0.65)	0.28 (0.39)	0.33 (0.55)
India	0.17 (0.26)	0.80 (0.86)	0.45 (0.56)	0.51 (0.77)

blue = "corrected" for measurement error, () = original numbers
Note: uses formula for $\hat{\mathbb{V}}$ from iid case, technically incorrect

Summary

- **Great paper!**
- **Potentially important role for informational frictions as source of misallocation, TFP losses**
- Comments/questions:
  1. how general is $\rho_{pk} \nearrow$ in $\mathbb{V}$?
  2. price correlations are just rescaled production-side variances. Doesn't solve all problems.
  3. measurement error?