

# Discussion of “The Intangible Gap”

by Xiaolan, Zhang, and Zhang

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# The Paper in One Slide

- **The Fact**

- Small U.S. public firms have become increasingly **intangible-intensive**.
- The H/K gap between small and large firms has **tripled since the 1980s**.

- **The Mechanism**

- Intangible quality risk + exit option  $\Rightarrow$  **convex payoff**.
- Employee equity financing  $\Rightarrow$  small firms can finance intangible investment.
- The option value is **strongest for small firms** near the exit margin, and is **amplified** by intangible financing capacity.

- **The Quantitative Answer**

- In the calibrated model, rising intangible-quality uncertainty  $\sigma_\omega$  explains approximately **60%** of the post-2000 widening in the small–large H/K gap.
- *Big picture: Intangible economy reallocates innovation risk toward small firms.*

# What I Like: Three Contributions

## 1. A New Cross-Sectional Fact about the Intangible Economy

- The rise of intangible capital is **not uniform across firms**.
- Small firms have become disproportionately more intangible-intensive than large firms.

## 2. A Useful Decomposition of Aggregate Intangible Deepening

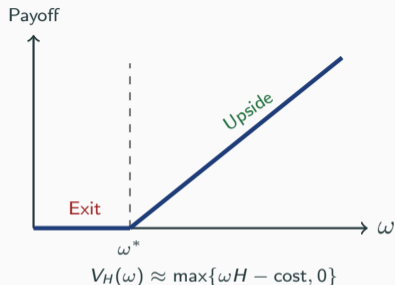
- The cumulant decomposition separates the role of the **typical firm** from the role of **cross-sectional dispersion**.
- The variance component  $\kappa_2$  becomes quantitatively important, suggesting that dispersion is central.

## 3. A New Mechanism: Uncertainty Can Encourage Intangible Investment

- **Standard real-options logic**: uncertainty delays investment.
- **This paper**: intangible quality risk + exit option creates a **convex payoff**.
- The mechanism links firm dynamics, financing frictions, and the allocation of innovation risk.

*Big picture: shifts the focus from aggregate intangible capital to who bears innovation risk.*

# Mechanism I: Intangible Investment as a Call Option



*Bad outcomes are truncated; good outcomes scale with  $\omega$ .*

## Key ingredients

### • Timing

- Invest in intangible capital first.
- Quality shock  $\omega$  realizes later.

### • Convex payoff

- Low  $\omega$ : firm exits and downside is truncated.
- High  $\omega$ : effective intangible capital scales up.

### • Small–large asymmetry

- Small firms are closer to the exit margin.
- Therefore, the abandonment option is more valuable.
- Large firms are farther from exit, so the option matters less.

Higher  $\sigma_\omega$  raises the option value of intangible investment, especially for small firms.

## Mechanism II: Financing Enables the Option

- **The tension**
  - Small firms value the intangible option most.
  - But they are also more financially constrained.
- **The financing channel**

$$d_t \geq -\theta h_t$$

- Intangible capital relaxes financing constraints.
- Financing is tied to **upside-sharing claims**: employee equity compensation; deferred wages; VC-type financing.
- **Euler-equation intuition**

$$MV_H = \underbrace{\omega\text{-scaled payoff}}_{\text{option upside}} + \underbrace{\lambda_{t+1}\theta}_{\text{financing benefit}} .$$

- The option channel creates the incentive.
- The financing channel gives constrained small firms the capacity to act on it.

**Takeaway:** financing does not create the option; it makes the option exercisable.

# Roadmap: Three Bridges to Build

- **Comment #1: From Fact to Behavior**

- Is the rising H/K gap a true *change in small-firm investment behavior*?
- Or is it partly driven by the changing *composition of small public firms*?

- **Comment #2: From Model Assumptions to Mechanism**

- The model assumes a powerful intangible-specific convex payoff.
- But this relies on key (assumed) asymmetries in quality risk, timing, exit, and waiting.
- Can these asymmetries be further microfounded or empirically disciplined?

- **Comment #3: From Prediction to Smoking-Gun Evidence**

- Does uncertainty *actually* raise intangible investment?
- Is the effect strongest for small firms near the exit margin?
- Do these firms exhibit the option-like payoff pattern: downside exit and upside skewness?

**Goal:** strengthen the chain from fact → mechanism → direct evidence.

# Comment #1: Composition vs. Behavior

A first question: has the identity of “small public firms” changed over time?

- **The public-firm universe has changed**
  - The number of listed firms declined substantially since the mid-1990s.
  - The IPO threshold became higher, especially after Sarbanes–Oxley Act (SOX, 2002).
  - Public firms became more selected toward high-growth, R&D-intensive businesses.
- **The meaning of “small firm” has changed**
  - **Earlier small public firms:**
    - regional manufacturers, retailers, service firms;
    - often more PPE-intensive.
  - **Recent small public firms:**
    - biotech, software, SaaS, AI, platform firms;
    - often asset-light by design, sometimes pre-revenue or pre-profit.
- **Why this matters?**
  - A rising small-firm H/K gap may reflect true changes in investment behavior.
  - But it may also reflect changing composition of which small firms become public.

## Comment #1: How to Strengthen the Fact?

The goal: separate true investment behavior from changing composition.

- **Control for industry composition**
  - Add industry  $\times$  year fixed effects
  - Ask whether the H/K gap survives *within* narrowly defined industries
- **Control for life-cycle composition**
  - Compare firms within industry  $\times$  age  $\times$  year cells
  - Separate young high-growth firms from mature small firms
- **Track comparable cohorts**
  - Follow IPO cohorts over time, e.g., firms listed in 1985–1990
  - Ask whether H/K widens within the same cohort as firms age

*If the gap survives within industry, cohort, and age cells, the behavioral interpretation becomes much stronger.*

# Comment #1 Supplement: Is H/K a Numerator or Denominator Story?

Even after addressing composition, the H/K ratio deserves a measurement check.

- **The concern**

- Small firms in biotech, software, SaaS, and AI are often asset-light by design.
- Their PPE stock  $K$  can be very small.
- A rising H/K ratio may partly reflect a shrinking or near-zero denominator.

- **Useful robustness checks**

- Report  $H/\text{assets}$ ,  $H/\text{sales}$ , and  $H/\text{employment}$ .
- Report  $I^H/\text{assets}$  and  $I^H/\text{employment}$ .
- Decompose the H/K gap into the contribution of  $H$  and the contribution of  $K$ .

**Takeaway:** the paper should show that the gap is not mechanically driven by small denominators.

## Comment #2: From Model to Identified Mechanism

My main concern: the model's key asymmetries are powerful, but close to assumptions.

- **Asymmetry #1: Intangible vs. physical capital**

- The exit option truncates downside for firms in general.
- But the model assigns the multiplicative quality shock only to intangible capital:

$$h_t = \omega_t \tilde{h}_t, \quad k_{t+1} = (1 - \delta_k)k_t + i_{k,t}.$$

- The question is whether the convex payoff is truly *intangible-specific*.
- **Asymmetry #2: Abandonment option vs. waiting option**
  - The quality shock is realized *after* investment.
  - Waiting therefore does not reveal information about future quality.
  - The model emphasizes the option to abandon, while shutting down the option to wait.
- **What would strengthen the mechanism?**
  - A microfoundation for why these asymmetries are natural for intangible capital.
  - Smoking-gun evidence showing that the mechanism is strongest where these assumptions are most plausible.

Move from an assumed convex payoff to an identified intangible-specific mechanism.

## Comment #2a: Is Convexity Truly Intangible-Specific?

The exit option alone is not enough.

- **Why this is a concern**
  - Firms can also abandon physical-capital projects.
  - Machines become obsolete; plants become stranded; real estate values collapse.
  - Large firms can also shut down projects without exiting the firm.
- **What makes the model work**
  - The multiplicative quality shock is assigned to  $H$ , not  $K$ .
  - Therefore, the key mechanism is not simply:
    - “exit option makes risky investment attractive.”
  - It is instead:
    - “exit option + **intangible-specific quality risk** makes  $H$  attractive.”
- **What would justify the asymmetry?**
  - Intangible capital has more right-skewed, scalable, and hard-to-predict payoffs.
  - Physical capital has more verifiable quality, resale value, and collateral value.
  - Small firms' intangible projects are closer to *firm-level bets*.

## Comment #2a: Is Convexity Truly Intangible-Specific?

- **Constructive tests**

- Show stronger effects in young, single-segment, R&D-intensive firms.
- Show weaker effects in physical-capital-intensive industries.
- Test whether intangible-intensive small firms have more right-skewed future growth and exit outcomes.
- Add a robustness exercise with a physical-capital quality shock and show the mechanism remains *H*-specific.

Takeaway: the paper should show that the convex payoff is a feature of intangible capital, not just an assumption placed on it.

## Comment #2b: Why Does Uncertainty Not Delay Investment?

The sign flip depends on a timing assumption.

- **Timing in the model**

- The firm invests first.
- The intangible quality shock  $\omega$  realizes later.
- Waiting does not reveal information about future intangible quality.
- This is why higher  $\sigma_\omega$  raises intangible investment rather than delaying it.

- **Implication**

- Uncertainty raises the value of the *abandonment option*.
- But the standard *option to wait* is largely shut down.
- This is why higher  $\sigma_\omega$  raises intangible investment rather than delaying it.

## Bridge #2b: Why Does Uncertainty Not Delay Investment?

The sign flip depends on a timing assumption.

- **Why this needs justification**

- Many intangible investments are staged:
  - biotech: Phase I → Phase II → Phase III;
  - software: MVP → beta → scale;
  - AI: small experiments → large training runs.
- In these settings, firms may learn before fully committing.
- Then uncertainty could raise the value of pilots and delay, not just the value of exit.

- **Constructive way forward**

- Interpret  $\omega$  as *experimentation risk*, not learnable uncertainty.
- Add a noisy pre-investment signal about  $\omega$ .
- Show the positive effect survives when signals are noisy or delay costs are high.
- Empirically test whether ex ante signals poorly predict ex post intangible success.

**Takeaway:** the paper should justify why intangible uncertainty is revealed by investing, rather than resolved by waiting.

## Comment #3a: Directly Test the Sign Flip

The cleanest test: does uncertainty raise intangible investment for firms near exit?

Testable prediction

$$I_{it}^H = \beta (\text{IntangUncert}_{jt} \times \text{ExitRisk}_{it} \times \text{Small}_{it}) + \text{controls} + \text{FE} + \varepsilon_{it}.$$

- **Prediction**

- $\beta > 0$ : uncertainty raises intangible investment.
- The effect should be strongest for small firms with high exit risk.
- The same effect should be weaker or absent for physical investment  $I^K$ .

This distinguishes the mechanism from a generic high- $q$  investment story.

## Bridge #3b: Test the Option-Like Payoff

- **Downside prediction**
  - Bad intangible realizations should be followed by exit, delisting, bankruptcy, or distressed acquisition.
  - This downside-exit sensitivity should be strongest for small, high-H/K firms.
- **Upside prediction**
  - Conditional on survival, intangible-intensive small firms should have larger upside.
- **Skewness prediction**
  - Future growth should be more right-skewed for small, intangible-intensive firms.
  - The skewness should increase with intangible uncertainty.
  - The effect should be strongest near the exit margin.
- **Why this is close to a smoking gun**
  - Higher H/K can come from many forces.
  - But “downside exit + upside skewness” is specific to the option mechanism.

## Additional Comment: How Disciplined Is the 60% Number?

The headline quantitative result is important, but should be interpreted carefully.

- **How is  $\sigma_\omega$  disciplined?**

- The calibration uses patent-value dispersion.
- But  $\omega$  in the model captures broader intangible quality risk:
  - R&D, organizational capital, human capital, software, brand, and business models.
- Patent values may also reflect discount rates, market sentiment, or market power.

- **Sensitivity and external validation**

- How sensitive is the 60% result to  $\theta$ ,  $\sigma_\omega$ , depreciation rates, SG&A capitalization, and adjustment costs?
- Can the model match untargeted moments?
  - Exit rates by H/K and size.
  - Future growth skewness.
  - Employee equity by firm size.
  - Survival and M&A outcomes conditional on intangible intensity.

**This paper speaks to a broader question:**

*How intangible economy reorganizes investment, risk-taking, and value creation across firms?*

- **Existing literature: the rise of intangible capital**
  - Aggregate intangible deepening, market power, and Tobin's  $q$
  - Cash holdings, debt capacity, and collateral constraints
  - Human capitalists, equity compensation, and innovation finance
  - Heterogeneous innovation and firm dynamics
- **This paper: the allocation of intangible risk**
  - The intangible economy is not only about a higher aggregate  $H/K$ .
  - It is about a widening cross-sectional gap in who invests in  $H$ .
  - Small firms appear to bear a disproportionate share of risky intangible experimentation.
- **Broader implication**
  - Small firms experiment, fail, survive, or get acquired.
  - Large firms may scale, acquire, and monetize successful intangible assets.
  - Workers and investors share upside and downside through equity-based claims.

# A Broader Channel: Small Firms Experiment, Large Firms Acquire?

An intriguing fact in the paper:

- **Accumulated intangible investment**
  - Small firms have much higher and faster-growing H/K.
  - This suggests small firms are doing more risky intangible experimentation.
- **Balance-sheet intangible assets**
  - The same small-firm pattern is much weaker.
  - Large firms may accumulate recorded intangibles through acquisitions.
- **A richer interpretation**
  - Small firms produce and test intangible assets.
  - Large firms acquire, integrate, and scale successful intangible assets.
  - The intangible gap may therefore reflect an innovation division of labor.

Question: are large firms investing less in intangibles, or investing through the M&A market?

**This is a very promising paper.**

- ✓ **A new fact:** the intangible economy is increasingly heterogeneous across firms.
- ✓ **A mechanism:** intangible risk, exit, and firm size create option-like investment incentives.
- ✓ **A quantitative framework:** the model speaks to the magnitude of the H/K gap.

**My main suggestion: make the mechanism more directly identified.**

- Separate behavior from composition and measurement.
- Further justify the intangible-specific convex payoff.
- Provide smoking-gun evidence for the sign flip and option-like payoffs.

*If these steps are taken, the paper can become a reference point for **intangible heterogeneity** and the allocation of innovation risk.*