Rising Intangible Capital and the Disappearance of Public Firms

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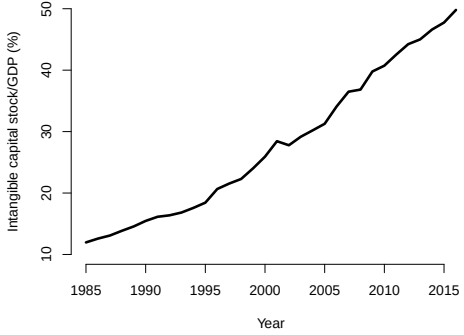
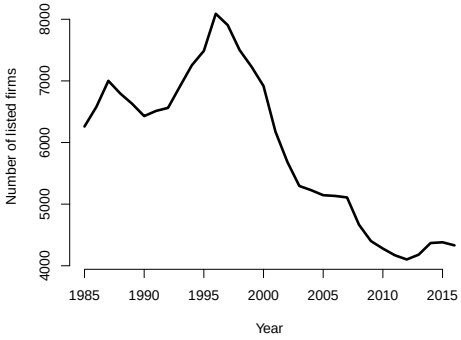
Motivating fact I

- The growth rate of intangibles outweighs the growth of GDP.
- The number of listed firms has decreased by half since 1996.

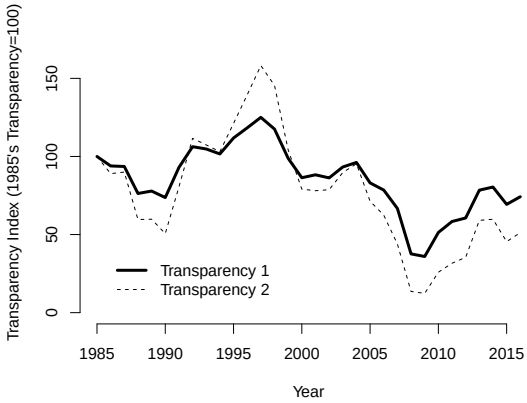
$\Longrightarrow$ Any relationships? What are the *macroeconomic consequences*?





Motivating fact II

- The inverse forecast errors (transparency) have significantly decreased since 1996.



Research question

1. What *drives* the disappearing listed firms in the U.S.?
2. What is the *macroeconomic impact* of the change?

This paper

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What this paper does

1. Develops an *analytic GE theory* of firm-level financing decision: **Go public vs. private**
2. *Quantitatively* decomposes the driving forces and analyzes the macroeconomic consequences.
3. Analyzes the **optimal regulation** of financial disclosure.

Why intangibles?

- Intangible share has been rising rapidly.
- Intangibles are subject to spillover (Haskel and Westlake, 2017).
  - One's intangibles are everybody's intangibles.
  - Examples:
    - Ongoing investment project.
    - Wasted investment project.
    - Cost structure.
    - Ownership structure.
- Evidence on the spillover externality:
  - Bushee and Leuz. (2005): Disclosing firms' stock prices $\downarrow$ and peer firms' stock price $\uparrow$
  - Badertscher et al. (2013), Shroff et al. (2017): Peer information $\rightarrow$ User cost of capital $\downarrow$.

What kind of disclosure is mandated?

The former chair of SEC, Mary Jo White, said
(at National Association of Corporate Directors – Leadership Conference 2013 in National Harbor, Md.):

"*Today, companies are required to disclose*:

- How they operate their business now and how they intend to do so in the future, and in some cases, how they did it before.
- How much money they made over the last few years, as well as in the current year, and how that might change in the future.
- Specific details about large shareholders.
- The money they have borrowed, repaid, will borrow and will repay.
- A description of the background and experience of the officers and directors of the company, how much they are paid, and why."

Example: Apple

"Apple acquired Siri, a firm with voice recognition technology (2010)."

"Apple acquired Authentec, a firm with a Touch-ID technology (2012)."

This news immediately went viral among commentators, leading to competitors' (Samsung) response.

- What would have happened if Apple had not been a listed firm?
- When Google was private, they said: (From Ewens and Farre-Mensa (2022))

  "*As a smaller private company, Google kept business information closely held, and we believe this helped us against competitors.*" The letter continued: "*As a public company, we will of course provide you with all information required by law. . . . But we will not unnecessarily disclose all of our strengths, strategies and intentions.*"

What's the role of policy?

- The mandated disclosure affects the *firm-level* incentive to be listed.
- At the *macro level*, this affects
  - household's portfolio decision: welfare
  - the quality and quantity of the total shared knowledge: productivity
- The SEC's goal:

  "The mission of the SEC is *to protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation.*"

  Protecting investors vs. *Facilitating capital formation*
- Public firms are subject to many mandatory disclosure requirements.
- U.S. private firms can be informationally opaque.

Related papers

- **Rising intangible capital**: Atkeson and Kehoe (2005), McGrattan and Prescott (2010), Eisfeldt and Papanikolaou (2014), Peters and Taylor (2017), McGrattan (2020), De Ridder (2021), Chiavari and Goraya (2022), Falato et al. (2022)
- **Disappearing listed firms**: Gao, Ritter, and Zhu (2013), Doidge, Karolyi, and Stulz (2017), Ewens and Farre-Mensa (2020)
- **Cost and benefit of financial disclosure**: Admati and Pfleiderer (2000), Bhattacharya and Ritter (1983), Bushee and Leuz (2005), Badertscher, Shroff, and White (2013), Dambra, Casares Field, and Gustafson (2015), Minnis and Shroff (2017)

This paper

- provides a unified framework to analyze the relationships among *intangibles*, endogenous choice of *going public*, and *information disclosure*.
- quantifies the macroeconomic consequences.

+) On the model side, our paper resembles Burdett and Mortensen (1998): endogenous demand and supply form an equilibrium distribution.

Empirical analysis

Measurement of intangibles

- The firm-level data is the U.S. Compustat.
- Following Corrado, Hulten, and Sichel (2009), we use the perpetual inventory method.

$$
\begin{aligned}
Knowledge_{it} &= (1-\delta^{G})Knowledge_{it-1} + R\&D_{it} \\
Organizational_{it} &= (1-\delta^{O})Organizational_{it-1} + \gamma^{O} SG\&A_{it} \\
Acquired_{it} &= Acquired_{it-1} + netIntan_{it}
\end{aligned}
$$

  - $\delta^{G} = \delta^{O} = 0.15$ (Corrado, Hulten and Sichel), $\gamma^{O} = 0.20$ (Falato, et al., 2022)
  - All deflated by the IPP deflators (base year = 2012).

Then, we obtain the intangible capital stock:

$$
Intangible_{it} = Knowledge_{it} + Organizational_{it} + Acquired_{it}
$$

Measurement of transparency

- Data on analysts' forecasts: the Institutional Brokers' Estimate System (I/B/E/S).
- Following Dellavigna and Pollet (2009), we calculate the *earnings surprise* (forecast error):

$$ES_{i,j,t} := \frac{\epsilon_{i,j,t} - e_{i,t}}{P_{i,t}}$$

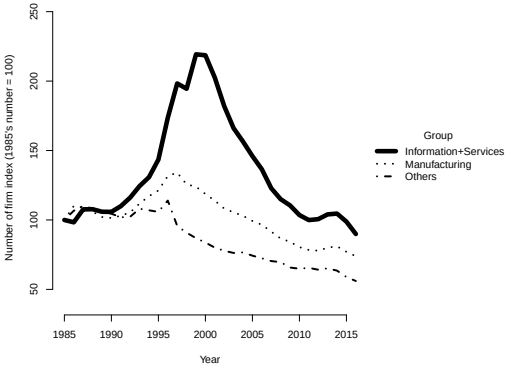
  - t is the indicator of a quarter; i and j are firm and analyst indicators, respectively;
  - $e_{t,i}$: Firm i's announced actual earnings per share
  - $\epsilon_{i,j,t}$: Firm i's the earnings forecast per share
  - $P_{i,t}$ is the stock price.

- We define *transparency* measures:

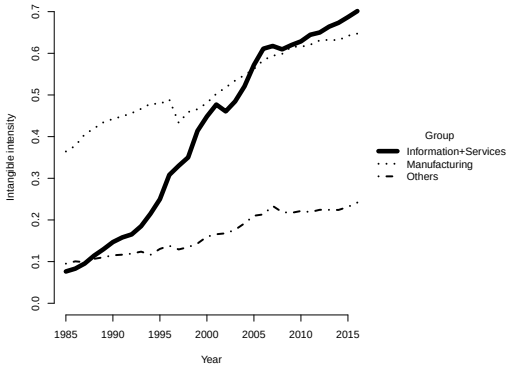
$$Transparency^1_{i,t} := \frac{1}{median(|ES_{i,j,t}|)}$$

$$Transparency^2_{i,t} := \frac{1}{var(ES_{i,j,t})}$$

- The declining trend in the number of listed firms is starker in "*intangible-intense*" industries.



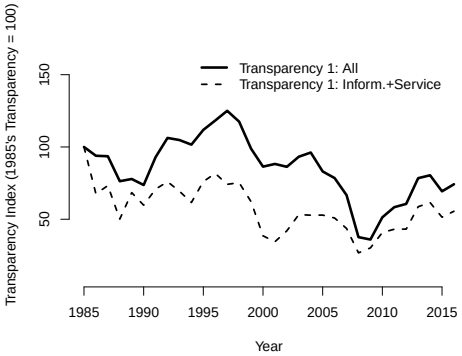
(a) Number of listed firms



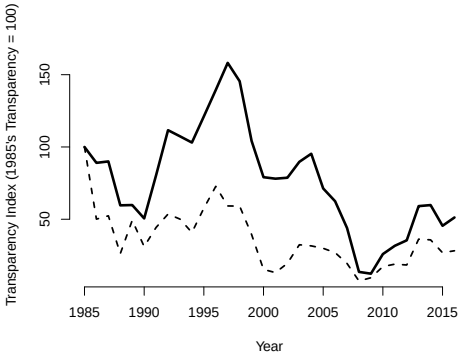
(b) Intangibles intensity

Industry-level analysis: transparency

- The trend of declining transparency is in all industries.
- In the long run, "*intangible-intense*" industries have shown a greater decline in transparency.
- In recent years, other industries, including manufacturing, has shown a sharp decline in transparency.



(a) Transparency 1



(b) Transparency 2

- The regression of forecast error measures on the intangible capital.

$$Transparency_{it} = \beta Intangible_{it} + Controls + FE + \epsilon_{it}$$

- The greater intangible a firm holds, the greater the forecast error is.

	Dependent Variables:	
	Transparency 1	Transparency 2
$Intangible_{it}$	-0.31	-0.303
	(0.049)	(0.096)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
Two-way cluster	Yes	Yes
Observations	256,962	256,962
R^2	0.275	0.289

Table: Cross-sectional relationship between the forecast error and intangibles

Model

Overview of the model economy

Household

A representative household holds an equity portfolio and consumes.

Firms

Measure one of ex-ante homogeneous firms decides whether to go public or private

Public firms determine the level of transparency for the disclosure

High transparency gets better financing from the household

General equilibrium

Disclosed intangible is aggregated as an externality

Investment demand and supply determine the price of firms

- The household is risk-averse, and the utility takes the following CARA form:

$$u(C) = -e^{-\Lambda C}$$

where $\Lambda > 0$ is the absolute risk aversion parameter.

- The household solves the following portfolio choice problem:

$$\max_{x(q), x^N} \quad \mathbb{E}(-e^{-\Lambda C})$$

$$\text{s.t. } C = \int x(\tilde{q})\tilde{r}(\tilde{q})d\tilde{q} + x^N\tilde{r}^N, \quad \int x(\tilde{q})d\tilde{q} + x^N = a$$

  - $x(q)$: the funding supply for firms with transparency level q.
  - x^N: the funding supply for non-listed firms.
  - a: the household's wealth.

- In the listed market, the household forms a belief on the return $\widetilde{r}(q)$ of a firm with transparency level q as follows:

$$\widetilde{r}(q) \sim_{iid} N\left(\overline{r}(q), \frac{1}{\xi + \psi(\overline{q} + q)}\right), \quad \overline{r}(q) = \frac{\pi(q)}{P(q)}$$

  where $q \geq 0$ is a transparency level; $\overline{q}$ is the *mandated transparency*; $\pi(q)$ is the profit of the firm with transparency q; $P(q)$ is the price of the firm with transparency q.

- Similarly, in the non-listed market,

$$\widetilde{r}^N \sim_{iid} N(\overline{r}^N, 1/\xi), \quad \overline{r}^N = \frac{\pi^N}{P^N}$$

- The framework naturally maps into the earnings forecast and surprise.

Technology: production function

- A continuum of measure one of homogeneous firms are considered.
- Two sub-periods: morning and night
  - Morning: choice of where to operate and the transparency level q
  - Night: choice of input levels
- Listed market with transparency q:

$$\pi(q) := \max_{k_T, k_I} \quad z k_T^{\alpha} (k_I (1 - \overline{q} - q))^{\theta} (\Phi^{ex})^{\gamma} - r k_T - p k_I$$

  - $q \in [0, 1 - \overline{q}]$ is a transparency level; $\overline{q}$ is the *mandated transparency* for the listed firms.
  - Φ^{ex} is the shared knowledge: the aggregate productivity z shifter.
- Non-listed market:

$$\pi^N := \max_{k_T, k_I} \quad z k_T^{\alpha} (k_I)^{\theta} (\Phi^{ex})^{\gamma} - r k_T - p k_I$$

- A possible heterogeneity in z: later, we show it does not matter in our framework.

The shared knowledge comes from:

$$\Phi^{ex} = \int_0^1 \mathbf{1}_{\{i \in \text{Listed}\}} \times k_{I,i} \left(\underbrace{\overline{q}}_{\text{Disclosure mandated by regulator}} + \underbrace{q_i}_{\text{Voluntary disclosure}} \right) di$$

The shared knowledge is deducted from the owned knowledge:

- The knowledge is symmetrically shared (no double counting).

Extensive margin decision

A financial market determines the values of the listed firm $P(q)$ and non-listed firm P^N given

- the household's preference over q
- the total funding demand: $\mathcal{M}$, the unnormalized probability density of listed firms over q.

$$P(q) = P(q, \pi(q); \mathcal{M})$$
$$P^N = P^N(\pi^N; \mathcal{M})$$

A firm (manager) chooses where to operate to maximize the firm's price (=value):

$$\max\{\max_{q \in [0, 1-\overline{q}]} P(q), P^N\}.$$

Two decision layers: 1) going public vs. private; 2) how much to reveal

The funding market is cleared in terms of ***the number (mass) of firms*** financed:

$$\text{[Listed market]}: \quad \underbrace{\frac{x^*(q)}{P(q)}}_{\textit{Supply}} = \underbrace{\mathcal{M}(q)}_{\textit{Demand}}$$

$$\text{[Non-listed market]}: \quad \frac{1}{\nu_N}\frac{x^{N*}}{P^N} = M_N$$

where $\nu_N > 1$ captures the ***congestion effect*** in the non-listed financial market.

Definition 1

A collection of functions $(k_T, k_I, q, \mathcal{M}, M_N, p, P, P^N, x^*, x^{N*}, \Phi^{ex})$ is an equilibrium if

1. $\left(x^*, x^{N*}\right)$ solves the household's problem.
2. $(k_T(q, \mathcal{M}), k_I(q, \mathcal{M}), q(\mathcal{M}))$ solves the listed firm's problem.
3. The measure of listed firms choosing a transparency level q is consistent with $\mathcal{M}(q)$ for all $q \in [0, 1 - \overline{q}]$.
4. The measure of non-listed firms is M_N and satisfies $\int_0^{1-\overline{q}} \mathcal{M}(q)dq + M_N = 1$.
5. R&D cost of intangible capital p is determined by the following equation: $K^I = \int_0^1 k_{I,i}di$.
6. Aggregate shared knowledge satisfies $\Phi^{ex} = \int_0^1 1_{\{i \in \text{Listed}\}} \times k_{I,i}(\overline{q} + q_i)di$.
7. Financial market is cleared:
$$\frac{x^*(q)}{P(q)} = \mathcal{M}(q) \quad \text{and} \quad \frac{1}{\nu_N}\frac{x^{N*}}{P^N} = M_N$$
8. Indifference in the extensive-margin decision: $P(q) = P^N$, for $\forall q \in [0, 1 - \overline{q}]$.

Equilibrium analysis

- Recall the household's maximization problem:

$$\max_{x(q),x^N} \quad \mathbb{E}(-e^{-\Lambda C})$$

$$\text{s.t. } C = \int x(\tilde{q})\tilde{r}(\tilde{q})d\tilde{q} + x^N\tilde{r}^N, \quad \int x(\tilde{q})d\tilde{q} + x^N = a$$

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- Using the CARA utility and the normally distributed returns, we obtain

$$\max_{\int x(\tilde{q})d\tilde{q}+x^N=a} \quad \int x(\tilde{q})\frac{\pi(\tilde{q})}{P(\tilde{q})}d\tilde{q} + x^N\frac{\pi^N}{P^N} - \frac{\Lambda}{2}\int x(\tilde{q})^2(\overline{q}+q)^{-\chi}d\tilde{q} - \frac{\Lambda}{2}(x^N)^2\frac{1}{\xi}$$

which is a mean-variance portfolio problem. Then, from the FOC,

$$\frac{\pi(q)}{P(q)} - \Lambda x^*(q)\frac{1}{\xi+\psi(\overline{q}+q)} - \mu = 0 \implies x^*(q) = \frac{\pi(q)/P(q)-\mu}{\Lambda/(\xi+\psi(\overline{q}+q))}.$$

Similarly, $x^{N*} = \frac{\pi^N/P^N-\mu}{\Lambda/\xi}$. We assume $\mu = 0$.

From the market clearing condition, we have

$$P(q) = \frac{x^*(q)}{\mathcal{M}(q)} = \frac{\pi(q)/P(q)}{\mathcal{M}(q)\Lambda/(\xi + \psi(\overline{q} + q))} \quad \textit{and} \quad P^N = \frac{\pi^N/P^N}{\nu_N M_N \Lambda/\xi}$$

where ν_N is the *PE market friction (efficiency) parameter.*
Then,

$$P(q) = \sqrt{\frac{\pi(q)}{\Lambda \frac{\mathcal{M}(q)}{\xi + \psi(\overline{q}+q)}}} \quad \textit{and} \quad P^N = \sqrt{\frac{\pi^N}{\Lambda \frac{\nu_N M_N}{\xi}}}$$

- Both prices increase in the profit and decrease in the return variance.
- The non-listed price decreases in the frictional parameter.

Each public firm chooses transparency level q to maximize the price of the firm:

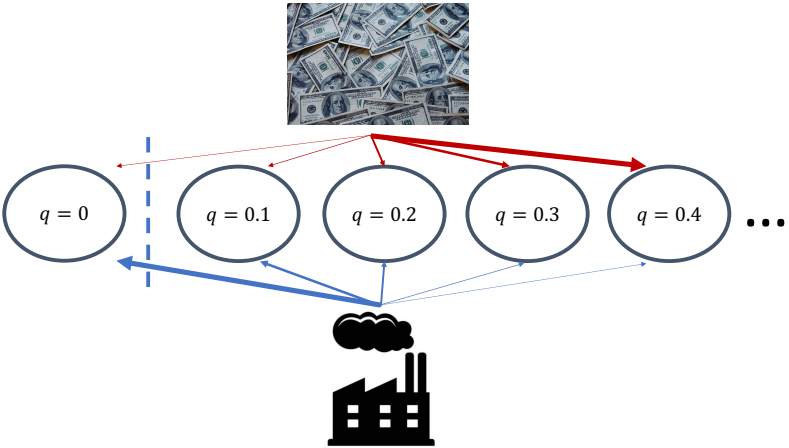
[**Listed market**] $$\max_{q \in [0,1-\overline{q}]} P(q) \iff \max_{q \in [0,1-\overline{q}]} \pi(q) \underbrace{(\xi + \psi(\overline{q}+q))/\mathcal{M}(q)}_{\text{Net Funding Intensity } \phi^L(q)}$$

[**Private equity market**] $$\pi^N \left(\underbrace{\xi \ / \ (\nu_N M_N)}_{\text{Net Funding Intensity } \phi^N} \right)$$

Trade-off:

- [**Funding supply**]: Higher transparency q increases funding intensity $\rightarrow$ **higher valuation**
- [**Funding demand**]: Higher transparency q increases a firm's shared intangible $\rightarrow$ **lower profits**

Simple illustration



- Equilibrium effect:
  - Firms understand the funding supply condition (household's preference).
  - Household understands the profit difference depending on q.

Summary

To summarize the key components that pin down the equilibrium,

$$\text{[Entry decision]} \quad V(\mathcal{M}, M_N) = \max\{J^L(\mathcal{M}), J^N(M_N)\}$$

$$\text{[Listed firm's problem]} \quad J^L(\mathcal{M}) = \max_{q} \max_{k_T, k_I} \left(z k_T^{\alpha} (k_I (1 - \overline{q} - q))^{\theta} (\Phi^{ex})^{\gamma} - r k_T - p k_I \right) \phi^L(q)$$
$$\text{s.t. } \phi^L(q) = (\overline{q} + q)^{\chi} / \mathcal{M}(q)$$

$$\text{[Non-listed firm's problem]} \quad J^N(M_N) = \max_{k_T, k_I} \left(z k_T^{\alpha} (k_I)^{\theta} (\Phi^{ex})^{\gamma} - r k_T - p k_I \right) \phi^N$$
$$\text{s.t. } \phi^N = \xi / M_N^{\iota_N}$$

And we focus on the equilibrium where $P(q) = P_N$ for $\forall q$: 2 Indifference conditions holds.

(1) Public firms become **indifferent among different q levels**.

(2) Firms become **indifferent between going public or private**.

Proposition 1

(Intangibles and the transparency)
Given $\alpha + \theta < 1$, $k^I(q, \mathcal{M}; \overline{q})$ decreases in both q and $\overline{q}$.

- From the first-order condition, we get

$$k_I = \left(\left(\frac{\alpha z (\Phi^{ex})^{\gamma}}{r} \right)^{\frac{1}{1-\alpha-\theta}} \left(\frac{r\theta}{p\alpha} \right)^{\frac{1-\alpha}{1-\alpha-\theta}} \right) (1 - \overline{q} - q)^{\frac{\theta}{1-\alpha-\theta}} = A(1 - \overline{q} - q)^{\frac{\theta}{1-\alpha-\theta}},$$

  where $A := \left(\left(\frac{\alpha z (\Phi^{ex})^{\gamma}}{r} \right)^{\frac{1}{1-\alpha-\theta}} \left(\frac{r\theta}{p\alpha} \right)^{\frac{1-\alpha}{1-\alpha-\theta}} \right)$.
  As $\alpha + \theta < 1$, the proposition is immediate from the last equation.

- **An *empirically supported* setup**: the cross-sectional evidence.

Proposition 2 (Intangible share and the transparency)

Given $\alpha + \theta < 1$, the sensitivity of $k^I(q, \overline{q}, \theta)$ to the changes in q and $\overline{q}$ increases in θ.

- We can show that

$$\begin{aligned}\frac{\partial}{\partial\theta}\left|\frac{\partial}{\partial q} log(K_I)\right| &= \frac{\partial}{\partial\theta}\left|\frac{\partial}{\partial q}\left(\frac{\theta}{1-\alpha-\theta}\right) log(1-q-\overline{q})\right| \\ &= \frac{\partial}{\partial\theta}\left(-1+\frac{1-\alpha}{1-\alpha-\theta}\right)\frac{1}{1-q-\overline{q}} \\ &= \frac{1-\alpha}{(1-\alpha-\theta)^2}\frac{1}{1-q-\overline{q}} > 0\end{aligned}$$

- If θ increases, the negative association between k^I and q becomes stronger.
- Given the fixed intangible capital stock, a greater θ is associated with a stronger incentive to conceal the information (lower q).

Proposition 3 (Transparency distribution)

The probability density function $\mathcal{M}$ of transparency q has the following closed form:

$$\mathcal{M}(q) = (\xi + \psi(\overline{q} + q))(1 - \overline{q} - q)^{\frac{\theta}{1-\alpha-\theta}} \frac{1}{\phi^N}.$$

- **The endogenous distribution supports the *indifference* condition among public firms.**
- $\xi + \psi(\overline{q} + q)$: Willingness to invest (supply side)
- $(1 - \overline{q} - q)^{\frac{\theta}{1-\alpha-\theta}}$: Costly knowledge sharing (demand side)
- $1/\phi^N$: Private equity market efficiency (equilibrium scaling object)
- We show this is actually a translated version of the *Beta distribution*.
  - The endogenous distribution has the analytic form: $q + \overline{q} \sim \frac{\mathbb{I}\{q \in [0, 1-\overline{q}]\}}{1 - M_N} \times \textit{Beta}\left(\frac{1-\alpha}{1-\alpha-\theta}, 2\right)$
- The distribution is ***independent*** of Φ, p and z.

The equilibrium mass of private firms is determined from the following characteristic eq.:

$$\psi \frac{\nu_N}{\xi} M_N \int_0^{1-\overline{q}} \left(\frac{\xi}{\psi} + (\overline{q} + q) \right) (1 - \overline{q} - q)^B dq = 1 - M_N$$

where $B = \frac{\theta}{1-\alpha-\theta}$.

- The equation is from the total mass condition: $\int M(q) di = 1 - M_N$
- The equation is *completely isolated* from Φ and p.
- By replacing $y := q + \overline{q}$, we can reshape it using the *Beta function*, $\mathcal{B}(B+1, 2)$:

$$M_N = \frac{1}{1 + \psi \frac{\nu_N}{\xi} (1 + \frac{\xi}{\psi})^{B+2} \mathcal{B}(B+1, 2) F\left(\frac{1-\overline{q}}{1+\xi}; B+1, 2 \right)}$$

where F is the CDF of Beta distribution; $\mathcal{B}$ is the beta function.

Proposition 4 (The number of listed firms and mandated transparency)

M_N strictly increases in $\overline{q} \in [0, 1]$.

Summary of the theory prediction

The theory predicts that

- The intangible demand is negatively correlated with "*transparency + regulation intensity*."
- The negative correlation becomes stronger when the intangible becomes more important.
- The number of listed firms decline in "*regulation intensity*."

On the other hand,

- "*regulation intensity*" improves listed firms' transparency.

Extensive margin ***vs.*** Intensive margin

Quantitative analysis

Structural parameters

We are interested in

$$\{\overline{q}, \theta, \xi, \psi, \nu_N\}$$

- $\overline{q}$: Mandated transparency
- θ: Intangible share
- ξ: Baseline information level
- ψ: Transparency's contribution to listed firms information
- ν_N: PE market friction

We estimate these parameters using SMM for 2 separate periods:

- Baseline: 1992 - 1996
- Post-change: 2012 - 2016

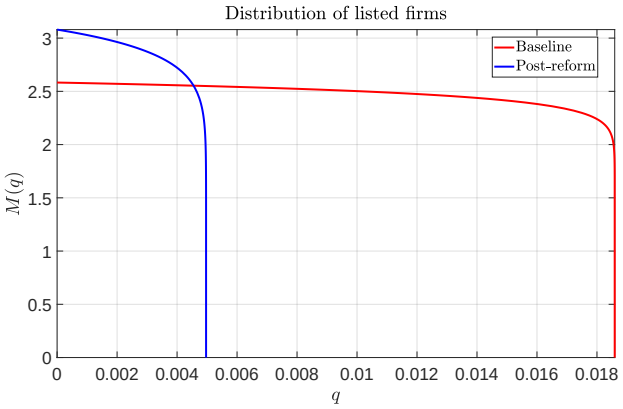
Simulated method of moments: exact identification

Moments	Data	Model	Reference
Baseline (1992 $\sim$ 1996)			
Fraction of listed after M&A adj. (%)	11.08	11.08	Compustat & BDS
(*cf. without M&A adj. (%)*)	(8.30)		
Intangible Exp./Sale (%)	2.906	2.906	Compustat
Average $sd(\widetilde{r})$ (%)	12.53	12.53	Compustat
Average $sd(\widetilde{r})$ of top 1% (%)	25.52	25.52	Compustat
Portion of funded non-listed firms (%)	30.30	30.00	Ewens and Farre-Mensa (2020)
Post-change periods (2012 $\sim$ 2016)			
Fraction of listed after M&A adj. (%)	7.60	7.60	Compustat & BDS
(*cf. without M&A adj. (%)*)	(4.01)		
Intangible Exp./Sale (%)	5.356	5.356	Compustat
Average $sd(\widetilde{r})$ (%)	28.00	28.00	Compustat
Average $sd(\widetilde{r})$ of top 1% (%)	84.81	84.81	Compustat
Portion of funded non-listed firms (%)	34.30	34.00	Ewens and Farre-Mensa (2020)

Estimated parameters

Parameters	Description	Value
Baseline (1992 $\sim$ 1996)		
$\overline{q}$	Mandated transparency	0.981
θ	Intangible share	0.029
ξ	Baseline information level	25.520
ψ	Transparency's contribution to listed firms information	38.539
ν_N	PE market friction	3.300
Post-change periods (2012 $\sim$ 2016)		
$\overline{q}$	Mandated transparency	0.995
θ	Intangible share	0.054
ξ	Baseline information level	1.390
ψ	Transparency's contribution to listed firms information	11.394
ν_N	PE market friction	2.915

- The estimated transparency distribution has *shifted towards left* and *shrank* (less mass).
  - Consistent with the macro facts: less transparency and public listed firms.



Welfare

$$\begin{aligned} \textit{Welfare} &= \int x(\widetilde{q})\frac{\pi(\widetilde{q})}{p(\widetilde{q})}d\widetilde{q} + x^N\frac{\pi^N}{P^N} - \frac{\Lambda}{2}\int x(\widetilde{q})^2\frac{1}{\xi+\psi(\overline{q}+q)}d\widetilde{q} - \frac{\Lambda}{2}(x^N)^2\frac{1}{\xi} \\ &= \frac{1}{2}\int \mathcal{M}(\widetilde{q})\pi(\widetilde{q})d\widetilde{q} + \frac{\nu_N}{2}M^N\pi^N. \end{aligned}$$

Productivity (externality)

$$\textit{Productivity} = (\Phi^{ex})^\gamma = \left(\int_0^{1-\overline{q}}(\overline{q}+q)k_I(q,\mathcal{M};\overline{q})\mathcal{M}(q)dq\right)^\gamma$$

Output

$$\textit{Output} = \int_0^{1-\overline{q}} zk_T(q)^\alpha(k_I(q)(1-\overline{q}-q))^\theta(\Phi^{ex})^\gamma M(q) + zk_{DT}^\alpha k_{DI}^\theta(\Phi^{ex})^\gamma M_N$$

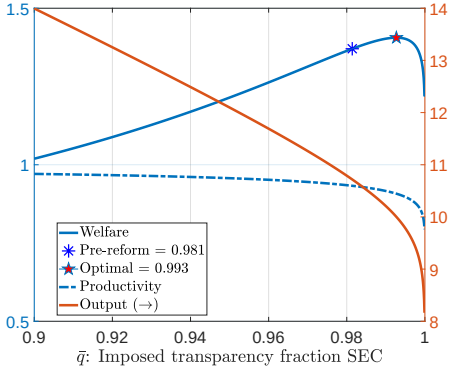
- The ***sluggish productivity growths*** in the U.S. and U.K. are partly accounted for by these changes. (-1.5%, annually)

Table: Decomposition of the channels in the post-change changes

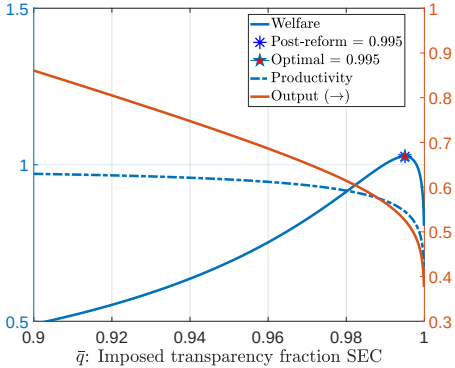
		Contribution to the change:			
Param.	Channel	#listed	transparency	productivity	welfare
	Total change (p.a.)	-1.88	-8.04	-0.42	-1.42
$\overline{q}$	SEC regulation (p.a.)	-6.22	0.03	-0.25	0.20
θ	Raising intangible share (p.a.)	-0.89	0.00	-0.37	-0.80
ξ	Baseline information level (p.a.)	8.62	-3.85	0.34	-0.92
ψ	Harder to forecast public firms (p.a.)	-3.72	-4.22	-0.16	0.16
ν_N	PE market friction (p.a.)	-0.56	0.00	-0.02	-0.59

Optimal policy

- The disclosure policy leads to the *inverted-U* shaped macro targets. (Laffer-type tax on knowledge?)
- A policy maker's **dilemma** between maximizing productivity and welfare.



(a) Baseline



(b) Post change

Concluding remarks

Concluding remarks

- **Rising intangible capital substantially contributed to the two trends:**
  - disappearing public firms.
  - declining average transparency.
- **These changes led to a drop in productivity and welfare.**
- **The macroeconomic outcomes nonlinearly respond to the disclosure policy:**
  - inverted U-shaped welfare and output.
  - policy maker's dilemma between productivity and welfare.
  - the recent policy changes have been welfare-improving at the cost of productivity.

APPENDIX

Fixed parameters

Table: Fixed parameters

Parameters	Description	Value
α	Capital share	$0.30 - \theta$
γ	Public intangible share	$= \theta$
r	Rental rate tangible capital plus depreciation	0.10
K^I	Total intangible supply	1
z	TFP level	1