Intangible Capital

Andrea L. Eisfeldt

UCLA Anderson and NBER

SFS Cavalcade 2022
Outline

- Motivation
- Measurement of Intangibles
- A Model of Intangibles
- Implications for Finance
Motivation
The Growing Importance of Intangibles

- Emphasis on *new economy, corporate culture, logistics, data*
  ...more intangible assets now?

- Or have there been changes in storage and scope of intangibles?
  
  1. Many things formerly stored in human minds are now stored in capital.
  2. Storage in capital offers external finance and larger scope.
  3. Returns to creators or managers of intangibles may have increased.

- Implications for asset pricing, TFP (TS and XS), factor shares, inequality, capital structure, capital budgeting,...

- Example from asset pricing: “Intangible Value”

- More implications at end of talk
Intangible Value
(Eisfeldt Kim Papanikolaou CFR 2022)

Figure 3: Performance of Intangible Value.
Description: The top panel plots the cumulative returns of one dollar invested in the HML\textsuperscript{INT} and HML\textsuperscript{FF} portfolios from the beginning of 1975, 1995, and 2007. The middle panel plots the cumulative returns of one dollar invested in the portfolio that is long the HML\textsuperscript{INT} portfolio and short the HML\textsuperscript{FF} portfolio. The bottom panel plots the cumulative returns of one dollar invested in HML\textsuperscript{INT}, the Fama and French five factors, and momentum.

Interpretation: Intangible value outperforms traditional value in both the full sample period and recent sub-samples. A long-short portfolio of intangible and traditional value also has positive returns. Lastly, intangible value exhibits similar performance as the top-performing momentum factor without suffering from as large of drawdowns.

Post-internet subsample and the post-crisis subsample. We find that going long the short leg of traditional value and short the long leg of traditional value appears to be a fairly low volatility, positive return strategy. This implies that intangible value avoids shorting firms with book anchors that understate total book capital by not incorporating intangibles.

Book anchor includes intangibles.
Data (return series, firm-level intangible stock) available on Intangible Value Github linked from SSRN.
Intangible Value
(Eisfeldt Kim Papanikolaou CFR 2022)

Figure 3: Performance of Intangible Value.

Description: The top panel plots the cumulative returns of one dollar invested in the HML and HML INT portfolios from the beginning of 1975, 1995, and 2007. The middle panel plots the cumulative returns of one dollar invested in the portfolio that is long the HML INT portfolio and short the HML FF portfolio. The bottom panel plots the cumulative returns of one dollar invested in HML INT, the Fama and French five factors, and momentum.

Interpretation: Intangible value outperforms traditional value in both the full sample period and recent sub-samples. A long-short portfolio of intangible and traditional value also has positive returns. Lastly, intangible value exhibits similar performance as the top-performing momentum factor without suffering from as large of drawdowns.

Book anchor includes internally generated intangibles.
Data (return series, firm-level intangible stock) available on Intangible Value Github linked from SSRN.
Measurement of Intangibles
Measurement of Intangibles:

3 Complementary Methods

1. Accumulated expenditures
2. Book values
3. Structural models combined with 1 & 2.
Measuring Intangibles using Accumulated SG&A Expenditures

For each of firm in the S&P500 in 2005, we chose a random year between 2000 and 2005 and searched that firm-year’s 10-K for a discussion of the SG&A expense. Out of these companies:

- 139 companies reported executive or incentive-based compensation.
  (Examples: performance-based compensation; bonuses; management salaries; commissions to sales force)

- 94 companies reported advertising, brand enhancement, and promotion expenses.
  (Examples: direct advertising; branding; public relations; trade shows; promotion costs)

- 66 companies reported consultant and professional advisory fees.
  (Examples: consulting expenses; professional fees)

- 64 companies reported expenses related to technology infrastructure.
  (Examples: information systems; investments to improve processes and systems; infrastructure investments; centralization of merchandising organization)

- 42 companies reported expenses related to recruiting, employee training, or travel.
  (Examples: recruiting, training; employee relations; travel)
Summary Statistics using Accumulated Firm SG&A Expenditures
Eisfeldt Papanikolaou JF 2013 Organization Capital & the XS of Returns

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Lo O/K</th>
<th>Hi O/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s Q</td>
<td>1.05</td>
<td>1.25</td>
</tr>
<tr>
<td>Productivity - Solow residual (%)</td>
<td>-11.38</td>
<td>4.18</td>
</tr>
<tr>
<td>Executive compensation to book assets (%)</td>
<td>0.57</td>
<td>1.29</td>
</tr>
<tr>
<td>IT expenditures to book assets (%)</td>
<td>1.17</td>
<td>2.10</td>
</tr>
<tr>
<td>Labor expense per employee (1000, real)</td>
<td>54.10</td>
<td>60.10</td>
</tr>
<tr>
<td>Capital to labor (log)</td>
<td>3.66</td>
<td>2.56</td>
</tr>
<tr>
<td>Physical capital to book assets</td>
<td>38.11</td>
<td>21.30</td>
</tr>
<tr>
<td>R&amp;D expenditures to book assets</td>
<td>1.36</td>
<td>6.03</td>
</tr>
<tr>
<td>Advertising expenditures to book assets</td>
<td>1.10</td>
<td>3.64</td>
</tr>
<tr>
<td>Debt to book assets</td>
<td>29.91</td>
<td>15.07</td>
</tr>
</tbody>
</table>
Accumulated Expenditures: Aggregate Intangible/Tangible Capital

Industry Intangible to Tangible Capital

Importance varies across industries. Compositional effect.

Caution on SG&A Components:
R&D summary statistics from Intangible Value (Eisfeldt Kim Papanikolaou CFR 2022)

<table>
<thead>
<tr>
<th>Industry</th>
<th>$xrd/sale$</th>
<th>% NA</th>
<th>% 0</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Equipment</td>
<td>11.74</td>
<td>0.98</td>
<td>71.20</td>
<td></td>
</tr>
<tr>
<td>Healthcare</td>
<td>12.38</td>
<td>5.87</td>
<td>1511.40</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>80.77</td>
<td>6.93</td>
<td>43.88</td>
<td></td>
</tr>
<tr>
<td>Telecommunications</td>
<td>79.26</td>
<td>2.93</td>
<td>95.33</td>
<td></td>
</tr>
</tbody>
</table>

Data (return series, intangible stocks) available on Intangible Value Github linked from SSRN.
Intangible to Tangible Capital: Balance Sheet Measure

Figure 3: Intangible capital as a fraction of total firm capital. The graphs report measures of the intangible share using Compustat data (solid lines) and BEA data (dashed line). The Compustat measures use the ratio $\text{intan} / \text{ppge}$t. The two Compustat ratios reported are industry-level averages of firm-level intangible shares, and industry level total intangible capital, as a fraction of total capital. In the BEA data, the intangible share is defined as the ratio of the replacement cost of non-physical capital (own-account software, R&D, and other intellectual property), to the replacement cost of total capital. Averages across industries are computed using the industry’s share of nominal value added in 2001. Details on the data sources and the industrial classification are reported in the Online Appendix.
Measurement of Intangibles:

3 Complementary Methods

1. Accumulated expenditures
   - Level is challenging

2. Book values
   - Driven by M&A activity

3. Structural models combined with 1 & 2.
   - Promising, but...
   - How to deal with “dark matter”? 
   - Make progress on theory – key if intangibles are really “different”!
A Model of Intangibles
What are intangibles? A Positive View

Existing approaches define intangibles by what intangibles lack

- Intangibles are not measured in accounting assets
- Productive assets that are not physical capital

Goal: Define positive features, derive properties endogenously

- Based on “The Economics of Intangibles” (Crouzet, Eberly, Eisfeldt and Papanikolaou (forthcoming JEP 2022)) and “A Model of Intangibles” (Crouzet, Eberly, Eisfeldt and Papanikolaou (2022))
Intangibles: Two Fundamental Properties

- Intangibles start as an idea stored in the mind of its creator.
Intangibles: Two Fundamental Properties

- Intangibles start as an idea stored in the mind of its creator.
  - Ideas can be codified, stored in documents, software or team of humans ⇒ storage choice.

- Technology Determines feasibility of storing and replicating intangibles (speaking → writing → software)

- Institutions Absent property rights, private value is limited.
  - Institutions enforce exclusivity & turn intangibles into intangible assets
  - Enforcement can be bilateral or centralized (why do both systems coexist?)
Intangibles: Two Fundamental Properties

Intangibles start as an idea stored in the mind of its creator.

1. Ideas can be codified, stored in documents, software or team of humans ⇒ storage choice.
2. Intangibles can be used in many locations/applications at once ⇒ non-rival in use
Intangibles: Two Fundamental Properties

- Intangibles start as an idea stored in the mind of its creator.
  - Ideas can be codified, stored in documents, software or team of humans ⇒ storage choice.
  - Intangibles can be used in many locations/applications at once ⇒ non-rival in use

**Technology**
- Determines feasibility of storing and replicating intangibles (speaking → writing → software)

**Institutions**
- Absent property rights, private value is limited.
- Institutions enforce exclusivity & turn intangibles into *intangible assets*
- Enforcement can be bilateral or centralized (why do both systems coexist?)
## Turning Intangibles into Corporate Assets

<table>
<thead>
<tr>
<th></th>
<th><strong>Storage Medium</strong></th>
<th><strong>Property-Rights Institution</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization capital</td>
<td>Key talent, manuals, software</td>
<td>Non-compete clauses, trade secrets</td>
</tr>
<tr>
<td>Patents</td>
<td>Patent application</td>
<td>Patent system</td>
</tr>
<tr>
<td>Brands</td>
<td>Consumers, Trademark media</td>
<td>Trademark system (c)</td>
</tr>
<tr>
<td>Software</td>
<td>Computers</td>
<td>Copyright system</td>
</tr>
<tr>
<td>Video and audio material</td>
<td>Audiovisual media</td>
<td>Copyright system</td>
</tr>
<tr>
<td>Franchise agreements</td>
<td>Contract</td>
<td>Contract enforcement</td>
</tr>
<tr>
<td>Consumer lists</td>
<td>Digital media, Contracts, Sales force</td>
<td>Contract enforcement</td>
</tr>
</tbody>
</table>
A Model of Intangibles

(1) Entrepreneur Invests and Creates Intangible Size $N$

(2) Entrepreneur Chooses Fraction $(1 - \theta)$ of $N$ Stored Externally Fraction $\theta$ is closely held (determines firm span $x$)

(3) Factors $K(s), N(s)$ Allocated Across Streams and production

Start from stage 3 and work backwards...
Stage 3: Production

Take as given:
Rented stock of machines $K$, intangible capital $N$, and firm span of production $x$.

Allocate $N(s)$ and $K(s)$ across production streams $s \in [0, x]$

$$V(N, x) = \max_{\{N(s), K(s)\}_{s \in [0, x]}, K} \int_0^x N(s)^{1-\alpha} K(s)^{\alpha} ds - rK$$

s.t.

each machine is exclusively allocated to a stream:

$$\int_0^x K(s) ds \leq K$$

same intangible can be allocated to multiple streams:

$$\left( \int_0^x N(s)^{\frac{1}{1-\rho}} ds \right)^{1-\rho} \leq N$$
Assumption (Non-Rivalry in Use)

0 < \rho \leq 1 in the constraint on intangible use:

\[
\left( \int_0^x N(s) \frac{1}{1-\rho} \, ds \right)^{1-\rho} \leq N
\]

- \( \rho = 0 \Rightarrow \) intangible capital used in \( s \) cannot be used in \( s' \)
- \( \rho \to 1 \Rightarrow \) the firm can set \( N(s) = N \) for all streams
Stage 2: Intangible Storage and Firm Span

- Entrepreneur $e$ (or key talent/manager) chooses:
  - Fraction of intangibles to retain, $\theta \equiv \frac{N_e}{N}$, $\theta \in (0, 1)$.
  - Fraction $1 - \theta$ stored in capital, owned by investors.

- Entrepreneur faces key tradeoff: Span vs. share of firm.
  - Higher $\theta \iff$ greater entrepreneurial ownership of $N$ but lower span.
Stage 2: Intangible Storage and Firm Span

Assumption (Intangible Storage & Span)

\[ x = f(\theta; \delta) \]

where \( \frac{\partial f}{\partial \theta} < 0 \) and \( \delta \) is a fixed parameter.

- Span \( x \) is decreasing in entrepreneurial retention of intangibles \( \theta \equiv \frac{N_e}{N} \).
- \( \delta \) determines the speed of this decline.
Stage 2: Intangible Storage and Firm Span

Interpretation of $\delta$ (depends on technologies, institutions)

1. $\delta$ captures benefits of storage in capital/general labor (codification)
   = costs of entrepreneurial retention of intangibles.
   - degree of loss in translation from entrepreneur to capital or general labor
   - how efficiently software can replace management for a certain task

2. $\delta$ captures the cost of outsiders stealing externally-stored intangibles.
   - how easy it is to steal/replicate algorithms or code
   - how well property rights to innovation are protected
Stage 1: Intangible Investment

Entrepreneur or manager exerts costly effort $e$
- Outcome is uncertain: intangible capital created $N \sim f(N; e)$
- Higher effort improves outcomes: $e' > e \implies f(N; e') > f(N; e)$

Invests until *Entrepreneur or Manager’s* (expected) marginal benefit equals marginal effort cost.

Underinvestment if entrepreneur can’t capture all of expected value.

Ex-ante vs. Ex post: Ex-post rents do not imply ex-ante (unconditional on success) rents.
Intangibles: Implications for Research
How Can the Model Inform Measurement?

What does the model tell us about measurement in general?

- Where intangibles stored determines where they can be measured

  Some in firm market values, some in household net worth

  (see Eisfeldt and Papanikolaou (2014 AER P&P)

- Firms’ value of intangibles depends on storage, property rights, non-rivalry

- Changes in technology and institutions change level and ownership distribution

Next, specific implications for measurement of:

1. TFP
2. Factor Shares
3. Capital Structure
4. Inequality
5. Capital Budgeting
TFP

Two views:

1. Growth only occurs due to investment in intangibles (e.g. ideas or new technologies)

   ⇒ Solow residual represents intangibles
   (A=N)

2. Intangibles and TFP are conceptually different (e.g. Covid shock)

   ⇒ Solow residuals larger due to intangibles
   (Measured A includes N)
TFP

Measured TFP function of ‘missing’ capital (N) AND its properties:

- TFP ↑ in stock of intangibles $N$
- TFP ↑ in non-rivalry $\rho$ (scalability)
- TFP ↑ in higher benefits to codification
- Effects vary across asset types, industry, time
Factor Shares

Shares of intangible share are:

\[
\theta = \frac{N_e}{N} \quad \text{and} \quad (1 - \theta) = \frac{N - N_e}{N}
\]

Entrepreneur’s share

Outsiders’ share

Implications:

- No ‘factorless’ income or ‘abnormal profits’ despite \( Y - wL - rK \neq 0 \)
- Some capital income compensates key talent for owning intangibles (Eisfeldt, Falato, Xiaolan (2022))
- Some intangibles appear in HH net worth, not firms’ market values (Eisfeldt and Papanikolaou (2014 AER P&P))
- Capital/Labor share corrections are function of \( \theta \) (which depends on \( \delta \) and \( \rho \))
Capital Structure

- Storage in capital or general labor can increase pledgability, external finance
- Codified intangibles can appear in firm value vs. Household balance sheets
- However, the returns may be very high to the creators of scalable intangible assets
- Some intangibles may be best financed by workers
  (Sun and Xiaolan JFE 2019)
- Intangible growth may lead firms to delever, hold cash
  (Falato, Kadyrzhanova, Sim, Steri JF forthcoming)
- Intangibles with strong property rights (eg. patents) more fully captured by firms
  (Kelly, Papanikolaou, Seru, Taddy AER-I 2021)
Inequality

- Shares of intangible share:

\[
\theta = \frac{N_e}{N} \quad \text{and} \quad (1 - \theta) = \frac{N - N_e}{N}
\]

- Entrepreneur’s share
- Outsiders’ share

- \( \Rightarrow \) concentrated exposure to firm-level risk

- And, possibly high factor exposures (drift)

- Eisfeldt, Falato, Lee, Xiaolan (2022 Working Paper)

- Eisfeldt, Falato, Xiaolan (2022) find that human capital of high-skilled labor is complementary to IT capital

- But risky. New intangible vintages can displace previously high-skill workers (Kogan, Schmidt, Seegmiller, and Papanikolaou, 2021)
Eisfeldt, Falato, Xiaolan (2022) Human Capitalists
Eisfeldt, Falato, Lee, Xiaolan (2022) Equity Pay Inequality

Top 10% of Equity pay/High Skilled Employee: Industry Composition

Consmr Manu HiTech Health
Capital Budgeting and Tobin’s Q

- In the presence of intangibles, average $Q \neq$ marginal $q$.
- Intangible-adjusted Tobin’s $Q$ is a function not only of missing intangible stock but also on its properties $(\rho, \delta)$.
- These properties likely vary over time and across industries and asset-types (organization capital vs. patents).

Conclusion

- Made some progress on measuring intangibles
- But, it is a challenging problem
- Perhaps theory can help
- Intangibles have 2 fundamental properties:
  1. Storage choice (distinguishes from human capital)
  2. Non-rivalry
- Implications for TFP, Factor Shares, Capital Structure, Inequality and Rents, Q