Asset Specificity of Non-Financial Firms

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Berkeley Haas    Chicago Booth

NBER Summer Institute
Motivation

- Specificity is a fundamental feature of production assets in practice
  - Assets are heterogeneous and specialized, rather than homogeneous

- Asset specificity **key to many economic issues:**
  1. Investment irreversibility, impact of uncertainty
  2. Contracting: debt, firm organization
  3. Productivity/misallocation...

- But challenging to measure
  - What is the value to alternative users?
  - How do we know if one asset is more specific than another?

- Poses obstacles for empirical and quantitative analyses
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1. **Systematic measures** of asset specificity across industries
   - For plant, property, equipment; inventory; receivable; intangibles...
     - Recovery rate: liquidation value/book value (cost net of depreciation)
     - Detailed analyses in US bankruptcy filings

2. **Determinants** of asset specificity
   - **Physical attributes** that make some assets more specific than others
     - Physical foundations of economic properties
   - **Macroeconomic and industry conditions** may also matter
     - Depends on asset attributes

3. **Implications**
   - Traditional investment theory
     - **Investment irreversibility**: investment & pricing behavior
   - “New economy” and **rising intangibles**
     - Physical of non-financial firms already highly specific
     - Intangibles may not affect firms’ liquidation values by much
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Asset Specificity

<table>
<thead>
<tr>
<th>Value in alternative use</th>
<th>Cost (book value)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Our Data: Recovery Rate</td>
</tr>
</tbody>
</table>

Models of investment irreversibility:

- When firms disinvest, they receive only $\lambda I$.
- Ramey-Shapiro 01: $\lambda \approx 0.28$.
  - Bloom 09: $\lambda \approx 0.66$. Lanteri 18: $\lambda \approx 0.93$.

Models of traditional collateral constraints:

- Firms can pledge physical assets and borrow $\lambda K$.
- Moll 14: $\lambda = 0.17$ (baseline), 0.76 (US). Midrigan-Xu 14: $\lambda = 0.86$.
  - Catherine-Chaney-Huang-Sraer-Thesmar 18: $\lambda \approx 0.15$. 
Asset Specificity

\[
\frac{\text{Value in alternative use}}{\text{Cost (book value)}} = \frac{\text{Cost}}{\text{Value in current use}} \times \frac{\text{Value in current use}}{\text{Value in alternative use}}
\]

Our Data: Recovery Rate

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   - Data
   - Asset-Level Specificity
   - Firm-Level Specificity

3 Determinants of Asset Specificity
   - Physical Attributes
   - Macro and Industry Conditions

4 Implications
   - Traditional Investment Theories
   - The “New Economy” and Rising Intangibles
   - A Short Note on Debt
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Data Source

- Hand collect liquidation recovery rates across asset types & industries
  - From liquidation analysis in Ch11 cases
  - Reports value of each type of asset if the firm gets liquidated
  - Asset types: plant, property, equipment (PPE); inventory; receivables...
  - Case coverage: 2000–2016
  - Liquidation recovery rate: liquidation value/book value (cost)

- Liquidation: Ch 7 — cease operations and sell off individual assets
  - Liquidation value estimates commonly derive from specialist appraisals: on-site field examinations, simulate live liquidations

- Industry average liquidation recovery rate $\lambda_{ij}$:
  - $\lambda_{ij}$: average liquidation recovery rate of asset type $j$ in industry $i$

- Data covers ~50 industries and all major asset categories
## Liquidation Analysis Example: LyondellBasell

### Obligor Debtors

*NBV, Low, High, Midpoint (MILLIONS)*

<table>
<thead>
<tr>
<th>Asset</th>
<th>NBV</th>
<th>Low</th>
<th>High</th>
<th>Midpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash &amp; Equivalents &amp; Short Term Investments</td>
<td>$238.1</td>
<td>$238.1</td>
<td>$238.1</td>
<td>$238.1</td>
</tr>
<tr>
<td>Trade Accounts Receivable</td>
<td>1,248.1</td>
<td>748.9</td>
<td>873.7</td>
<td>811.3</td>
</tr>
<tr>
<td>Other Receivables</td>
<td>268.1</td>
<td>8.4</td>
<td>57.0</td>
<td>32.7</td>
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<tr>
<td>Intercompany Receivables</td>
<td>30,474.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Inventory</td>
<td>1,872.5</td>
<td>1,295.9</td>
<td>1,511.0</td>
<td>1,403.5</td>
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<tr>
<td>Prepaid and Other Current Assets</td>
<td>305.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Property, Plant &amp; Equipment, net</td>
<td>9,366.5</td>
<td>1,577.4</td>
<td>1,577.4</td>
<td>1,577.4</td>
</tr>
<tr>
<td>Investments and Long-Term Receivables</td>
<td>27.5</td>
<td>0.2</td>
<td>1.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Intercompany Investments</td>
<td>43,823.1</td>
<td>336.1</td>
<td>373.1</td>
<td>354.6</td>
</tr>
<tr>
<td>Intangible Assets, net</td>
<td>1,254.1</td>
<td>427.6</td>
<td>427.6</td>
<td>427.6</td>
</tr>
<tr>
<td>Insurance Proceeds</td>
<td>0.0</td>
<td>0.0</td>
<td>229.6</td>
<td>114.8</td>
</tr>
<tr>
<td>Other Long-Term Assets</td>
<td>72.2</td>
<td>61.6</td>
<td>63.6</td>
<td>62.6</td>
</tr>
<tr>
<td><strong>Gross Proceeds</strong></td>
<td>88,949.4</td>
<td>4,694.2</td>
<td>5,352.9</td>
<td>5,023.5</td>
</tr>
</tbody>
</table>

### Costs Associated with Liquidation:

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<tr>
<th>Cost</th>
<th>NBV</th>
<th>Low</th>
<th>High</th>
<th>Midpoint</th>
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</thead>
<tbody>
<tr>
<td>Payroll/Overhead</td>
<td>(93.9)</td>
<td>(107.1)</td>
<td>(100.5)</td>
<td></td>
</tr>
<tr>
<td>Liquidation Costs of PP&amp;E</td>
<td>(157.7)</td>
<td>(157.7)</td>
<td>(157.7)</td>
<td></td>
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<tr>
<td>Chapter 7 Trustee Fees</td>
<td>(140.8)</td>
<td>(160.6)</td>
<td>(150.7)</td>
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</tr>
<tr>
<td>Chapter 7 Professional Fees</td>
<td>(70.4)</td>
<td>(80.3)</td>
<td>(75.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Net Estimated Proceeds before EAI Assets</strong></td>
<td></td>
<td></td>
<td></td>
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Asset-Level Recovery Rates
By SIC2 Industry

Average liquidation recovery rates by industry & asset type ($\lambda_{i,j}$)

- **Plant, Property, and Equipment (PPE)**
  - Mean: **0.33**; 75th: 0.43; 25th: 0.24
  - High: Transportation (0.69), Lumber (0.58), Wholesale (0.57)
  - Low: Personal services (0.08), Educational services (0.15)

- **Inventory**
  - Mean: **0.44**; 75th: 0.56; 25th: 0.32
  - High: Auto dealers (0.88), Apparel stores (0.75), Supermarkets (0.75)
  - Low: Restaurants (0.14), Special construction (0.2), Telecom (0.26)
Checks for Data Informativeness

1. Auction recovery rate of equipment in aerospace manufacturing
   - 28% in Ramey-Shapiro 01; 32% in our data

2. Total liquidation proceeds in Chapter 7
   - Chapter 7 reports total receipts by trustee (not by asset category)
   - Also need to impute value of “abandoned” assets

3. Liquidation value benchmarks used by lenders
   - PPE: lend 20% to 30% of book value for avg non-financial firm

4. Recovery rate implied by PPE sales of Compustat firms
   - Levels match. 0.4 correlated across industries.

Consistent w/ market-based transactions & firms in general
- Asset specificity shaped by physical attributes of assets in an industry
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Firm-Level Liquidation Values

- Firm-level liquidation value: \( \text{Liq}_k^t = \sum_j \lambda_{ij} \text{NBV}_{jt}^k \)
  - \( \lambda_{ij} \): liquidation recovery rate of asset \( j \) in industry \( i \)
  - \( \text{NBV}_{jt}^k \): net book value of asset type \( j \) in year \( t \) for firm \( k \)
  - \( \text{Liq}_k^t \) can be calculated for Compustat firms

- Assumption: firms in a given industry use similar assets
  - E.g., steel mills use similar equipment
  - Later connect \( \lambda_{ij} \) to physical attributes of assets in industry

- Industry-average liquidation value: mean of \( \text{Liq}_t^k \) in industry \( i \)
Firm-Level Liquidation Values

Firm-Level Liquidation Value (PPE + Working Capital)/Book Assets

Mean: 0.23; 75th: 0.33; 25th: 0.12
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Determinants of Asset Specificity: Physical Attributes

A. Overview

- **Mobility**
  - Some assets very mobile (e.g., aircraft, vehicle)
  - Some assets location specific (e.g., heating system, shelf)

- **Durability**
  - Some assets perishable (e.g., fresh food)
  - Some assets last long (e.g., buildings)

- **Standardization/customization**
  - Some assets highly customized (e.g., optical lenses)
  - Some assets relatively standardized (e.g., trucks)
Determinants of Asset Specificity: Physical Attributes

B. Assessing Physical Attributes of Assets

How to measure physical determinants of asset specificity?

1. Capital stock composition in each industry
   ▶ BEA Fixed Asset Table: 71 types of equipment & structures

2. Attribute of each type of asset
   ▶ Mobility: transportation cost (BEA I-O)
   ▶ Durability: depreciation rate (BEA/Compustat)
   ▶ Standardization: design cost/total production cost of asset (BEA I-O)

3. Industry’s overall asset attribute
   ▶ Weighted average using capital stock composition

Use 1997 BEA tables
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B. Assessing Physical Attributes of Assets

Mobility (transportation cost/production cost of asset)
- Low mobility: nuclear fuel, furniture
  High mobility: ships, aircraft, electronics

Durability (depreciation rate of asset)
- Low durability: office equipment
  High durability: railroad, pipeline, sewage system

Standardization/customization (design cost/production cost of asset)
- Low standardization: telecom, special ind machinery, fabricated metal
  High standardization: vehicles, mining equipment, nuclear fuel
Determinants of Asset Specificity: Physical Attributes

C. Impact of Physical Attributes

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<thead>
<tr>
<th>Industry-level PPE Recovery Rate</th>
<th>Industry Classification</th>
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<tr>
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<td>2-digit SIC</td>
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<tr>
<td>Transportation cost</td>
<td>-0.47***</td>
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<td>Industry size (value-added share)</td>
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<tr>
<td>Constant</td>
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<tr>
<td></td>
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</tr>
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<td>Obs</td>
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Note: *** p < 0.001, ** p < 0.01, * p < 0.05.
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Impact of Macro and Industry Conditions

Industry-specific: few industries use the asset.
  - Compute HHI for each type of asset. Take assets in top tercile.

Firm-specific: customized to the firm.
  - Compute design share in total cost. Take assets in top tercile.
Impact of Macro and Industry Conditions

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  - Compute HHI for each type of asset. Take assets in top tercile.
Firm-specific: customized to the firm.
  - Compute design share in total cost. Take assets in top tercile.

For each asset, assign to 4 types. For an ind, calculate % of each type.

1. Not industry-specific & not firm-specific.
   - vehicles

2. Industry-specific & not firm-specific.
   - aircraft, ships, railroad equipment, oil & gas equipment, nuclear fuel

   - fabricated metal products, electronic devices

   - communications structures & equipment
## Impact of Macro and Industry Conditions

<table>
<thead>
<tr>
<th>Case-level PPE Recovery Rate</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</thead>
<tbody>
<tr>
<td>GDP gr</td>
<td>0.28</td>
<td>-2.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.58)</td>
<td>(3.56)</td>
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</tr>
<tr>
<td>GDP gr × % non-ind spec, non-firm spec</td>
<td>8.46**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.80)</td>
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</tr>
<tr>
<td>GDP gr × % ind spec, non-firm spec</td>
<td>3.15</td>
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</tr>
<tr>
<td></td>
<td>(3.19)</td>
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<td></td>
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<tr>
<td>GDP gr × % non-ind spec, firm spec</td>
<td>-7.77</td>
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<tr>
<td></td>
<td>(5.15)</td>
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<tr>
<td>Industry lev</td>
<td>-0.25</td>
<td>0.70</td>
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</tr>
<tr>
<td></td>
<td>(0.20)</td>
<td>(0.96)</td>
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</tr>
<tr>
<td>Industry lev × % non-ind spec, non-firm spec</td>
<td>-1.23</td>
<td></td>
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<td>(0.58)</td>
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<td></td>
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<tr>
<td>Industry lev × % non-ind spec, firm spec</td>
<td>0.60</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.41)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed effect</td>
<td>Industry</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Impact of Macro and Industry Conditions

The table below presents the case-level PPE recovery rate regression results, considering the impact of macro and industry conditions.

<table>
<thead>
<tr>
<th>Case-level PPE Recovery Rate</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP gr</td>
<td>0.28</td>
<td>-2.05</td>
<td>(0.58)</td>
<td>3.56</td>
</tr>
<tr>
<td>GDP gr × % non-ind spec, non-firm spec</td>
<td>8.46**</td>
<td>(3.80)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP gr × % ind spec, non-firm spec</td>
<td>3.15</td>
<td>(3.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP gr × % non-ind spec, firm spec</td>
<td>-7.77</td>
<td>(5.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry lev</td>
<td>-0.25</td>
<td>0.70</td>
<td>(0.20)</td>
<td>0.96</td>
</tr>
<tr>
<td>Industry lev × % non-ind spec, non-firm spec</td>
<td>-1.23</td>
<td>(1.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry lev × % ind spec, non-firm spec</td>
<td>-2.52***</td>
<td>(0.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry lev × % non-ind spec, firm spec</td>
<td>0.60</td>
<td>(2.41)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fixed effect Industry
Impact of Macro and Industry Conditions

How much industry conditions need to change to bring PPE recovery rate from highest industries (e.g., transportation \(\sim 69\%\)) to median (e.g., manufacturing \(\sim 33\%\))?

To induce a change in PPE recovery rate of \(\sim 35\text{pp}--\)

- For typical industry: industry leverage needs to increase by 140 percentage points.

- If industry has 100% industry-specific but not firm-specific assets: industry leverage needs to increase by 19 percentage points.
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   - Firm-Level Specificity

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   - Macro and Industry Conditions

4 Implications
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   - The “New Economy” and Rising Intangibles
   - A Short Note on Debt
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Impact of Investment Irreversibility

A. Prevalence of Disinvesting

- Higher irreversibility $\rightarrow$ less disinvestment

**PPE Recovery Rates & Prevalence of PPE Sales**

- **Frequency of PPE Sales**
- **PPE Sold/Net Book PPE**

Similar results using PPE recovery rates predicted by physical attributes
Impact of Investment Irreversibility

A. Prevalence of Disinvesting

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PPE Recovery Rates & Prevalence of PPE Sales

Similar results using PPE recovery rates predicted by physical attributes
Impact of Investment Irreversibility

B. Investment Response to Uncertainty

- Higher irreversibility → more responsive to uncertainty shocks
  - When investment irreversible, ∃ option value to wait and see
  - \( I_{i,t+1} = \alpha_i + \eta_{j,t} + \beta \sigma_{i,t} + \phi \lambda_i \times \sigma_{i,t} + \gamma X_{i,t} + \epsilon_{i,t} \)

<table>
<thead>
<tr>
<th></th>
<th>PPE Invest Rate (1)</th>
<th>Inventory Invest Rate (2)</th>
<th>PPE Invest Rate (3)</th>
<th>Inventory Invest Rate (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vol</td>
<td>-3.09***</td>
<td>-3.71***</td>
<td>-4.23***</td>
<td>-3.84***</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.46)</td>
<td>(0.55)</td>
<td>(0.83)</td>
</tr>
<tr>
<td>Vol × PPE recovery rate</td>
<td>3.11***</td>
<td>2.89**</td>
<td></td>
<td>-1.29</td>
</tr>
<tr>
<td></td>
<td>(1.08)</td>
<td>(1.10)</td>
<td></td>
<td>(1.70)</td>
</tr>
<tr>
<td>Vol × Inventory recovery rate</td>
<td>1.67*</td>
<td>3.85***</td>
<td>3.94***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.88)</td>
<td>(1.21)</td>
<td>(1.19)</td>
<td></td>
</tr>
<tr>
<td>Fixed effect</td>
<td>Firm. Industry-Year.</td>
<td></td>
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<td></td>
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Similar results using recovery rates predicted by physical attributes
Impact of Investment Irreversibility

B. Investment Response to Uncertainty

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- $I_{i,t+1} = \alpha_i + \eta_{j,t} + \beta \sigma_{i,t} + \phi \lambda_i \times \sigma_{i,t} + \gamma X_{i,t} + \epsilon_{i,t}$

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<td></td>
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<tr>
<td></td>
<td>Firm. Industry-Year.</td>
<td></td>
</tr>
</tbody>
</table>

Similar results using recovery rates predicted by physical attributes
Impact of Investment Irreversibility

C. Firm-Specific Capital and Price Rigidity

- Firm-specific capital can induce higher price rigidity
  - Sbordone 02, Woodford 05, Altig-Christiano-Eichenbaum-Linde 11
  - More cautious to raise prices in response to positive demand shock
  - If raise price and have excess capacity, cannot reduce capital easily

Asset Specificity and Frequency of Price Change (Nakamura-Steinsson)
Impact of Investment Irreversibility

D. Dispersion in $Q$

- High asset specificity $\rightarrow$ more productivity dispersion
  - More frictions in capital reallocation (Eisfeldt-Rampini 06, Lanteri 18)

Standard Deviation of $Q$

Regular $Q$

$Q$ w/ Intangibles
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The “New Economy” and Rising Intangibles

Recent research highlights rise of intangible assets

- Intangibles relative to fixed assets rose substantially by all measures Corrado-Hulten-Sichel 05, Haskel-Westlake 18, Crouzet-Eberly 19

**Intangibles: production assets without physical presence**

Identifiable intangibles:

- Data/software, usage rights/licenses, patent/trademark…
- Sometimes on balance sheet: if purchased from outside.

Non-separable intangibles:

- Organizational capital, “economic competencies”
- Mostly off balance sheet. Sometimes part of goodwill.
The “New Economy” and Rising Intangibles

How does rising intangibles affect firms’ asset specificity?

- Common concern: **Liquidation value ↓**, tighten borrowing constraints
  - Caggese & Perez-Orive 18, Li 19, Falato et al 20
The “New Economy” and Rising Intangibles

How does rising intangibles affect firms’ asset specificity?

- Common concern: Liquidation value ↓, tighten borrowing constraints
  ▶ Caggese & Perez-Orive 18, Li 19, Falato et al 20

Data: Rising intangibles may not change liquidation values by much

1. Physical assets highly specific in the first place
2. Identifiable intangibles not necessarily more specific
3. Rising intangibles strong in industries w/ specialized physical assets
Rising Intangibles and Liquidation Values

A. Identifiable intangibles not much more specific than PPE

**Average Liquidation Recovery Rate: PPE vs. Book Intangibles**

Book intangibles: Mean: 16%; IQR: 2% to 25%.
Non-goodwill book intangibles: Mean: 35%; IQR: 4% to 59%.
Rising Intangibles and Liquidation Values

B. Intangibles rose more in industries with higher PPE specificity

BEA industry-level intangible stock: primarily intellectual property

\[
\frac{\text{IP}}{(\text{IP} + \text{Fixed Asset})}: \text{2016 minus 1996}
\]

\[
\text{IP Share: 2006 minus 1996}
\]

\[
\text{PPE Recovery Rate}
\]
Rising Intangibles and Liquidation Values

B. Intangibles rose more in industries w/ higher PPE specificity

Compustat firm-level intangible stock from Peters-Taylor 17

- Book intangibles + capitalize R&D, 30% of SG&A

\[
\frac{\text{Intangibles}}{\text{(Intangibles} + \text{PPE}): \text{2016 minus 1996}}
\]
Rising Intangibles and Liquidation Values

C. Estimated firm liquidation value has not changed much

Liquidation Value/Book Assets

<table>
<thead>
<tr>
<th>Year</th>
<th>Book Intangible</th>
<th>PPE</th>
<th>Inventory</th>
<th>Receivable</th>
<th>Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What is Different about Intangibles?

- Growth accounting, nature of investment
  - Corrado-Hulten-Sichel 05, Crouzet-Eberly 19

- Economy of scale
  - Crouzet-Eberly 19, Hsieh & Rossi-Hansberg 19

Much to be understood about the nature and impact of intangibles
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Nature of Debt

Companion paper on debt contracting (Kermani-Ma 20)

- Large firms, firms with positive earnings:
  - Total borrowing not sensitive to liquidation value

- Small firms, firms with negative earnings:
  - Total borrowing is sensitive to liquidation value

- Liquidation values affect debt composition & contract features
  - Not always total debt capacity
  - Many firms borrow based on earnings/cash flow value (Lian-Ma 20)
### Borrowing and Liquidation Value

#### Total Book Leverage (Debt/Assets) and Liquidation Value

<table>
<thead>
<tr>
<th>Total Debt/Total Assets</th>
<th>Liquidation Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large Firms</td>
</tr>
<tr>
<td></td>
<td>Small Firms</td>
</tr>
</tbody>
</table>

The graph illustrates the relationship between total book leverage (debt/assets) and liquidation value. The x-axis represents liquidation value, while the y-axis shows the total debt/assets ratio. Two sets of data points are plotted, one for large firms (represented by blue dots) and another for small firms (represented by red diamonds). The graph shows how the leverage and liquidation values vary across different firms, with large firms generally having a lower leverage ratio compared to small firms. The trend indicates that as liquidation value increases, the total debt/assets ratio decreases, suggesting better financial health for large firms in this context.
Borrowing and Liquidation Value: Large Firms

![Graph showing the relationship between Total Debt/Assets and Liquidation Value (PPE + Working Capital). The graph includes a color scale indicating the number of observations.](image-url)
Borrowing and Liquidation Value: Small Firms
Summary

Comprehensive data on asset specificity across industries and categories

1. Non-financial firms’ assets often highly specific (not just “tech firms”)
2. Physical bases of economic properties & cross-industry variations
3. Implications for a number of macro-finance issues
   ▶ Investment irreversibility, uncertainty shocks
   ▶ Impact of rising intangibles

Ongoing effort to understand the nature of firms & their assets

- Hope new micro data facilitates a wide range of analyses