Cowles Lecture 2018

Theory and Measurement of Business Capital

Ellen McGrattan
Special thanks to co-authors:

– Anmol Bhandari
– Serdar Birinci
– Ed Prescott
– Kurt See

Papers, data, codes: www.econ.umn.edu/~erm
“The motto *Theory and Measurement* succinctly captures the mission of the Cowles Foundation: development and application of rigorous logical, mathematical, and statistical methods of analysis in economics and related fields.”
Theory and Measurement

- In current “big data” era, still need
  - Theoretical lens
  - Econometric rigor
- Because not everything that counts can be counted
Theory and Measurement

• In current “big data” era, still need
  ○ Theoretical lens
  ○ Econometric rigor

• Because not everything that counts can be counted

• Subject of today’s lecture: Business capital
Business Capital

- Hard to measure without theory

- Yet, central for studies of
  - Stock valuations
  - International capital flows
  - Income and wealth
  - Macro policies
Why Hard to Measure?

- Expensed, eg,
  - R&D
  - Brand equity

- Created in-house, eg,
  - Software
  - Organizational capital

- Accumulated partly by hours, eg,
  - Sweat equity
Plan of Lecture

- For projects related to business capital, show
  - Theory is needed for measurement
  - Measurement is needed for theory

⇒ in the spirit of Cowles Foundation’s mission
Outline

1. Stock Valuations

2. International capital flows

3. Dispersion of business income and wealth
1. Stock Valuations
Irving Fisher in 1929

- Argued stock market still undervalued

- Lost his fortune
Irving Fisher in 1929

- Argued stock market still undervalued
- Lost his fortune
- Was he wrong?
Fisher’s Reasoning

- Business capital includes
  - Scientific R&D
  - Organizational capital

- Consistent with *high* price-earnings ratios
  - More productive capital implies higher value
  - More expensing implies lower earnings
Fisher’s Reasoning

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Next, apply growth theory...
Market Value

\[ V \equiv \sum_{t=0}^{\infty} \sum_{s^t} p(s^t) D(s^t) \]

- Where,
  - \( p(s^t) \): consumption price in state \( s^t \) relative to \( s^0 \)
  - \( D(s^t) \): dividends in state \( s^t \)
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Hard to compute, but can use fixed assets ...
Estimating Market Value

\[ V = (1 - \tau_{\text{div}}) qK \]

- Why?
  - Without tax, \( V \) is value of productive fixed assets
  - With tax, value adjusted by tax on dividends
The Value with Intangible Capital

\[ V = (1 - \tau_{\text{div}}) \left( q_T K_T + (1 - \tau_{\text{prof}}) q_I K_I \right) \]

- Why?
  - Tangible \((T)\) investment is capitalized
  - Intangible \((I)\) investment is expensed
Inference About Intangible Capital

- Applying basic principles:
  - Investments in intangibles lead to future profits
  - Optimality implies returns to different capitals equated

- On balanced growth with only taxes affect capital prices
Inference About Intangible Capital

• Applying basic principles:
  ○ Investments in intangibles lead to future profits
  ○ Optimality implies returns to different capitals equated

• Using accounting relation:

\[
\Pi = (1 - \tau_{\text{prof}}) \left( r_T K_T + r_I K_I - \delta_T K_T - X_I \right)
\]

- \(\Pi\): profits
- \(r_T K_T\): rents to capital
- \(r_I K_I\): tangible depreciation
- \(\delta_T K_T\): intangible investment
Inference About Intangible Capital

• Applying basic principles:
  ○ Investments in intangibles lead to future profits
  ○ Optimality implies returns to different capitals equated

• Using accounting relation on BGP ($X_I = (g + \delta_I)K_I$):

$$\Pi = (1 - \tau_{\text{prof}}) \left( r_T K_T + r_I K_I \right) - \delta_T K_T - (g + \delta_I)K_I$$

- **profits**
- **rents to capital**
- **tangible depreciation**
- **intangible investment**
Inference About Intangible Capital

- Applying basic principles:
  - Investments in intangibles lead to future profits
  - Optimality implies returns to different capitals equated

- Using accounting relation with returns equated \((i)\):

\[
\Pi_{\text{profits}} = iK_T + (1 - \tau_{\text{prof}})iK_I - (1 - \tau_{\text{prof}})gK_I
\]

- Profits
- Income to capital
- Growth in intangibles
Inference About Intangible Capital

• Applying basic principles:
  ◦ Investments in intangibles lead to future profits
  ◦ Optimality implies returns to different capitals equated

• Using accounting relation with $\Pi$, $\tau_{\text{prof}}$, $K_T$, $i$, $g$:

\[
\Pi = iK_T + (1 - \tau_{\text{prof}})iK_I - (1 - \tau_{\text{prof}})gK_I
\]
Back to Irving Fisher

- Conservative estimates imply $K_I \approx 60\% K_T$

(See McGrattan and Prescott, 2004)
Back to Irving Fisher

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\[ \Rightarrow \hat{V} = 21.6 \times \text{after-tax corporate earnings} \]
Back to Irving Fisher

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  $\Rightarrow \hat{V} = 21.6 \times \text{after-tax corporate earnings}$

  $\Rightarrow \hat{V} > 20$, the S&P composite PE ratio
Back to Irving Fisher

- Conservative estimates imply $K_I \approx 60\% K_T$

  $\Rightarrow \hat{V} = 21.6 \times \text{after-tax corporate earnings}$

  $\Rightarrow \hat{V} > 20$, the S&P composite PE ratio

  $\Rightarrow$ Fisher was right!
But, Not Completely Right

• Fisher and many others:
  ◦ Had leveraged investments
  ◦ Would have been rich if held long-term

• Anyone challenging Fisher’s reasoning needs to:
  ◦ Develop new theory
  ◦ Solve volatility puzzle \((\text{var}(V) \gg \text{var}(K))\)
Challenge: $\text{var}(V) \gg \text{var}(K)$

Source: *Stock Market Crash—And After*
Why Getting it Right Matters

- Governments react
  - Lower interest rates
  - Increase tax rates
- Without fully understanding what happened
2. International Capital Flows
A Related Question

- Why do
  - US subsidiaries abroad return 9% on capital
  - Foreign subsidiaries in US return 3%?
- With economy-wide returns \( \approx 4.6\% \)
A Related Question

• Why do
  ○ US subsidiaries abroad return 9% on capital
  ○ Foreign subsidiaries in US return 3%?

• With economy-wide returns \(\approx 4.6\%\) since early 1980s?
A Related Answer

- Multinationals invest in intangibles:
  - R&D
  - Brands
  - Organizational capital

- That generate returns to FDI openness:
  - Profits abroad for already developed technologies
  - Expensed investments for innovating multinationals
A Related Answer

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Next, start with closed economy algebra...
Accounting Rates of Return

\[
\text{RoR} = \begin{cases} 
\frac{(r_T K_T + r_I K_I - \delta_T K_T - X_I)}{K_T} & \text{if expensed} \\
\frac{(r_T K_T + r_I K_I - \delta_T K_T - \delta_I K_I)}{(K_T + K_I)} & \text{if capitalized}
\end{cases}
\]

where

- \( r_T K_T, r_I K_I = \text{Rents to tangible, intangible capital} \)
- \( K_T, K_I = \text{Reproducible cost of tangible, intangible capital} \)
- \( \delta_T K_T = \text{Depreciation of tangible capital} \)
- \( X_I = \text{Intangible investment} \)
Accounting Rates of Return

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\]

- Expensing distorts RoR if
  - Net intangible investment large \((X_I - \delta_I K_I)\)
  - Intangible capital large \((K_I)\)
Accounting Rates of Return

\[
\text{RoR} = \begin{cases} 
(r_T K_T + r_I K_I - \delta_T K_T - X_I) / K_T & \text{if expensed} \\
(r_T K_T + r_I K_I - \delta_T K_T - \delta_I K_I)/(K_T + K_I) & \text{if capitalized}
\end{cases}
\]

- Expensing distorts RoR if
  - Net intangible investment large (young firms)
  - Intangible capital large (mature firms)
- And differs for young and mature firms
Trickier Inference with Open Economies

- Accounting RoRs on FDI depend on whether
  - Firms are young or mature
  - Expensing done at home or abroad
  - Capital is rival or nonrival

- Next, consider some examples
Some Examples

- Mature US tech firm in Europe
  - Has done R&D at home
  - Uses the R&D in all countries
  - Does little expensing abroad

⇒ High RoR for US subsidiaries abroad
Some Examples

• Young foreign car company in US
  ○ Has done R&D at home
  ○ Uses R&D in all plants
  ○ Lots of plant-specific investments in US

⇒ Temporarily low RoR for subsidiary in US
Some Examples

- Young foreign car company in US
  - Has done R&D at home
  - Uses R&D in all plants
  - Lots of plant-specific investments in US
    \[\Rightarrow\] Temporarily low RoR for subsidiary in US

- Next, consider quantifying this...
Model Prediction for FDI RoR

- **US FDI ($u$) in ROW ($r$):**

\[
 r_{FDI} = i + (1 - \tau_{p,r}) \left[ \phi_I \frac{Y^u_r}{K^u_{T,r}} - \frac{X^u_{I,r}}{K^u_{T,r}} \right] \\
\]

\begin{itemize}
  \item $i$ = actual return on capital
  \item $\tau_{p,r}$ = profits tax in ROW
  \item $\phi_I$ = total intangible capital share (nonrival+rival)
  \item $Y^u_r$ = output of US firms in ROW
  \item $K^u_{T,r}$ = tangible capital abroad (rival)
  \item $X^u_{I,r}$ = plant-specific intangible abroad (rival)
\end{itemize}

- And similar formula for ROW FDI in US
From Theory to Measurement

- Assume all investments earn 4.6% on average
- Choose parameters consistent with US accounts
- Use BEA methodology for model returns
From Theory to Measurement

- Find average returns on DI, 1982–2006:
  - Model:
    - 7.1% for US firms abroad
    - 3.1% for foreign firms in US
  - BEA measures:
    - 9.4% for US firms abroad
    - 3.2% for foreign firms in US

⇒ Mismeasurement accounts for over 60% of return gap

(See McGrattan and Prescott, 2010)
Why Getting it Right Matters

- Governments react
  - Propose greater financial regulation
  - Restrict capital flows
- Without fully understanding what is happening
3. Dispersion in Business Income and Wealth
From Macro to Micro

- Business income and wealth
  - Macro: how large?
  - Micro: how dispersed?

- To answer, need data for pass-through businesses
Pass-through Net Income Quantitatively Important

- Currently, accounts for
  - 1/2 business net income
  - Most of increase in income of top 1%
- But, not publicly traded
Pass-through Net Income Quantitatively Important

- Currently, accounts for
  - 1/2 business net income
  - Most of increase in income of top 1%
- But, not publicly traded
- So, how to value their business capital?
Market Value for Business $b$

\[ V_b \equiv \sum_{t=0}^{\infty} \sum_{s^t} p_b(s^t) D_b(s^t) \]

- Where,
  - $p_b(s^t)$: consumption price in state $s^t$ relative to $s^0$
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- Good news: \( V_b \) and \( D_b/V_b \) available from survey data
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⇒ Theories can be tested with these data
Market Value for Business $b$

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- Good news: $V_b$ and $D_b/V_b$ available from survey data
- Bad news: these survey data are unreliable
Which Surveys?

- Survey of Consumer Finances (SCF)
- Survey of Income and Program Participation (SIPP)
- Kauffman Firm Survey (KFS)
- Panel Surveys of Entrepreneurial Dynamics (PSED)
- Panel Surveys of Income Dynamics (PSID)

⇒ Have documentable issues for business income and wealth

(See Bhandari, Birinci, McGrattan, and See, 2018)
Widely-Used Survey: SCF

- Can compare survey responses directly to IRS data
  - Total adjusted gross incomes (AGI) match
  - Business net incomes do not
- Households with business income asked

*What was the business’s total net income before taxes?*

*Partnership: IRS Form 1065, Line 22*

*Sole proprietorship: IRS Form 1040, Sch. C, Line 31*

*S-corporation: IRS Form 1120S, Line 21*
AGI: SCF vs IRS

![Graph comparing AGI values for SCF and IRS over time from 1990 to 2010. The graph shows a significant increase in AGI for both SCF and IRS, with SCF consistently higher than IRS in most years. Notable peaks and troughs are observed, highlighting fluctuations in the data.](image-url)
Pass-through Net Income: SCF vs IRS

- SCF
- IRS

$ Billions

<table>
<thead>
<tr>
<th>Year</th>
<th>SCF</th>
<th>IRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
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<td></td>
<td></td>
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<tr>
<td>2010</td>
<td></td>
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</tbody>
</table>
Pass-through Net Income: SCF vs IRS

![Graph showing the comparison of SCF and IRS net income over time from 1990 to 2010. The SCF line starts relatively low, rises sharply in 2005, and plateaus afterward. The IRS line is relatively flat until 2005, then rises sharply reaching a peak before declining.](image-url)
Why Incomes Off?

• Are sample weights wrong?

• Are there errors in measurement?
Why Incomes Off?

- Are sample weights wrong? Yes
- Are there errors in measurement? Yes
Sample Weights Wrong

![Graph showing the comparison between SCF and IRS over time in millions. The graph indicates a steady increase in both categories from 1990 to 2010, with IRS consistently higher than SCF.]
Tax Documents Not Referenced

- In 2007, tax documents referenced
  - Frequently
    - 7% of all households
    - 13% of all business owners
  - Never
    - 80% of all households
    - 73% of all business owners
• In 2007, tax documents referenced
  
  ○ Frequently
    
    – 7% of all households
    – 13% of all business owners
  
  ○ Never
    
    – 80% of all households
    – 73% of all business owners
  
  ... and only 1% of households reference all documents
Negative Net Income: Owners confused?
Rectifiable Issues?

• Problems with incomes:
  ○ Even after adjusting for tax misreporting
  ○ Not same across surveys, eg,
    – Income understated in SIPP, Kauffman
    – Legal entity unknown in PSID
    – Small response rate in PSED

• And hard to measure business values or returns
Business Values

• SCF households with business income asked:
  
  *If sold business, what would you get for it?*

• Implied value-weighted dividend yields look crazy
Look Crazy in the Aggregate

- SCF
- S&P500
Look Crazy in the Aggregate

- SCF
- S&P500
Look Crazy in the Aggregate
Look Crazy in the Cross-Section

<table>
<thead>
<tr>
<th></th>
<th>S&amp;P 500</th>
<th></th>
<th>SCF</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>2003</td>
<td>2006</td>
<td>2003</td>
<td>2006</td>
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<tr>
<td>25 %tile</td>
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</tr>
<tr>
<td>75 %tile</td>
<td>2.2</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 %tile</td>
<td>6.1</td>
<td>5.6</td>
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Dividend Yields (%)
Look Crazy in the Cross-Section

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<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>50 %tile</td>
<td>0</td>
<td>0</td>
<td>16.7</td>
<td>22.1</td>
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<tr>
<td>75 %tile</td>
<td>2.2</td>
<td>2.3</td>
<td>50.0</td>
<td>78.9</td>
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<tr>
<td>90 %tile</td>
<td>6.1</td>
<td>5.6</td>
<td>133.3</td>
<td>207.5</td>
</tr>
</tbody>
</table>

Dividend Yields (%)
Why So Crazy? Something’s Missing

Income too high by 2
& Value too low by 10
Why So Crazy?

• Some assets hard to measure
  ○ Client & customer lists
  ○ Tradenames & trademarks
  ○ Noncompete agreements
  ○ Goodwill

• But constitute most of private business sales
Sales of Private Businesses

- *Pratt’s Stats*: transaction level broker data
  - 27,000 acquired private businesses
  - Seller and sale details
  - Income and balance sheet data
  - Purchase price allocation to
    - Cash
    - Fixed assets
    - Real estate
    - Identifiable intangibles (eg, clients, tradenames)
    - Unidentified intangibles (eg, goodwill)

- Main finding: private businesses are intangible intensive
### Intangible Intensity by Legal Structure

<table>
<thead>
<tr>
<th>Legal Structure</th>
<th>Count</th>
<th>Mean</th>
<th>Median</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Corporations</td>
<td>5,519</td>
<td>0.58</td>
<td>0.64</td>
<td>0.32</td>
</tr>
<tr>
<td>Sole Proprietors</td>
<td>1,140</td>
<td>0.57</td>
<td>0.64</td>
<td>0.31</td>
</tr>
<tr>
<td>Partnerships</td>
<td>196</td>
<td>0.57</td>
<td>0.67</td>
<td>0.32</td>
</tr>
</tbody>
</table>

- These data are suggestive, but
  - Not representative
  - Don’t include on-going concerns
Need Theory for Measurement

- Need theory with heterogenous agents choosing to
  - Work for someone else or
  - Run own business and
    - Accumulate *sweat equity* (eg, clients, brands)
    - Produce goods & services

- Need data other than surveys to discipline theory

(See Bhandari and McGrattan, 2018)
Valuing Sweat Equity

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- Infer shares, dispersion, duration by matching
  - National accounts
  - Tax returns
  - Age profile of businesses
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- Infer shares, dispersion, duration by matching
  - National accounts
  - Tax returns
  - Age profile of businesses → helps pin down duration
What We Find

- Large value for business sweat equity ($V_b$)
  - $\frac{2}{3} \times GDP$
  - $\Rightarrow \approx$ value of their fixed assets

- Little dispersion in $V_b$
  - Gini is roughly 0.2
  - $\Rightarrow$ High dispersion in returns

- Why?
  - Duration of business relatively short
  - $\Rightarrow$ PV of dividends similar for everyone
Why Getting it Right Matters

• Want to run tax experiments (before enacting!)

• If lower tax on pass-throughs like TCJA17, find:
  
  ○ Large sectoral and aggregate effects
  
  ○ Smaller effects if abstract from sweat capital
    – Duration of business lives shorten
    – Less production in private businesses
Cowles Foundation Motto

“The motto *Theory and Measurement* succinctly captures the mission of the Cowles Foundation: development and application of rigorous logical, mathematical, and statistical methods of analysis in economics and related fields.”