Cowles Lecture 2018:

Ellen McGrattan (Minnesota): *Theory and Measurement of Business Capital*

Chaired by John Genakoplos (Yale)
Cowles Lecture 2018

THEORY AND MEASUREMENT OF BUSINESS CAPITAL

ELLEN McGRATTAN
Special thanks to co-authors:

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– Serdar Birinci
– Ed Prescott
– Kurt See

Papers, data, codes: www.econ.umn.edu/~erm
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.”
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

- Business capital includes
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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 \( s^t \)
Market Value

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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

\(X_I\): 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 \( X_I = (g + \delta_I)K_I \):

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

$$\Pi = iK_T + (1 - \tau_{prof})iK_I - (1 - \tau_{prof})gK_I$$

- 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 $\Pi$, $\tau_{prof}$, $K_T$, $i$, $g$:

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

- Profits
- Income to capital
- Growth in intangibles
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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  \[ \Rightarrow \hat{V} = 21.6 \times \text{after-tax corporate earnings} \]

  \[ \Rightarrow \hat{V} > 20, \text{ the S&P composite PE ratio} \]
• 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?
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

- 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

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

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

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

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

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

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

- 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

  ⇒ Temporarily low RoR for subsidiary in US

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

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

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

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

- 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
• Currently, accounts for
  o 1/2 business net income
  o Most of increase in income of top 1%
• But, not publicly traded
• 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 \( s^0 \)
  - \( D_b(s^t) \): dividends to business capital in state \( s^t \)
Market Value for Business $b$

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- Good news: $V_b$ and $D_b/V_b$ available from survey data
Market Value for Business \( b \)

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- Good news: \( V_b \) and \( D_b/V_b \) available from survey data
  \[\Rightarrow\] Theories can be tested with these data
Market Value for Business $b$

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  - $D_b(s^t)$: dividends to business capital in state $s^t$

- 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

$Billions


SCF
IRS
Pass-through Net Income: SCF vs IRS

$ Billions

- SCF
- IRS

Years:
- 1990
- 1995
- 2000
- 2005
- 2010
Pass-through Net Income: SCF vs IRS
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

- SCF
- IRS

Millions

Years:
- 1990
- 1995
- 2000
- 2005
- 2010
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?

The chart illustrates the net income trends over a period from 1990 to 2010. The red line represents SCF, and the green line represents IRS. The net income is measured in billions of dollars.
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
Look Crazy in the Aggregate
Look Crazy in the Aggregate

- SCF
- S&P500

Percent

Look Crazy in the Cross-Section

<table>
<thead>
<tr>
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<th>S&amp;P 500</th>
<th></th>
<th>SCF</th>
<th></th>
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<tr>
<td></td>
<td>2003</td>
<td>2006</td>
<td>2003</td>
<td>2006</td>
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<tr>
<td>25 %tile</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>50 %tile</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</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>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dividend Yields (%)
Look Crazy in the Cross-Section

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>0</td>
<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td>0</td>
<td>16.7</td>
<td>22.1</td>
</tr>
<tr>
<td>75</td>
<td>2.2</td>
<td>2.3</td>
<td>50.0</td>
<td>78.9</td>
</tr>
<tr>
<td>90</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 (e.g., clients, tradenames)
    - Unidentified intangibles (e.g., goodwill)

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

<table>
<thead>
<tr>
<th></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

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

- Where,
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- Infer shares, dispersion, duration by matching
  - National accounts
  - Tax returns
  - Age profile of businesses
Valuing Sweat Equity

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

- Large value for business sweat equity ($V_b$)
  - $2/3 \times GDP$
  - $\Rightarrow \approx$ 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
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."