Cross-Country Income Differences Revisited: Accounting for the Role of Intangible Capital

*The Second International Conference of the Society for Economic Measurement*

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July 22-24, 2015
**What is intangible capital?**

- Soft-side of assets

<table>
<thead>
<tr>
<th>Broad category</th>
<th>Type of Investment</th>
</tr>
</thead>
</table>
| Computerized Information| • Software  
                         | • Databases                                                                        |
| Innovative Property     | • R&D  
                         | • Mineral exploration  
                         | • Entertainment and artistic originals  
                         | • Design and other new product development costs                                  |
| Economic Competencies   | • Branding (market research and long-lived advertising)  
                         | • Firm-specific human capital (training)  
                         | • Organizational capital (business process investment)                            |

Source: Corrado, Hulten and Sichel (2005)
Shift in investment composition towards intangibles

**Investment as a portion of GDP**

- Tangible investment
- Intangible investment

1977 - 2010

DATA: CORRADO AND HULTEN, 2012
Motivation

Existing literature:

- Increasingly recognized importance of intangible capital

- Country-specific growth accounting studies (e.g. CHS, 2009; Fukao et.al, 2009)

- Econometric analysis on intangibles and labor productivity (Roth and Thum, 2013)

Yet missing:

- Incorporating intangibles into the development accounting framework (intangibles data for a larger sample of countries needed)
1. The rapidly growing literature on intangibles
   - contribution by providing intangible investment estimates for a wider range of countries

2. The vast and still expanding literature on international income differences
   - contribution by explicitly accounting for intangible investment
**Coverage: Countries**

- 60 economies (sum of GDP over 90% of the world total, covering countries at all stages of development), 1995-2011
Coverage: Assets

- Organizational capital
- Brand equity
- Software
- R&D

Data source: INTAN-Invest
**WHY: 60 COUNTRIES & 1995**

<table>
<thead>
<tr>
<th>Asset type</th>
<th>year</th>
<th># years</th>
<th># countries</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>96'-11'</td>
<td>16</td>
<td>156</td>
<td>UNESCO Institute for Statistics &amp; OECD</td>
</tr>
<tr>
<td>OC</td>
<td>95'-11'</td>
<td>17</td>
<td>101</td>
<td>ILO, BLS (OES), PWT 8.1</td>
</tr>
<tr>
<td>Software</td>
<td>03'-11'</td>
<td>9</td>
<td>75</td>
<td>WITSA</td>
</tr>
<tr>
<td>Brand Equity</td>
<td>95'-11'</td>
<td>17</td>
<td>65</td>
<td>WARC (84) &amp; ESOMAR (80)</td>
</tr>
</tbody>
</table>

\[
95'-11': \quad (1-0.2)^{17} = 0.02
\]
**Coverage: sectors**

Exclude public sectors (NACE Rev.1):
- Public Administration (L)
- Education (M)
- Health and Social Work (N)

That means:

\[ y' = \frac{(s_Y \cdot Y + N)}{s_L \cdot EMP} \]

\[ k' = \frac{s_K \cdot K}{s_L \cdot EMP} \]
Measurements

Expenditure-based approach

- $N^{R&D}_{c,t}$: Business investment in R&D
- $N^{OC}_{c,t}$: Fraction of managers’ wage $\times$ number of managers
- $N^{BE}_{c,t}$: Advertising spending + Marketing Research expenditures
- $N^{SW}_{c,t}$: Expenditures on computer software
**Total intangible investment:** $N$

$$N = N^{RD} + N^{OC} + N^{BE} + N^{SW}$$
Total intangible investment: $N$

- $Y' = s^M \text{GDP} + N^{RD} + N^{OC} + N^{BE}$; \hspace{1cm} (54 SNA 1993; 6 SNA 2008)

- SNA (2008): AUS, CAN, HKG, MEX, SGP, USA

GDP numbers obtained from WDI are cross-checked with IMF WEOD (where GDP is solely based on SNA 1993): $\text{GDP}^{WDI} = \text{GDP}^{IMF}$
Data Feature 1

Intangible investment positively associated with per capita income:

![Graph showing the relationship between Intangible Investment as % of Adj.Market-GDP and Log of Adj.Market-GDP per capita in 2011 PPP$.](image-url)

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Data Feature 2

![Graph showing the percentage of Total Tangible Investment and Total Intangible Investment as a percentage of Adj. MGDP from 1995 to 2011]

- **Total Tangible Investment**: 3.2% to 4.0%
- **Total Intangible Investment**: 1995 to 2011

**Year**:
- 1995
- 1997
- 1999
- 2001
- 2003
- 2005
- 2007
- 2009
- 2011

**Intangible investment share**
- 20%
- 21%
- 22%
- 23%
- 24%

**Tangible investment share**
- 3.2%
- 3.4%
- 3.6%
- 3.8%
- 4.0%

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Basic setup of Development accounting

- **Benchmark production function (Hall and Jones, 1999):**
  \[ Y = A \cdot K^\alpha (Lh)^\gamma \]

- **Per worker & CTRS:**
  \[ y = A \cdot k^\alpha (h)^{1-\alpha} \]

- **Rewrite as follows:**
  \[ y = A \cdot y_{KH}; \quad y_{KH} \equiv k^\alpha h^{1-\alpha} \]
Basic setup of Development accounting

- Variance decomposition ($y = A \cdot y_{KH}$):
  \[
  \text{var}[\log(y)] = \text{var}[\log(A)] + \text{var}[\log(y_{KH})] + 2\text{cov}[\log(A), \log(y_{KH})]
  \]

- If $A$ is constant (in theory):
  \[
  \text{var}[\log(y)] = \text{var}[\log(y_{KH})]
  \]

- In practice:
  \[
  VAF = \frac{\text{var}[\log(y_{KH})]}{\text{var}[\log(y)]}
  \]
**Extended Model**

- **Adding intangible capital:**

  \[ Y' = A \cdot K^\alpha R^\beta (Lh)^{1-\alpha-\beta} \]

  \[ y' = A \cdot k^\alpha r^\beta (h)^{1-\alpha-\beta} \]

- **Rewrite as follows:**

  \[ y' \equiv A \cdot y_{KRH} \]

- **Using variance decomposition and assuming \( \bar{A} \):**

  \[ \frac{\text{var}[\log(y_{KRH})]}{\text{var}[\log(y')]} \]
Data Description

- \( k \): PIM (\( \delta^K = 0.06; 1960-2011 \))

- \( r \): PIM (\( \delta^R_j; 1995-2011 \))

- \( h \): standard procedure as function of the average years of schooling \( s \)

- \( \alpha \): 1/3 (e.g. Caselli, 2005)

- \( \alpha' = 0.25; \beta = 0.15; \gamma' = 0.6 \), following CHS (2009)
## Results: Basic Model

\[
\begin{align*}
VAF & \quad VAF' \\
\frac{k^{\alpha} h^{1-\alpha}}{y} & \quad \frac{k^{\alpha} r^{\beta} h^{1-\alpha-\beta}}{y'}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Coverage</th>
<th>( \text{N} )</th>
<th>( \text{var}[\log(y)] )</th>
<th>( \text{var}[\log(y_{KH})] )</th>
<th>( \text{VAF} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own data</td>
<td>Total Economy (60)</td>
<td>0.397</td>
<td>0.098</td>
<td>24.66%</td>
</tr>
<tr>
<td>Drop if ( I_0 &gt; 1970 )</td>
<td>Total Economy (51)</td>
<td>0.443</td>
<td>0.110</td>
<td>24.94%</td>
</tr>
<tr>
<td>PWT 8.1</td>
<td>Total Economy (60)</td>
<td>0.453</td>
<td>0.111</td>
<td>24.50%</td>
</tr>
<tr>
<td>Own data</td>
<td>Market Economy (60)</td>
<td>0.443</td>
<td>0.110</td>
<td>24.87%</td>
</tr>
</tbody>
</table>

*Note:* Market economy indicates that the analysis is based on market- GDP, -investment, and -employment. The share of variance accounted for in the last column is calculated based on values to the seventh decimal point. For brevity, variance values to the third decimal point are shown in the table in columns 3 and 4.
Sensitivity to changing the exponents
Results: Extended Model

\[
\frac{VAF}{k^\alpha h^{1-\alpha} / y} \quad \frac{VAF'}{k^\alpha r^\beta h^{1-\alpha-\beta} / y'}
\]

Table 5: Variance Accounted For: Augmented Model for 2011 (Market Economy)

<table>
<thead>
<tr>
<th></th>
<th>Factor shares</th>
<th>var[log(y)]</th>
<th>var[log(y_{KRH})]</th>
<th>VAF'</th>
<th>(\Delta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower-bound</td>
<td>(\alpha = .33 &amp; \beta = .03)</td>
<td>0.456</td>
<td>0.136</td>
<td>29.8%</td>
<td>+5%</td>
</tr>
<tr>
<td>Baseline</td>
<td>(\alpha = .25 &amp; \beta = .15)</td>
<td>0.456</td>
<td>0.195</td>
<td>42.8%</td>
<td>+18%</td>
</tr>
<tr>
<td>Alternative OC measure ((R_o))</td>
<td>(\alpha = .25 &amp; \beta = .15)</td>
<td>0.455</td>
<td>0.191</td>
<td>42.0%</td>
<td>+17%</td>
</tr>
<tr>
<td>Dropping ESP &amp; GRC</td>
<td>(\alpha = .25 &amp; \beta = .15)</td>
<td>0.468</td>
<td>0.200</td>
<td>42.7%</td>
<td>+18%</td>
</tr>
<tr>
<td>Dropping Imputation</td>
<td>(\alpha = .25 &amp; \beta = .15)</td>
<td>0.460</td>
<td>0.200</td>
<td>43.5%</td>
<td>+19%</td>
</tr>
</tbody>
</table>
Varying Intangible Capital Share

Intangible capital share (%)

Variance Accounted For (Augmented Model)

Additional Variance Accounted For by intangibles

Baseline specification

VAF'

VAF'-VAF

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Conclusions

- Intangible investment has become increasingly important over time.

- In all variants of the model considered, differences in intangible capital systematically increases the VAF. In benchmark specification, it helps to explain another 18% of income variation, significantly diminishing the role of TFP.

- The explanatory potential of intangibles could be greater, given that only a subset of intangibles are captured in the current study.
Thank you for your attention!