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

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May 23-24, 2016
What is intangible capital?

- Soft-side of assets

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

Source: Corrado, Hulten and Sichel (2005)
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 in a development accounting exercise (intangibles data for a larger sample of countries needed)
Literature

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 investments in intangible capital
Coverage: Countries

- 60 economies (sum of GDP over 90% of the world total, covering countries at all stages of development), 1995-2011 (17 years).
Coverage: Three Major Assets

- R&D
- Organization capital
- Brand equity

Data source: INTAN-Invest
Coverage: Market-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

- $N_{c,t}^{RD}$: Business expenditures on R&D
- $N_{c,t}^{OC}$: Fraction of managers’ wage $\times$ number of managers
- $N_{c,t}^{BE}$: Advertising spending + Market Research expenditures
Total intangible investment: $N$

- $N = N^{RD} + N^{OC} + N^{BE}$

- $Y' = s^M GDP + N$;

  - where GDP (and I) are based on SNA 1993 (retrieved from UN NA)
Intangible investment positively associated with per capita income:

Notes: Author’s calculation. The line shown in the figure is OLS regression line. The shares of intangible investment are averaged over time.
Notes: Author’s calculation. The shares of tangible and intangible investments are averaged across countries.
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** \((y = A \cdot y_{KH})\):
  \[
  \text{var}[\log(y)] = \text{var}[\log(A)] + \text{var}[\log(y_{KH})] + 2\text{cov}[\log(A), \log(y_{KH})]
  \]

- **Following Caselli (2005):**
  \[
  \text{VAF} = \frac{\text{var}[\log(y_{KH})]}{\text{var}[\log(y)]}
  \]
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:

\[ VAF' = \frac{\text{var}[\log(y_{KRH})]}{\text{var}[\log(y')]}. \]
Data Construction

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

- \( k \): PIM (\( \delta^K = 0.06; 1960-2011; P^{I}_{c,t} \) from UN NA)
- \( r \): PIM (\( \delta^R_j; 1995-2011; P^{N}_{j,c,t} \) imputed)
- \( h \): standard procedure as function of the average years of schooling \( s \)
- \( \alpha \): 1/3 (e.g. Caselli, 2005)
- \( \alpha' = 0.25; \beta = 0.15 \), following CHS (2009)
**Results: Basic Model**

\[ VAF = \frac{k^\alpha h^{1-\alpha}}{y} \]

**Table:** Variance Accounted For of the Basic Model for 2011

<table>
<thead>
<tr>
<th>Coverage</th>
<th>\var[\log(y)]</th>
<th>\var[\log(y_{KH})]</th>
<th>VAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own data</td>
<td>Total Economy (60)</td>
<td>0.387</td>
<td>0.088</td>
</tr>
<tr>
<td>Own data (excl. F.USSR)</td>
<td>Total Economy (51)</td>
<td>0.432</td>
<td>0.101</td>
</tr>
<tr>
<td>Data from PWT 8.1</td>
<td>Total Economy (60)</td>
<td>0.452</td>
<td>0.109</td>
</tr>
<tr>
<td>Own data</td>
<td>Market Economy (60)</td>
<td>0.432</td>
<td>0.101</td>
</tr>
</tbody>
</table>
Sensitivity to changing the exponents

- Variance Accounted For
- Physical capital share (%)
- Market economy (own data)
- Total economy (own data)
- Total economy (PWT)

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Results: Extended Model

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

Table: VAF of the Augmented Model for 2011 (Market Economy)

<table>
<thead>
<tr>
<th>Output elasticities</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 = .05 )</td>
<td>0.445</td>
<td>0.124</td>
<td>27.9%  +5%-points</td>
</tr>
<tr>
<td>Mid-range</td>
<td>( \alpha = .33 &amp; \beta = .10 )</td>
<td>0.445</td>
<td>0.166</td>
<td>37.2%  +14%-points</td>
</tr>
<tr>
<td>Upper-bound (Baseline)</td>
<td>( \alpha = .25 &amp; \beta = .15 )</td>
<td>0.445</td>
<td>0.177</td>
<td>39.8%  +16%-points</td>
</tr>
</tbody>
</table>

\( \Delta \): denotes the difference in the explanatory power of the augmented model as compared to the basic model (i.e. VAF' - VAF) in percentage points.
Varying Intangible Capital Share

Additional Variance Accounted For by Intangibles

VAF'

Upperbound specification

VAF'−VAF

Upperbound improvement
## Robustness of the Main Result

<table>
<thead>
<tr>
<th></th>
<th>$\text{var}[\log(y')]$</th>
<th>$\text{var}[\log(y_{KRH})]$</th>
<th>VAF'</th>
<th>$\Delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline result</strong></td>
<td>0.445</td>
<td>0.177</td>
<td>39.8%</td>
<td>+16%-points</td>
</tr>
<tr>
<td><strong>(1) Alternative OC</strong></td>
<td>0.443</td>
<td>0.171</td>
<td>38.6%</td>
<td>+15%-points</td>
</tr>
<tr>
<td><strong>(2) Dropping GRC&amp;ESP</strong></td>
<td>0.456</td>
<td>0.181</td>
<td>39.7%</td>
<td>+16%-points</td>
</tr>
<tr>
<td><strong>(3) Dropping sample</strong></td>
<td>0.403</td>
<td>0.160</td>
<td>39.7%</td>
<td>+16%-points</td>
</tr>
<tr>
<td><strong>(4) Alternative $\delta_j$</strong></td>
<td>0.445</td>
<td>0.183</td>
<td>41.1%</td>
<td>+18%-points</td>
</tr>
<tr>
<td><strong>(5) Alternative $K_0$ &amp; $R_0$</strong></td>
<td>0.445</td>
<td>0.177</td>
<td>39.8%</td>
<td>+16%-points</td>
</tr>
<tr>
<td><strong>(6) Alternative price $P^{BS}$</strong></td>
<td>0.445</td>
<td>0.173</td>
<td>38.9%</td>
<td>+15%-points</td>
</tr>
<tr>
<td><strong>(7) Alternative price $P^{GDP}$</strong></td>
<td>0.445</td>
<td>0.172</td>
<td>38.6%</td>
<td>+15%-points</td>
</tr>
<tr>
<td><strong>(8) Alternative price $P^I$</strong></td>
<td>0.456</td>
<td>0.173</td>
<td>38.9%</td>
<td>+15%-points</td>
</tr>
</tbody>
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Conclusions

- Intangible investment has become increasingly important over time and it is positively associated with income levels.

- In all variants of the model considered, differences in intangible capital systematically increases the VAF. In the baseline specification, it helps to account for another 16 percentage points 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.
Caveats

- ‘One-size-fits-all’ output elasticities (e.g. \( \alpha = \frac{1}{3} \) & \( \beta = 0.15 \)).

- Analysis based on capital stocks rather capital services, which would have been more appropriate as short-lived assets should have a larger return in production as it would be indicated by its user cost.

- Results are comparable to previous studies (e.g. Caselli, 2005; Mutreja, 2014), thus it is still a useful step forward.
Thank you for your attention!
Price deflator for N

- Price indices of the industries that produce (in part) intangible assets, such as management consulting industry for OC, and advertising and marketing research industry for BE.

\[ R_{j,t,US}^N = \frac{P_{j,t,US}^N}{P_{t,US}^I} \]

\[ P_{j,c,t}^N = \frac{P_{c,t}^I}{R_{j,t,US}^N} \]
Human capital

\[ h = e^{\phi(s)} \]

\[ \phi(s) = \begin{cases} 
0.134 \cdot s & \text{if } s \leq 4 \\
0.134 \cdot 4 + 0.101 \cdot (s - 4) & \text{if } 4 < s \leq 8 \\
0.134 \cdot 4 + 0.101 \cdot 4 + 0.068 \cdot (s - 8) & \text{if } s > 8 
\end{cases} \]