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

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Motivation

Existing literature:

- Tremendous progress in understanding and measuring intangibles (CHS, 2005)
- 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)

Literature

1. The rapidly growing literature on intangibles

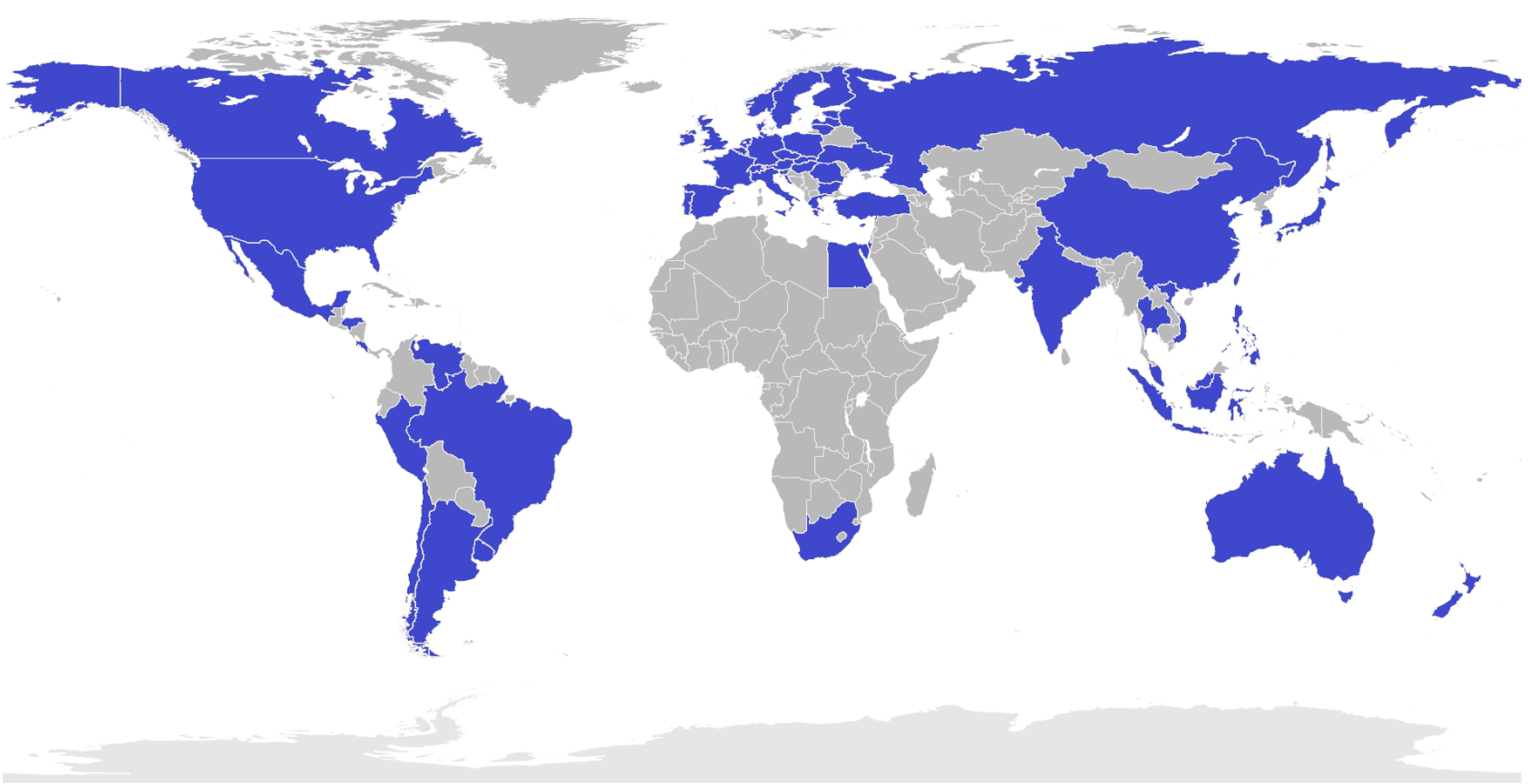
- contribution by providing intangible investment estimates for a wider range of countries

2. The vast and still expanding literature on international income differences

- contribution by explicitly accounting for intangible investment

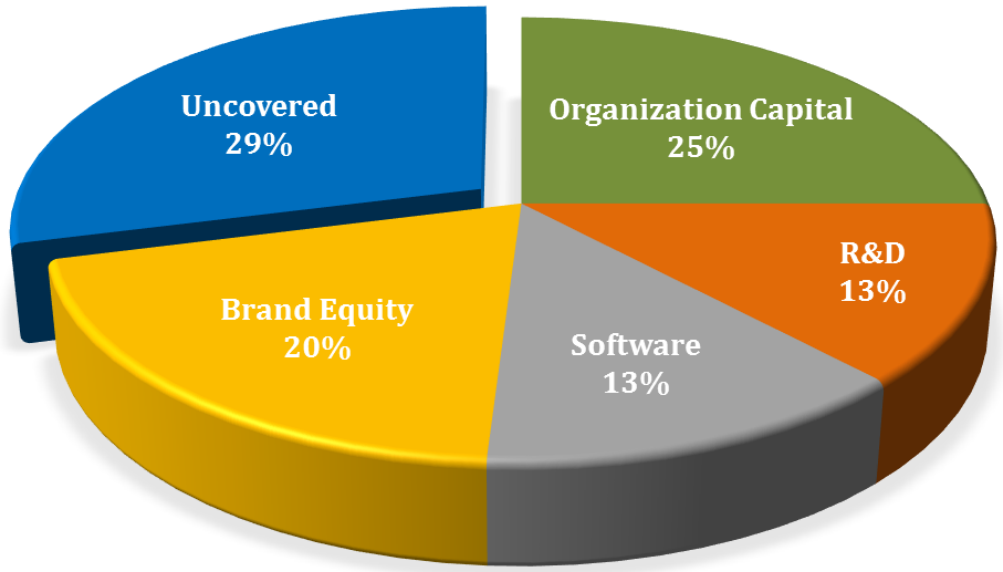
Coverage: Countries

- 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

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

95'-11': $(1\text{-}0.2)^{17}=0.02$

Coverage: sectors

Exclude public sectors (NACE Rev.1):

- Public Adminstration (L)
- Education (M)
- Heal and Social Work (N)

That means:

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

$$k' = \frac{s_K \cdot K}{s_L \cdot EMP}$$

Measuring BERD: N^{RD}

- Primary data source: Data Center of UNESCO Institute for Statistics (i.e. GERD performed by Business Enterprises)
- 27% data on BERD missing from UNESCO
- Whenever possible, extrapolate the missing values using the growth of the actual BERD numbers from external data source (e.g. OECD, Eurostat, Statistical office)
- Linear interpolation based on logged variables (assuming constant growth rates)
- 16% missing (extrapolate based on the average growth rate of R&D investment share of GDP observed in the last (first) five years)

Measuring Organizational Capital: N^{OC}

20% of manager's wage considered as investment in OC

- Number of managers employed (ISCO-88), per country, from ILO (ILOSTAT & LABORSTA databases): EMP_c^M
- Wage rate of the managers per country: WAGE_c^M

$$\text{N}_{c,t}^{OC} = (20\% \cdot \text{WAGE}_{c,t}^{M}) \times \text{EMP}_{c,t}^{M}$$

Measuring Organizational Capital: N^{OC}

Impute the manager's wage rate in two steps:

1. The wage rate of an average worker (using PWT8.1)

$$W_{c,t}^{average} = \left(\frac{labshare \times cgdpo \times pl\_gdpo}{emp} \right)_{c,t} \times xr_{c,t}$$

2. The relative wage of managers for the US

$$R_t^{US} = \left(W_{BLS}^{Managers} / W_{PWT}^{average} \right)_t^{US}$$

where $W_{BLS}^{Managers}$ is derived from BLS/OES

Measuring Organizational Capital: N^{OC}

Relative wage constant across countries:

$$W_{c,t}^{Managers} = R_t^{US} \times W_{c,t}^{average}$$

This assumption is subject to scrutiny for robustness check

- Allow for R to differ by country (based on the limited earnings data from ILO)

Measuring Brand Equity: N^{BE}

Following the approach of Corrado and Hao (2014)

- ADV: WARC (World Advertising Research Center)
- MKT: ESOMAR (European Society for Opinion and Marketing Research)

$$I_{c,t}^{BE} = \underbrace{\left(0.6 \cdot \gamma_{adv} \cdot E_{c,t}^{adv}\right)}_{\textit{Investment in advertising}} + \underbrace{\left(\gamma_{mkt} \cdot E_{c,t}^{mkt}\right)}_{\textit{Investment in market research}}$$

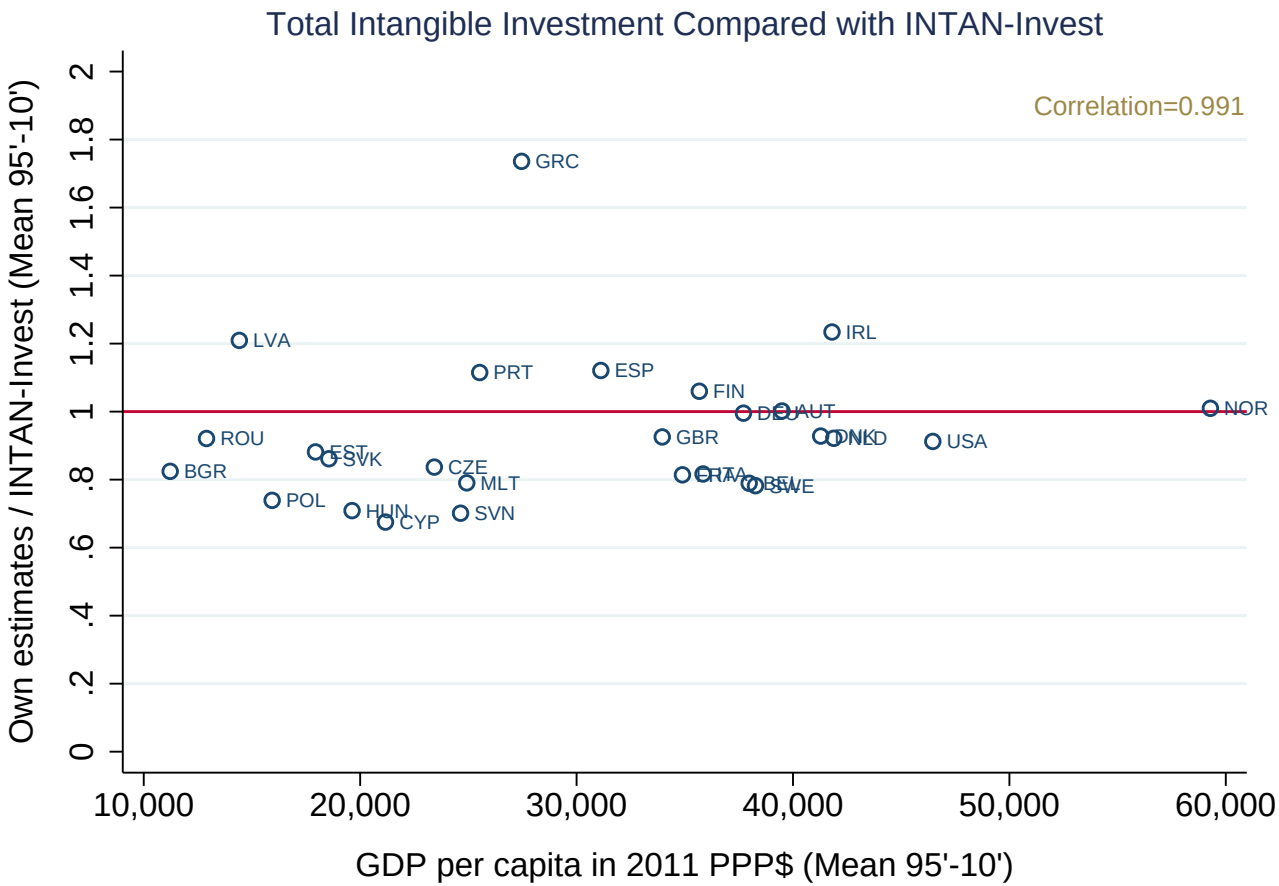
where $\gamma_{adv} = 1.39$ and $\gamma_{mkt} = 2$, adjustment factors

Measuring software: N^{SW}

- Data source: WITSA (Digital Reports for computer software spending)
- Only available for 2003-2011
- Missing data extrapolated based on the average growth rate of software investment as share of GDP observed in the first five years (i.e. 2003-2007)

Total intangible investment: N

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



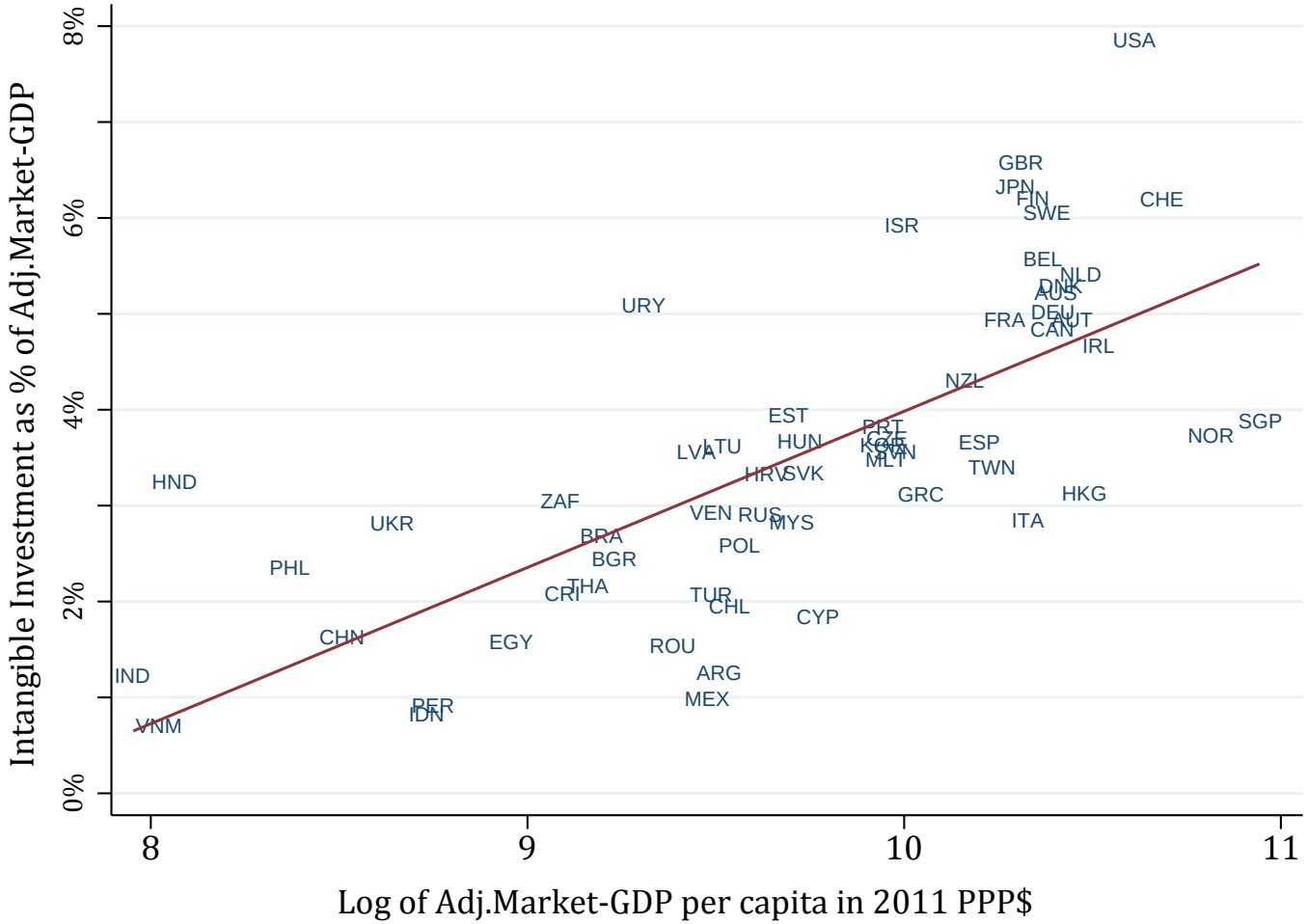
Total intangible investment: N

- $\mathrm{Y}' = \mathrm{s}^{M}\mathrm{GDP} + N^{RD} + N^{OC} + N^{BE}$; (54 SNA 1993; 6 SNA 2008)
- SNA (2008): AUS, CAN, HKG, MEX, SGP, USA

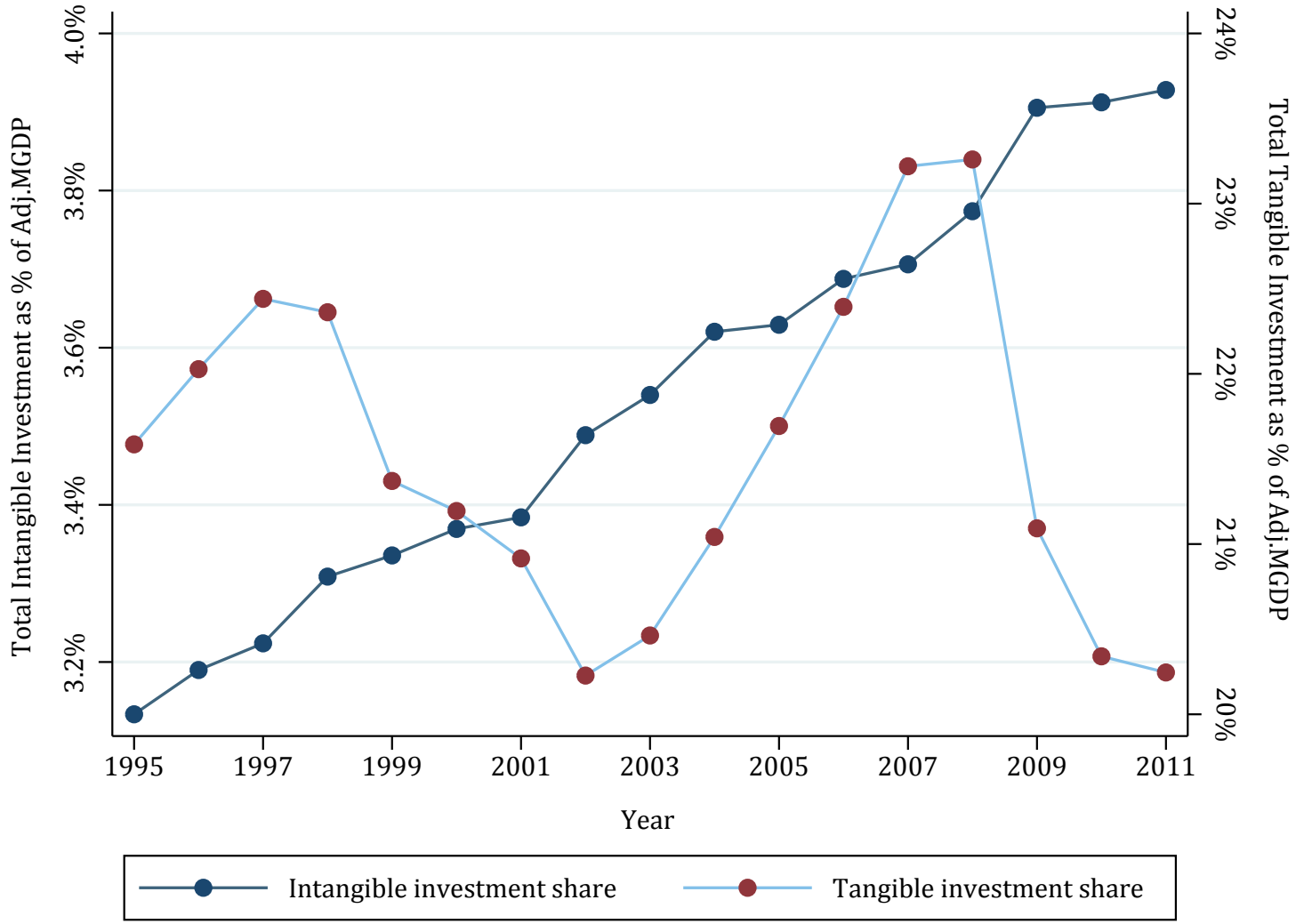
GDP numbers obtained from WDI are cross-checked with IMF WEOD (where GDP is solely based on SNA 1993): $\mathrm{GDP}^{WDI} = \mathrm{GDP}^{IMF}$

Data Feature 1

Intangible investment positively associated with per capita income:



Data Feature 2



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:**

$$y = A \cdot y_{KH}; \qquad y_{KH} \equiv k^{\alpha} h^{1-\alpha}$$

Basic setup of Development accounting

- **Variance decomposition ($y = A \cdot y_{KH}$):**

$$var[log(y)] = var[log(A)] + var[log(y_{KH})] + 2cov[log(A), log(y_{KH})]$$

- **If A is constant (in theory):**

$$var[log(y)] = var[log(y_{KH})]$$

- **In practice:**

$$VAF = \frac{var[log(y_{KH})]}{var[log(y)]}$$

Extended Model

- **Adding intangible capital:**

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

$$y\prime = A \cdot k^{\alpha} r^{\beta} (h)^{1-\alpha-\beta}$$

- **Rewrite as follows:**

$$y\prime \equiv A \cdot y_{KRH}$$

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

$$VAF' = \frac{var[log(y_{KRH})]}{var[log(y\prime)]}$$

Data Description: Basic Model

VAF	VAF'
$k^{\alpha} h^{1-\alpha} / y$	$k^{\alpha} r^{\beta} h^{1-\alpha-\beta} / y'$

- $y_{c,t}$: $(Y_{c,t}/p_t^{2011}/ppp_c^{2011})/emp_{c,t}$
  - Y: Nominal GDP in LCU (WDI);
  - p: GDP price deflator constant at 2011 price (WDI)
  - 2011 PPP exchange rate (WDI)
  - Number of persons engaged (PWT8.1)
- k: $K_{c,t}/emp_{c,t}$
  - $K_{c,t} = (1 - \delta^K) \cdot K_{c,t-1} + \frac{I_{c,t}}{p_{c,t}}$;
  - I= GFCF (WDI)
  - $\delta^K = 0.06$
  - 1960-2011 (52 years)
- $h_{c,t}$: standard procedure as function of the average years of schooling s
- α: 1/3 (Caselli, 2005)

Results: Basic Model

VAF	VAF'
$k^{\alpha} h^{1-\alpha} / y$	$k^{\alpha} r^{\beta} h^{1-\alpha-\beta} / y'$

Table 3: Variance Accounted For: Basic Model

Specification	Coverage (N)	var[log(y)]	var[log(y_{KH})]	VAF
Own data	Total Economy (60)	0.397	0.099	24.9%
Drop if $I_0 > 1970$	Total Economy (51)	0.443	0.111	25.0%
PWT 8.1	Total Economy (60)	0.453	0.111	24.5%
Own data	Market Economy (60)	0.443	0.111	25.0%

Note: Market economy indicates that the analysis is based on market- GDP, -investment, -employment.

Data Description: Extended Model

VAF	VAF'
$k^{\alpha} h^{1-\alpha} / y$	$k^{\alpha} r^{\beta} h^{1-\alpha-\beta} / y'$

- $y'_{c,t}$: $(Y'_{c,t}/p_t^{2011}/ppp_c^{2011})/emp'_{c,t}$; where $Y'_{c,t} = Y_{c,t} + \sum_{j=1}^{3} N_{j,c,t}$
- $k'_{c,t}$: $K'_{c,t}/emp'_{c,t}$;
- $r_{c,t}$: $R_{c,t}/emp'_{c,t}$
  - $R_{c,t} = (1 - \delta_j^R) \cdot R_{c,t-1} + \frac{N_{c,t}}{p_{c,t}}$;
  - N: Own data (developed in the study)
  - $\delta^{be} = 0.6$; $\delta^{oc} = 0.4$; $\delta^{rd} = 0.2$; (CHS, 2009)
  - 1995-2011 (17 years)
- h: same as before
- $\alpha\prime = 0.25$ [0.25-0.3]; $\beta = 0.15$ [0.15-0.25]; $\gamma\prime = 0.6$ [0.6-0.45]

Results: Extended Model

VAF	VAF'
$k^{\alpha} h^{1-\alpha} / y$	$k^{\alpha} r^{\beta} h^{1-\alpha-\beta} / y'$

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

	Factor shares	var[log(y′)]	var[log(y_{KRH})]	VAF′	Δ
Lower-bound	$\alpha = .27$ & $\beta = .1$	0.456	0.160	35.1%	*+10%*
Benchmark	$\alpha = .25$ & $\beta = .15$	0.456	0.195	42.8%	*+18%*
Alternative OC measure (R_c)	$\alpha = .25$ & $\beta = .15$	0.455	0.191	42.0%	*+17%*
Dropping ESP & GRC	$\alpha = .25$ & $\beta = .15$	0.468	0.200	42.7%	*+18%*
Upper-bound	$\alpha = .275$ & $\beta = .2$	0.456	0.261	57.2%	*+32%*

Conclusions & Discussions

- Intangible investment becomes increasingly important over time
- In all variants of the model considered, differences in intangible capital can account for 10% to 32% of the observed income differences, 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!

Human capital

$$\mathbf{h}=\mathbf{e}^{\phi(s)}$$

- $\phi(s) = 0.134 \cdot s$ $\quad if \quad s \leq 4$
- $\phi(s) = 0.134 \cdot 4 + 0.101 \cdot (s-4)$ $\quad if \quad 4 < s \leq 8$
- $\phi(s) = 0.134 \cdot 4 + 0.101 \cdot 4 + 0.068 \cdot (s-8)$ $\quad if \quad s > 8$

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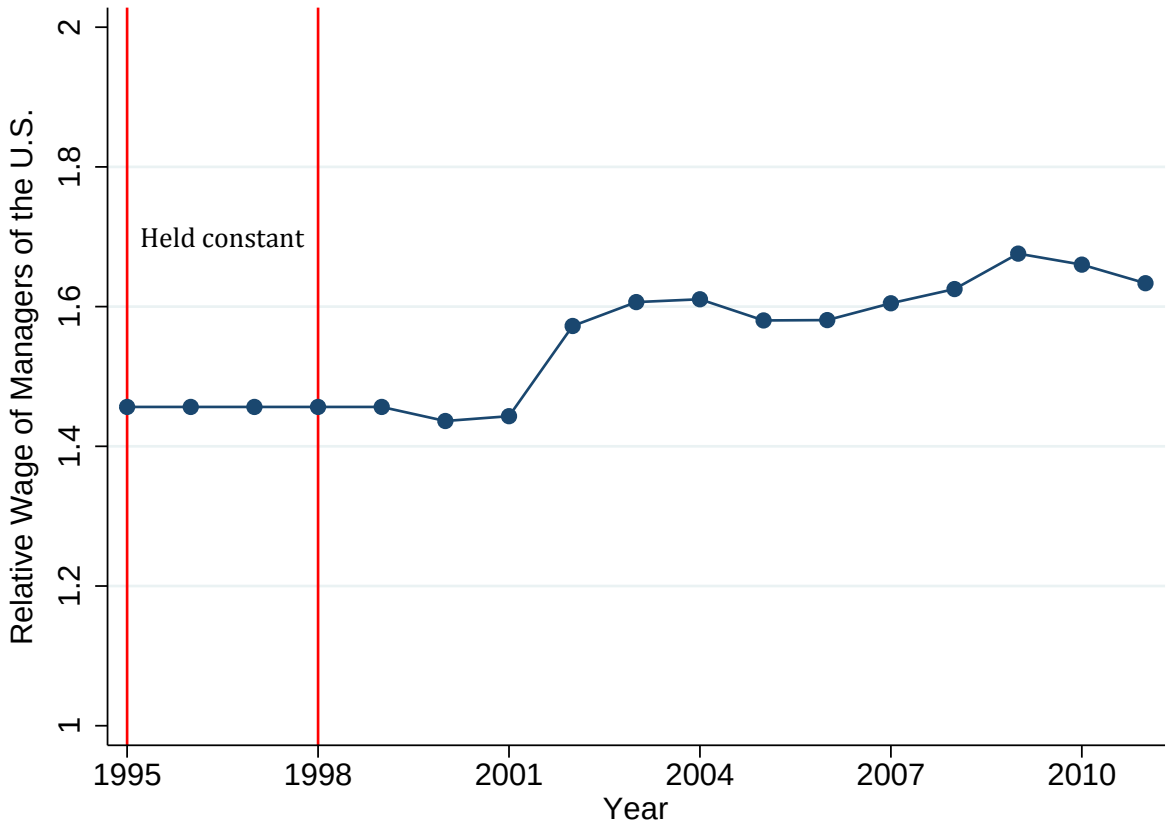
Relative Wage of Managers (USA)



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Relative Wage of Managers (ILO)

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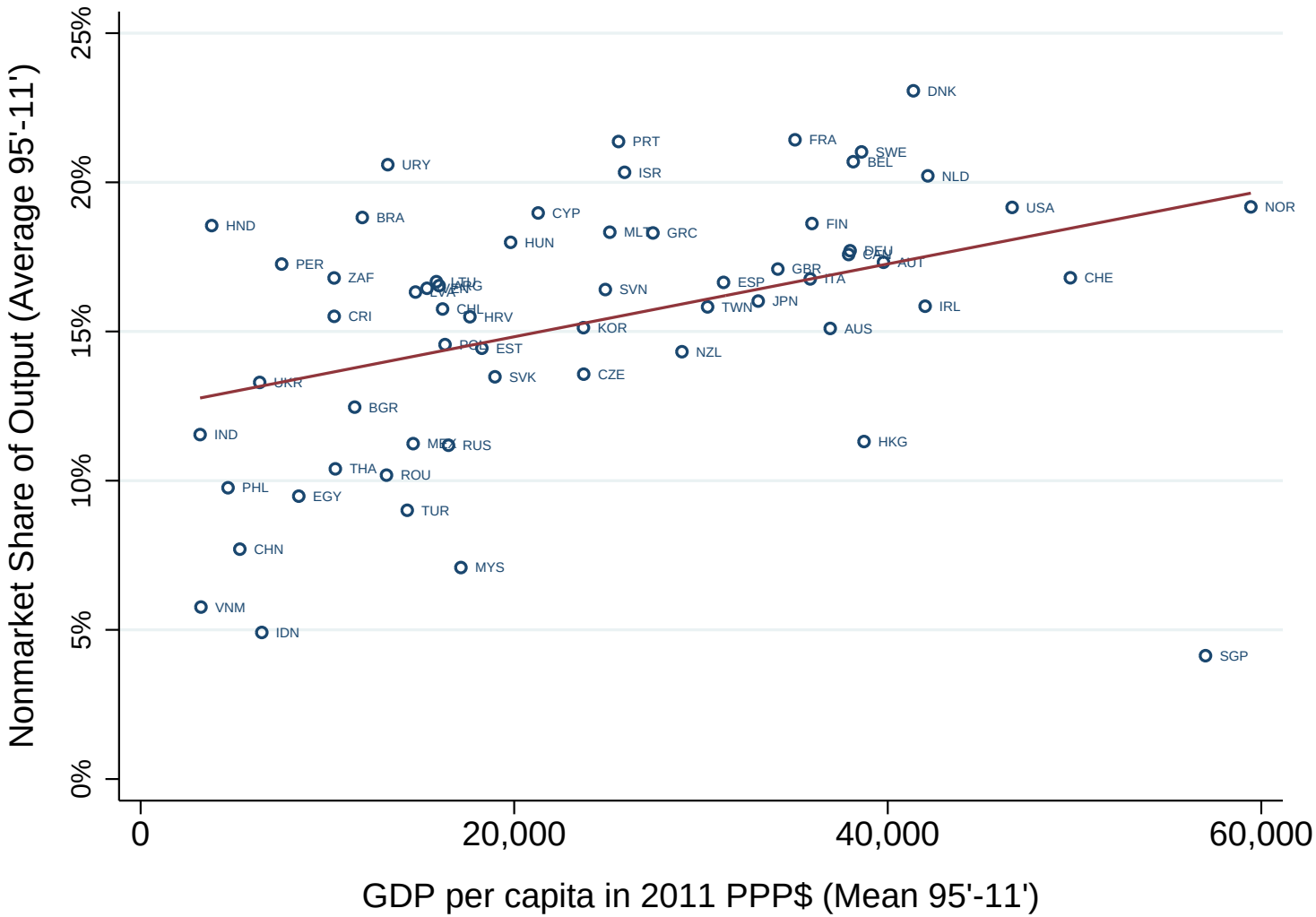
Nonmarket Share of Output (Average 95'-11')
0%
5%
10%
15%
20%
25%
0
20,000
40,000
60,000
GDP per capita in 2011 PPP$ (Mean 95'-11')
DNK
PRT
FRA
SWE
BEL
URY
ISR
NLD
USA
NOR
HND
BRA
CYP
MLT
GRC
FIN
HUN
DEU
AUT
PER
ZAF
GBR
ITA
CHE
SVN
ESP
TWN
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