Intangible Capital Around the World

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Overview

Motivation

- Firms increasingly rely on intangible capital to produce and generate profits
- Belo, Gala, Salomao, Vitorino (2022) shows that in the last 20 years in the US over 75% of firms value is associated to non physical capital

Questions

- What is the contribution of intangible capital for firm's market value around the world?
- What are the economic determinants of intangible capital investment?

This Paper

Approach

- Incorporate intangible capital into a neoclassical model of investment.
- Construct firm-level intangible capital stocks using financial data (balance-sheet and income statement) across 77 countries
- Estimate the model allowing for country-specific capital adjustment costs
- Link the adjustment costs in each country to country characteristics (IP protection, etc)

Preview of the Results

Intangible capital is crucial for explaining the dynamics of firm value across the globe!

1. Neoclassical q-theory model with two inputs fits the data well

- Time-series $R^2 = 55\%$ and Cross-sectional $R^2 = 88\%$.

2. Intangible capital accounts for a greater share of market value than physical capital.

- World: 54.92%

Preview of the Results (cont.)

Intangible capital is crucial for explaining the dynamics of firm value across the globe!

3. **Intangible capital adjustment costs are large and vary across countries**
   - *Physical capital*: Avg 3.68 and std of 1.86 (1.17% of sales)
   - *Intangible capital*: Avg 11.60 and std 6.22 (5.42% of sales)
4. **Cost of investing in intangible capital is lower in countries with:**
   - Stronger intellectual property (IP) protection
   - Lower costs of contract enforcement
   - More competitive financial market

The Model: Key Ingredients

Neoclassical model with 2 quasi-fixed inputs, subject to adjustment costs.

- K_t^P: physical capital (property, plant, and equipment)
- K_t^I: intangible capital (knowledge/skilled workers, brand)
- I_t^P: investment in physical capital
- I_t^I: investment in intangible capital

- Capital specific adjustment cost $C(\mathbf{I}_t, \mathbf{K}_t)$ describes the costs in investing
  - **Physical:** Planning/installation, temporary interruption of production
  - **Intangible:** Disruptions due to R&D/advertising/training

The Model: Firm's Problem

The manager chooses the firm's investment to maximize its value:

$$V_{it} \equiv \max_{\{L_{it+\triangle t}, \mathbf{I}_{it+\triangle t}, \mathbf{K}_{it+\triangle t+1}, B_{it+\triangle t+1}\}_{\triangle t=0}^{\infty}} E_t \left[\sum_{\triangle t=0}^{\infty} M_{t+\triangle t} D_{it+\triangle t} \right], \tag{1}$$

where the payout is

$$D_{it} \equiv (1-\tau_t)[\Pi_{it} - C(\mathbf{I}_{it}, \mathbf{K}_{it}) - I_{it}^I] \quad \begin{array}{l} -I_{it}^P + B_{it+1} - r_{it}^B B_{it} \\ +\tau_t \delta_{it}^P K_{it}^P + \tau_t (r_{it}^B - 1) B_{it}. \end{array} \tag{2}$$

B_{it+1} is debt and $\Pi_{it} = \Pi(\mathbf{K}_{it}, L_{it})$ is operating profit.

Physical and intangible capital evolve as:

$$K_{it+1}^P = I_{it}^P + (1-\delta_{it}^P) K_{it}^P \qquad [q_{it}^P] \tag{3}$$

$$K_{it+1}^I = I_{it}^I + (1-\delta_{it}^I) K_{it}^I \qquad [q_{it}^I] \tag{4}$$

q_{it}^P and q_{it}^I are Lagrange multipliers.

The model: First Order Conditions

Optimal **physical capital** investment:

$$\underbrace{1+(1-\tau_t)\frac{\partial C_{it}}{\partial I_{it}^P}}_{q_{it}^P\text{: Physical Capital Marginal q}} = E_t\left[M_{t+1}\left[(1-\tau_{t+1})\left(\frac{\partial \Pi_{it+1}}{\partial K_{it+1}^P}-\frac{\partial C_{it+1}}{\partial K_{it+1}^P}\right)+\delta_{it+1}^P\tau_{t+1}+(1-\delta_{it+1}^P)q_{it+1}^P\right]\right]$$

Optimal **intangible capital** investment:

$$\underbrace{(1-\tau_t)\left[1+\frac{\partial C_{it}}{\partial I_{it}^I}\right]}_{q_{it}^I\text{: Intangible Capital Marginal q}} = E_t\left[M_{t+1}\left[(1-\tau_{t+1})\left(\frac{\partial \Pi_{it+1}}{\partial K_{it+1}^I}-\frac{\partial C_{it+1}}{\partial K_{it+1}^I}\right)+(1-\delta_{it+1}^I)q_{it+1}^I\right]\right]$$

The Model: Empirical Implications

Let $P_{it} \equiv V_{it} - D_{it}$ be the ex-dividend equity value.

Theorem (Hayashi,1982)

If operating profit function $\Pi(.)$ and adjustment cost function $C(.)$ are CRS, firm's value maximization implies that

$$P_{it} + B_{it+1} = q^P_{it} K^P_{it+1} + q^I_{it} K^I_{it+1}, \tag{5}$$

in which

$$\begin{aligned} q^P_{it} &= 1 + (1 - \tau_t) \cdot \frac{\partial C_{it}}{\partial I^P_{it}}, \\ q^I_{it} &= (1 - \tau_t) \cdot (1 + \frac{\partial C_{it}}{\partial I^I_{it}}). \end{aligned} \tag{6}$$

Economic interpretation

- Euler equation: marginal cost = marginal benefit
- q's: shadow price of installed capital inputs, inferred from marginal cost
- => Value of each capital input: q*stock

Estimation Procedure: Stationarity

Estimate the model using valuation ratios (VR), not levels

- Denote $A_{it} = K_{it}^I + K_{it}^P$ as firm's total assets.
- The firm's *observed* valuation ratio (VR_{it}) is given by

$$VR_{it} = \frac{P_{it} + B_{it+1}}{A_{it+1}} \tag{7}$$

- And the *model-implied* valuation ratio $V\hat{R}_{it}$ is given by

$$V\hat{R}_{it} = q_{it}^P \cdot \frac{K_{it+1}^P}{A_{it+1}} + q_{it}^I \cdot \frac{K_{it+1}^I}{A_{it+1}}, \tag{8}$$

Parameterization

- Country-specific adjustment costs function for home country $c(i)$

$$C_{it} = \frac{\theta_{P,c(i)}}{2}\left(\frac{I_{it}^P}{K_{it}^P}\right)^2 K_{it}^P + \frac{\theta_{I,c(i)}}{2}\left(\frac{I_{it}^I}{K_{it}^I}\right)^2 K_{it}^I, \tag{9}$$

- The *model-implied* valuation ratio $V\hat{R}_{it}$ is

$$V\hat{R}_{it} = [1+(1-\tau_{c(i),t})\theta_{P,c(i)}\left(\frac{I_{it}^P}{K_{it}^P}\right)]\cdot\frac{K_{it+1}^P}{A_{it+1}}+(1-\tau_{c(i),t})\left[1+\theta_{I,c(i)}\left(\frac{I_{it}^I}{K_{it}^I}\right)\right]\cdot\frac{K_{it+1}^I}{A_{it+1}},$$

$\Rightarrow$ The $\Theta = (\theta_P, \theta_I)$ is the set of parameters to be estimated.

Estimation Approach

- Benchmark: Estimate model by country/area.
- Portfolio-level: diversify firm-level noise; 20 portfolios sorted on (lagged) input value of each capital input
- Estimation targets cross-sectional mean of firm's VR:

$$\overline{VR}_{it} = \widehat{\overline{VR}}_{it}\left(\Theta\right) + \varepsilon_{it} \tag{10}$$

where:

$$\overline{VR}_{jt} = \sum_i \frac{VR_{it}}{N_{jt}} \text{ and } \widehat{\overline{VR}}_{jt}\left(\Theta\right) = \sum_i \frac{\widehat{VR}_{it}}{N_{jt}}\ ,\ i \in \text{portfolio } j$$

How? Minimize sum of squared errors:

$$\widehat{\Theta} = \arg\min_{\Theta} \frac{1}{TN} \sum_{t=1}^{T} \sum_{j=1}^{N} \left(\overline{VR}_{jt} - \widehat{\overline{VR}}_{jt}\left(\Theta\right)\right)^2 \tag{11}$$

- Number of observations: N $\times$ T, #portfolios $\times$ #periods

Data

- **Listed firms** in Compustat Global, Compustat North America
  - Home Country: Headquarter (not incorporation)
  - Sample period: 2001-2020
  - Debt Value: book value
  - All values in USD (real terms, deflate by CPI)
  - τ_{it} : corporate income tax rate from the Tax Foundation

Data: Capital Accounting

- **Intangible Capital**
  - Investment is set to be 30% of XSGA
  - Depreciation rate is calibrated as $\delta^I = 20\%$
  - Use the perpetual inventory method to calculate initial capital stock:

$$K_{i,0}^I = \frac{I_{i,0}^I}{g^I + \delta^I - \pi \cdot (1 - \delta^I)}$$

g^I :average growth rate of XSGA; π :inflation rate;

- **Physical Capital**
  - Installed capital is PPENT
  - Depreciation is DP ($\delta_{it}^P = \frac{DP_{it}}{K_{it}^P}$)
  - Infer investment from law of motion of capital

$$I_{it}^P = K_{it+1}^P - (1 - \delta_{it}^P) K_{it}^P$$

Data: Major Economies and Areas

77 Countries: 17 Major Economies and 4 Remaining Areas

- China, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, **Rest of Asia** (Israel, Pakistan, Turkey, Viet Nam, Others)
- France, Germany, Poland, United Kingdom, **Rest of Europe** (Greece, Italy, Sweden, Switzerland, Others)
- Canada, United States of America, **Rest of America** (Brazil, Others)
- Australia
- *Africa* (South Africa, Others)

$\Rightarrow$ **12869 firm/year with sales equal to 36.77% of World GDP**

$\Rightarrow$ Estimate country/area specific parameters

Estimated Adjustment Cost Parameters

Summary of Estimation				
	Point Estimate		Cost as % of Sales	
	θ_P	θ_I	Physical $\frac{\frac{\theta_P}{2}\left(\frac{I^P_{it}}{K^P_{it}}\right)^2 K^P_{it}}{Y_{it}}$	Intangible $\frac{\frac{\theta_I}{2}\left(\frac{I^I_{it}}{K^I_{it}}\right)^2 K^I_{it}}{Y_{it}}$
Per Country/Area Estimation (17 Countries and 4 Areas)				
Average θ	**3.68**	**11.60**	1.17	5.42
S.D. θ	**1.86**	**6.22**		

=> Large adjustment costs, especially for intangible capital ($\gg$ physical capital)

Estimated Adjustment Cost Parameters

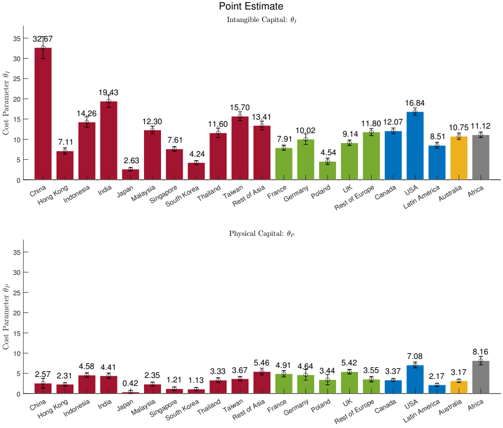

Figure 1: Point Estimates in Benchmark Model

=> Intangible capital costs $\gg$ physical capital (globally); Heterogeneity

Model Fit

	Two Input Model (Benchmark)			Physical Capital Only			Using Globe Parameters		
World									
	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
	0.88	0.55	0.22	0.13	-0.27	0.40	0.31	0.20	0.30
Per Region Estimation Outcome									
	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
Asia	0.88	0.56	0.23	0.37	-0.09	0.38	0.19	0.11	0.34
Europe	0.83	0.41	0.23	-0.39	-0.64	0.41	0.56	0.28	0.26
Americas	0.94	0.70	0.18	-0.00	-0.30	0.41	0.44	0.34	0.27
Oceania	0.67	0.32	0.24	-1.69	-1.07	0.46	0.77	0.32	0.25
Africa	0.46	0.37	0.20	-5.17	-1.01	0.40	-0.70	0.21	0.23

=> Intangible capital and country-specific parameters are crucial for explaining firm's valuation around the world

Robustness Checks

Industry-level heteregeneity? Not much effect. Here

Firm-level vs portfolio-level estimation? Similar results. Here

Home country: Only domestic firms? (Headquarters =Incorporation) Here

Alternative intangible capital measures? Here

Intangible Capital Share of Market Value

	Market Share of Intangible (%)	Book Share of Intangible (%)
World		
	54.92	**31.45**
S.D.	9.15	11.16
Regions		
Asia	53.00	27.55
Europe	60.81	46.52
Americas	60.80	42.72
Oceania	53.32	33.47
Africa	58.21	35.57

=> Intangible capital accounts for a greater share of firm market value than physical capital!

Takeaways on Country-Specific Estimation

- Inputs are expensive to adjust
  - Intangible $>>$ Physical
- Intangible capital contributes to a large share of firm's market value
  - Contribution of intangible capital for firm value $>$ contribution of physical capital

Next: **What are the economic determinants of adjustment costs?**

- Link country-level adjustment costs to country-characteristics

Country Characteristics

(a) Protection of Intellectual Property Rights

- Secrets and Patents (Institutional Profile Database)
  industry competition and creative destruction: Klette and Kortum (2004) Crouzet, Eberly, Eisfeldt, and Papanikolaou (2022), Rempel (2021)

(b) Employment Contract Protection

- Tenure Contract, Collective Dismissal (Institutional Profile Database)
  talent retention and dismissal compensation:Eisfeldt and Papanikolaou (2013),Acharya, Baghai, and Subramanian (2014), McLean, Zhang, and Zhao (2012)

(c) Ease of Contract Enforcement

- Procedures, Litigation Years (Doing Business - WB)

(d) Cost of Financing (Market Power of Lender)

- Bank Profit , Concentration (WFD), Competition (Institutional Profile Database)
  loan screening and information rent: Hauswald and Marquez (2006); financial wedge: Chari, Kehoe, and McGrattan (2007),Bolton, Chen, and Wang (2011)

(e) Protection of Investor Rights

- Information Disclosure, Director Liability, Shareholder Suits (Doing Business - WB)
  voting right, corporate governance and shareholder valuation: La Porta, Lopez-de Silanes, Shleifer, and Vishny (2002), McLean, Zhang, and Zhao (2012)

(f) Economic Development

- GDP per capita (UN), Population(UN), Construction Permit (Doing Business - WB)
  wage cost, scale effect in industry competition, physical infrastructure

Country Characteristics Model

Model Specification and Estimation Method

- Quadratic adjustment costs function with state-contingent cost $\theta_P(\mathbf{X}), \theta_I(\mathbf{X})$

$$C_{it} = \frac{\theta_P(\mathbf{X})}{2}\left(\frac{I_{it}^P}{K_{it}^P}\right)^2 K_{it}^P + \frac{\theta_I(\mathbf{X})}{2}\left(\frac{I_{it}^I}{K_{it}^I}\right)^2 K_{it}^I, \tag{12}$$

- Adjustment cost function is parameterized as,

$$\begin{aligned} \theta_I(\mathbf{X}) &= \theta_{I,g} + \boldsymbol{\gamma^I} \cdot \mathbf{X_c} \\ \theta_P(\mathbf{X}) &= \theta_{P,g} + \boldsymbol{\gamma^P} \cdot \mathbf{X_c} \end{aligned} \tag{13}$$

- State variables of institutional environment in countries are determinants
  - (a) Protection of Intellectual Property Rights
  - (b) Employment Contract Protection
  - (c) Ease of Contract Enforcement
  - (d) Cost of Financing
  - (e) Protection of Investor Rights
  - (f) Economic Development

Point Estimates

Incremental Cost Coefficient

- Joint estimation of incremental cost.
  - Stronger IP protection, lower cost of contract procedures, lower bank profits (competition) has smaller cost: $\gamma^I < 0$

Incremental Cost Coefficient		Point Estimates (for the subset of 14 characteristics) (a) IPR	(b-1) Labor	(c-1) Contract	(d-1) Finance	(e-1) Shareholder	(f-1) Devp.
		Secrets and Patents	Tenure	Procedures (Cost)	Bank Profit	Information Disclosure	GDP per capita
Intangible Capital	γ_x^I	-2.93 ** (0.77)	-0.47 (0.40)	0.59 *** (0.09)	15.49 *** (1.60)	-0.55 * (0.29)	2.07 ** (0.50)
Physical Capital	γ_x^P	-0.33 (0.44)	-0.25 (0.23)	-0.03 (0.05)	2.28 ** (0.88)	-0.09 (0.15)	0.57 * (0.28)

Other Country Characteristics

Importance of IP protection

- 17 large countries grouped by Intellectual Property Protection

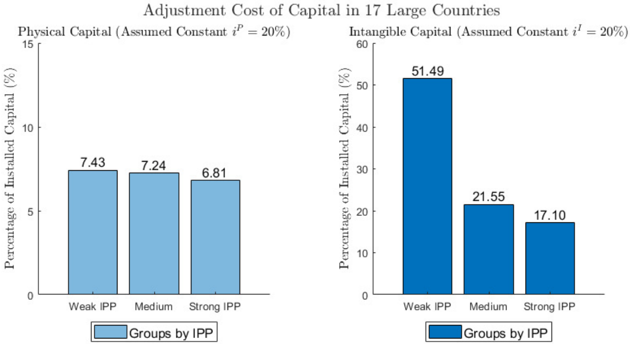

Figure 2: Cost of Intangible Capital Calibrated using Model Estimates

Other relevant country-characteristics

- Other determinants: cost is larger if there is lengthy procedures in contract enforcement, high bank profit, etc.

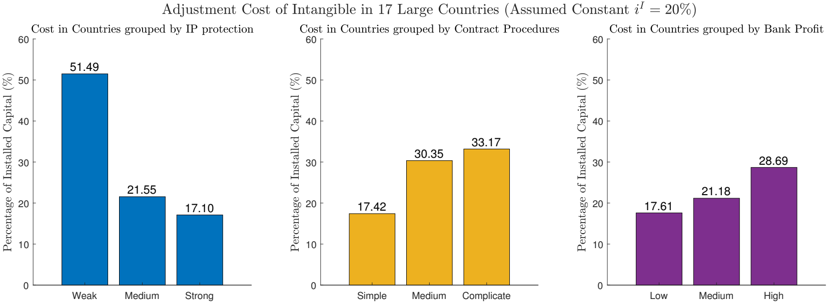

Figure 3: Cost of Intangible Capital Calibrated using Model Estimates

Cost of Physical Capital

Country characteristics and adjustment costs

- Asymmetric correlation: high cost in intangible capital, but no large effect for the physical capital

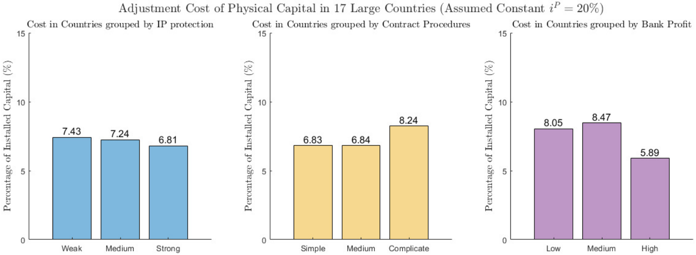

Figure 4: Cost of Physical Capital Calibrated using Model Estimates

Slide of Intangible Capital

Link between country-characteristics and shares

- Relationship between capital input shares and adjustment costs/country characteristics is more nuanced...

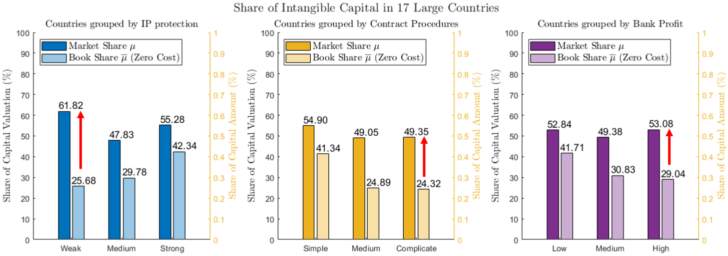

Figure 5: Share of Intangible Capital in Model Estimation

Summary and Conclusion

Intangible capital

- is costly to adjust and this cost varies across countries
- is crucial for explaining firm valuation across all countries
- accounts for a large share of firm's market value around the world; more than physical capital!
- has heterogeneous market value across countries
- variation in value across countries is mostly explained by differences in protection of intellectual property rights, and cost of financing

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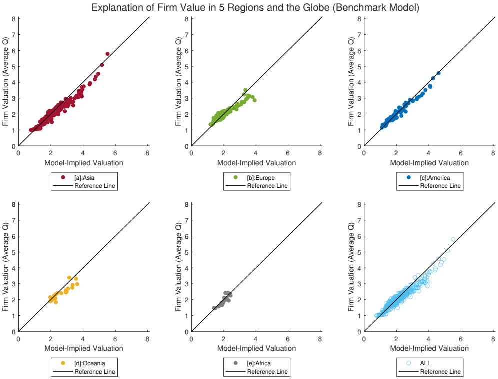
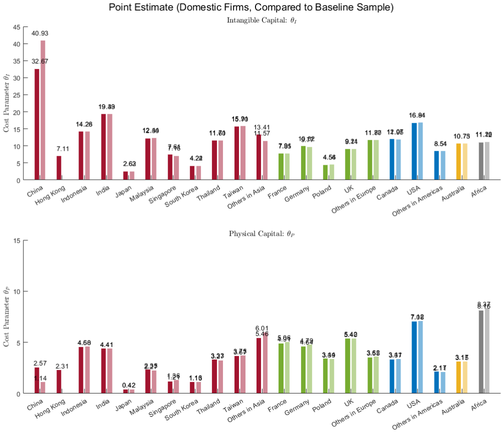
Model Fit in Characteristic Portfolios



Model-implied valuation for the 10 * 3 * 21 portfolios around the world. In each country/area, firms are grouped by investment rate in intangible capital, physical capital, and intensity of intangible capital.

Summary of Estimation

Estimation using only Domestic Firms



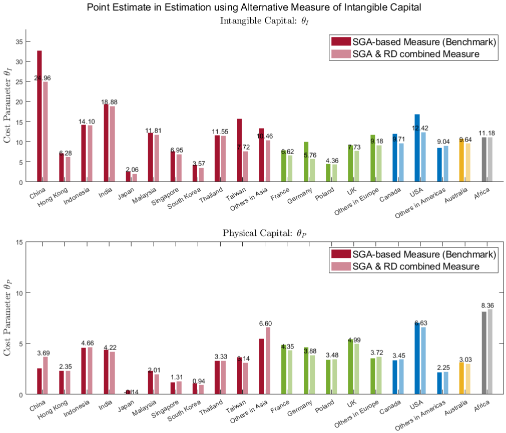
=> Including only domestic firms (headquarters=incorporation) leads to small changes. Robustness

Alternative Measures (1 of 2)

- The coverage of firms reporting XRD varies by country and time period.
- Infeasible to compare Knowledge capital for each firm
- Alternative measure: **0.3 * (SGA-RD) + RD** as the total flow of investment in intangible capital
  - some countries report both in aggregate expense and item-level expense
  - U.S., Canada, South Korea, Japan, etc: 0.3 * (SGA-RD) + RD
  - Taiwan, Singapore, Germany, Malaysia: 0.3 * SGA + RD

Alternative Measures (2 of 2)

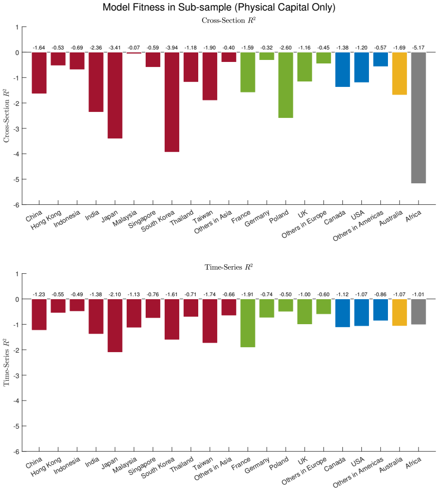
- Alternative measure: 0.3 * (SGA-RD) + RD as the flow of investment in intangible capital



=> Similar results Robustness

Counter-factual Model Fit

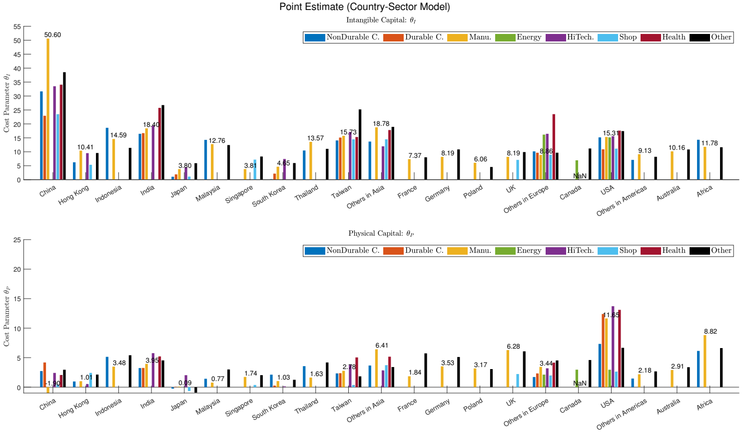
- Counter-factual model of single capital (physical capital)



Summary of Estimation

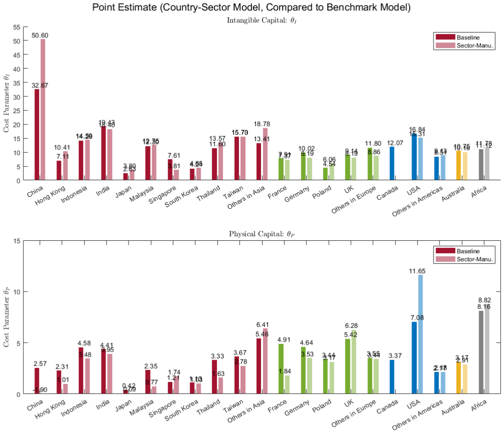
Industries in Countries

- Extended model of country-sector specific adjustment cost

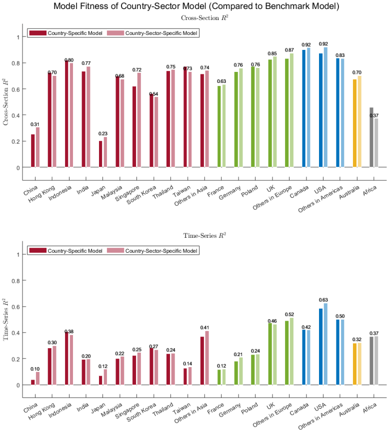


Manufacturing sectors in Countries

- Example: large cross-country variation in Manufacturing sectors



Country-Industry Parameters



=> Industry heterogeneity leads to a small improvement in fitness. Robustness

Country Characteristics: Pairwise Correlation

Abb.	Name of Characteristic	Pairwise Correlation													
		(a)	(b-1)	(b-2)	(c-1)	(c-2)	(d-1)	(d-2)	(d-3)	(e-1)	(e-2)	(e-3)	(f-1)	(f-2)	(f-3)
(a)	Secrets and Patents														
(b-1)	Tenure	0.34													
(b-2)	Collective Dismissal	0.08	0.15												
(c-1)	Procedures	-0.51	-0.22	0.01											
(c-2)	Litigation Years	-0.19	0.02	0.21	0.34										
(d-1)	Bank Profit	-0.27	-0.13	-0.15	0.28	-0.10									
(d-2)	Concentration (%)	0.35	0.13	0.11	-0.17	-0.07	-0.07								
(d-3)	Competition	0.21	0.22	-0.03	-0.04	-0.07	-0.13	0.10							
(e-1)	Information Disclosure	0.05	0.03	-0.15	-0.10	-0.12	0.35	-0.06	0.03						
(e-2)	Director Liability	0.12	0.13	0.00	0.03	0.07	0.14	0.09	-0.05	0.13					
(e-3)	Shareholder Suits	0.31	0.27	0.08	-0.44	0.01	-0.15	0.06	0.01	0.16	0.17				
(f-1)	GDP per capita	0.70	0.25	0.06	-0.40	-0.30	-0.13	0.45	0.14	0.15	0.20	0.17			
(f-2)	Population	-0.36	-0.12	0.05	0.15	0.12	0.03	-0.48	-0.09	0.17	-0.08	-0.05	-0.45		
(f-3)	Construction Permit	-0.46	-0.29	0.01	0.20	0.15	0.06	-0.27	-0.01	-0.18	-0.01	-0.07	-0.46	0.35	
	Average abs(corr)	0.31	0.18	0.08	0.22	0.14	0.15	0.19	0.09	0.13	0.10	0.15	0.30	0.19	0.19

Relation Between Country Characteristics and Adjustment Cost

Name of topic	Name of Characteristic	Correlation to Benchmark Estimate			
		θ_P	(s.e.)	θ_I	(s.e.)
(1)	(2)	(3)	(4)	(5)	(6)
(a) **Intellectual Property Rights**	Secrets and Patents	-0.22	(0.26)	-0.66 **	(0.19)
(b) **Labor Market**	Tenure	0.01	(0.15)	-0.31 **	(0.12)
	Collective Dismissal	-0.26	(0.18)	-0.36 **	(0.10)
(c) **Contract Enforcement**	Procedures	0.31 *	(0.14)	0.47 **	(0.09)
	Litigation Years	0.25 *	(0.13)	0.31 *	(0.18)
(d) **Financial Market**	Bank Profit	0.06	(15.32)	0.61 **	(0.22)
	Concentration (%)	-0.32	(0.24)	-0.35 *	(0.18)
	Competition	0.22 *	(0.10)	-0.37	(0.34)
(e) **Investor Protection**	Information Disclosure	-0.36 *	(0.17)	0.19	(0.15)
	Director Liability	-0.06	(0.15)	-0.24	(0.26)
	Shareholder Suits	-0.20	(0.14)	-0.45 **	(0.13)
(f) **Economic Development**	GDP per capita	-0.25	(0.21)	-0.39 *	(0.17)
	Population	0.16	(0.20)	0.59 **	(0.17)
	Construction Permit	0.17 *	(0.11)	0.43 **	(0.11)

Main Slide of Summary Stats.

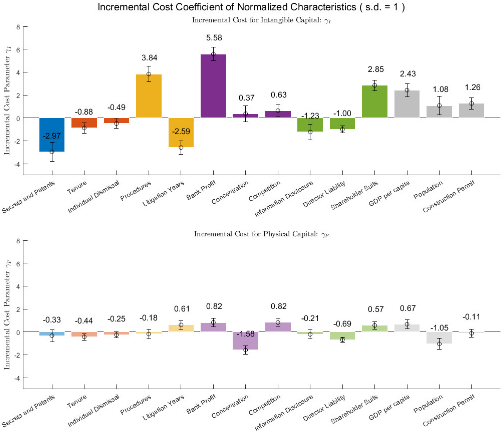
Incremental Cost Coefficient for Country Characteristics

Name of topic	Name of Characteristic	Incremental Cost Coefficients			
		γ_P	(s.e.)	γ_I	(s.e.)
(1)	(2)	(3)	(4)	(5)	(6)
(a) **Intellectual Property Rights**	Secrets and Patents	-0.33	(0.44)	-2.93 **	(0.77)
(b) **Labor Market**	Tenure	-0.25	(0.23)	-0.47	(0.40)
	Collective Dismissal	-0.46 *	(0.26)	-0.92 *	(0.45)
(c) **Contract Enforcement**	Procedures	-0.03	(0.05)	0.59 ***	(0.09)
	Litigation Years	0.74 *	(0.37)	-3.14 **	(0.64)
(d) **Financial Market**	Bank Profit	2.28 **	(0.88)	15.49 ***	(1.60)
	Concentration (%)	-0.10 **	(0.02)	0.02	(0.04)
	Competition	1.07 **	(0.37)	0.81	(0.68)
(e) **Investor Protection**	Information Disclosure	-0.09	(0.15)	-0.55 *	(0.29)
	Director Liability	-0.31 **	(0.08)	-0.46 **	(0.14)
	Shareholder Suits	0.29 *	(0.14)	1.47 ***	(0.23)
(f) **Economic Development**	GDP per capita	0.57 *	(0.28)	2.07 **	(0.50)
	Population	-0.60 **	(0.24)	0.61	(0.47)
	Construction Permit	-0.02	(0.05)	0.20 **	(0.08)

Note: for an aspect with highly correlated characteristic variables, principal variable is included in the model.

Main Slide of Parameters

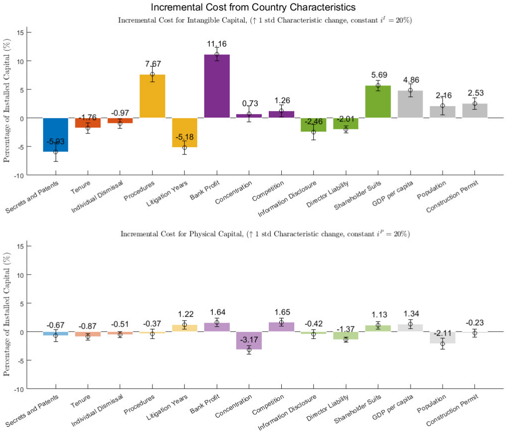
Normalized Cost Coefficient for Country Characteristics



Main Slide of Parameters

Incremental Cost from Country Characteristics

- Counter-factual calibration of stronger IP protection by 1 std
  => cost decreases by 5.93% per unit of intangible capital



Main Slide of Parameters

Validation of Country-Characteristic Model

- Country-Char. model explains firm valuation about as well as benchmark model

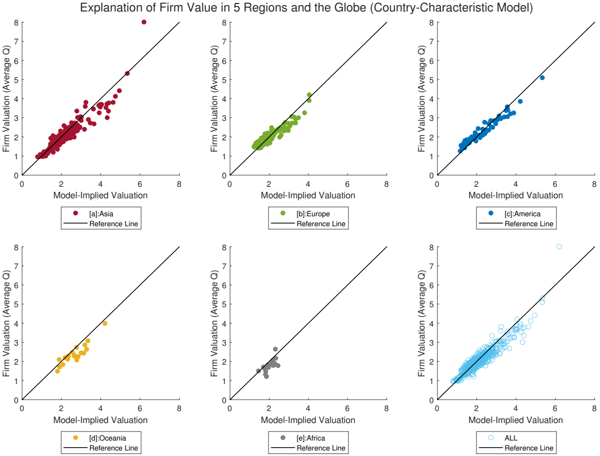
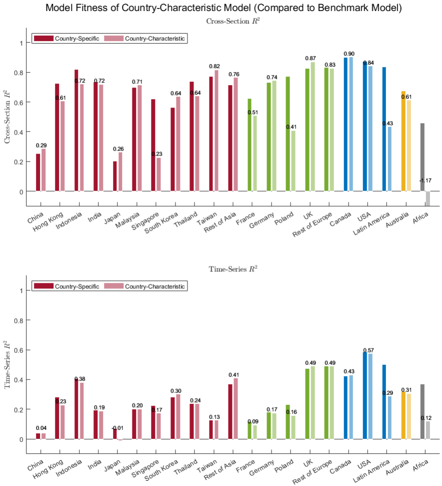


Figure 6: Fitness of Model in 420 Portfolios of 5 Regions (Country-Characteristic Model)

Fitness of Country-Characteristic Model

- Extended model has comparable fitness in most large economies and areas



Explanation from Country-Characteristic Model

- Cross-country variation of capital valuation is determined as

$$\begin{aligned} q_c^I &= (1-\tau_c) + (1-\tau_c) \cdot [q_g^I + \mathbf{q}_X^I \cdot \mathbf{X_c}] \\ q_c^P &= 1 + (1-\tau_c) \cdot [q_g^P + \mathbf{q}_X^P \cdot \mathbf{X_c}] \end{aligned} \tag{14}$$

- Cost compensation for country characteristic X_c

$$q_X^I = \gamma_x^I \cdot i^I \quad , \quad q_X^P = \gamma_x^P \cdot i^P \tag{15}$$

- Valuation contributed by country characteristic (deviation from global),

$$\{\gamma_z^I \cdot i^I \cdot \frac{K^I}{K^P + K^I} \cdot X_{z,c}\}_z, \qquad s.t. \frac{1}{N_c} \sum_c X_{z,c} = 0$$

- Large γ_z^I and sizable variation in $X_{z,c}$
  $\Longrightarrow$ Firm value differs from other countries due to country-characteristic X_z

Characteristic-Specific Valuation of Capitals

- Cross-country variation in capital valuation
  joint decomposition => main drivers : **IP protection** and **cost of financing**

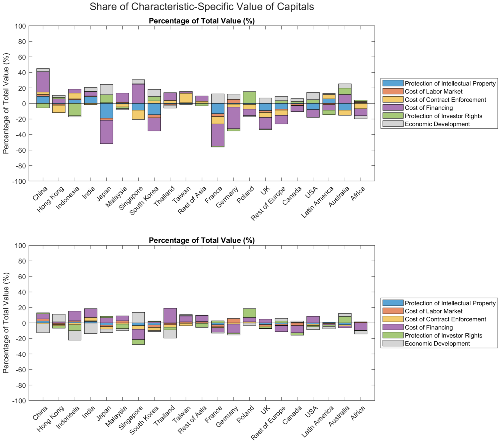
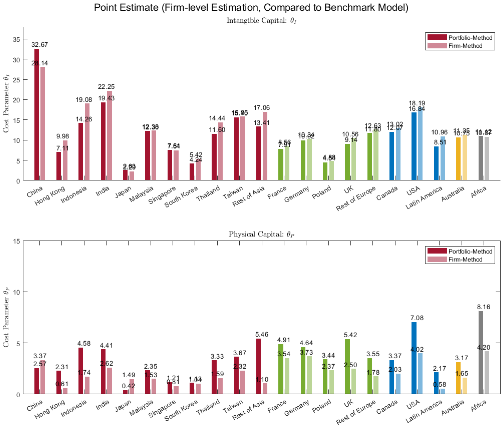


Figure 7: Composition of Characteristic-Specific Value

Firm-Level Estimates



=> Firm-level estimates are similar. Robustness

Comparison to Investment-Q Regression

- The equivalent OLS regression,

$$\begin{aligned}&\frac{V}{K^P+K^I}-\frac{K^P}{K^P+K^I}-(1-\tau_c)\frac{K^I}{K^P+K^I}\\=\quad&\theta_I(\mathbf{X})\cdot(1-\tau_c)\cdot i^P\cdot\frac{K^P}{K^P+K^I}+\theta_P(\mathbf{X})\cdot(1-\tau_c)\cdot i^I\cdot\frac{K^I}{K^P+K^I}\end{aligned} \tag{16}$$

- Institutional development and financial market development determine the adjustment cost parameters,

$$\theta_I(\mathbf{X})=\quad\theta_{I,g}+\boldsymbol{\gamma}^{\boldsymbol{I}}\cdot\mathbf{X_c}\quad,\quad\theta_P(\mathbf{X})=\quad\theta_{P,g}+\boldsymbol{\gamma}^{\boldsymbol{P}}\cdot\mathbf{X_c} \tag{17}$$

- The role of intangible capital and country-characteristics

$$\begin{aligned}\frac{V}{K^P}\quad=\quad&\underbrace{1+(1-\tau_c)\cdot\theta_{P,g}\cdot i^P}_{\text{Hayashi}}+\underbrace{(1-\tau_c)\cdot\boldsymbol{\gamma}^{\boldsymbol{P}}\cdot\mathbf{X_c}\cdot i^P}_{\text{McLean et al (2012)}}\\&\underbrace{+(1-\tau_c)\cdot\frac{K^I}{K^P}+(1-\tau_c)\cdot\theta_{I,g}\cdot i^I\cdot\frac{K^I}{K^P}+(1-\tau_c)\cdot\boldsymbol{\gamma}^{\boldsymbol{I}}\cdot\mathbf{X_c}\cdot i^I\cdot\frac{K^I}{K^P}}_{\text{Intangible Capital and Country-Specific Cost}}\end{aligned} \tag{18}$$

Return to C-Characteristics | Return to Q-equation