

Early Childhood Development and Structural Change

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Introduction

Motivation

- **Structural change:** economic activity reallocates across sectors w/ development
- Dominant theories of structural change stress the role of preferences and technology...
 - Non-homothetic preferences → income effects (Kongsamut et al., 2001)
 - Uneven sectoral TFP growth → relative price effects (Ngai and Pissarides, 2007)
- ... but sectors also vary in skill intensity
 - Human capital → skill supply (Caselli and Coleman, 2001; Porzio et al., 2022)
 - Modeled as single-schooling decision or cohort-level endowment
- **Problem:** Overlooks a large literature on skill formation
 - Skills are built over multiple stages of childhood (Cunha and Heckman, 2007)
 - Early skills ↑ return to later investments (*dynamic complementarity*)

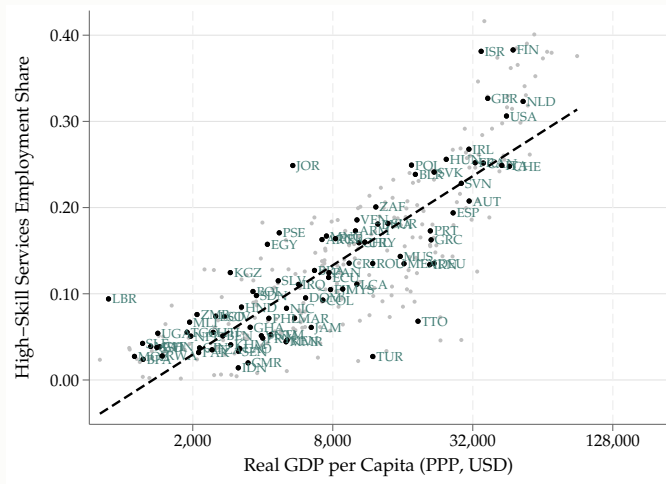
The Research Question

How does early childhood development shape structural change?

- Pay special attention to the composition of Services
 - Services: main destination of labor in rich *and* poor countries
 - But only *skill-intensive*, high-productivity Services sustain high wages

Early Childhood Development → Skill Supply → High-Skill Services

High-Skill Services Share $\uparrow$ w/ Development



In This Paper

Contribution: Skills via **early childhood development** in structural change

1. Documents two new cross-country facts

- Parental time with 0–4 yr. olds $\uparrow$ with development ► Why time?
- 4 yr. old cognitive scores $\uparrow$ with development

2. Develops a heterogeneous-agent GE model

- Structural change + endogenous skill distribution
- Multi-stage human capital formation w/ dynamic complementarity
- Income effects over *both* sectoral consumption *and* time with children

3. Quantifies ECD's contribution to structural change

- Calibrate to US (i) struct. change (ii) time allocation (iii) skill distribution
- Run a number of quantitative exercises

Preview of Results

1. **Parental time allocation is quantitatively important** (accounting)
 - Accounts for **35.0%** of the rise in the HSS share in GE and **64.3%** in PE
2. **Dynamic complementarity amplifies skill formation**
 - Accounts for **33.1%** of the rise in the HSS share in GE and **64.0%** in PE
3. **Human-capital inequality slows structural change**
 - Higher inequality reduces the rise in the HSS share by **19.3%**

Related Literature

1. ECD and macroeconomic outcomes

Yum, 2023; Daruich, 2018; Manuelli and Seshadri, 2014; Schoellman, 2016; Youderian, 2019; Caucutt and Lochner, 2020; Lee and Seshadri, 2019; de la Croix and Licandro, 2013

→ Explicit focus on parental time allocation, structural change

2. Sources of structural change

Kongsamut et al., 2001; Ngai and Pissarides, 2007; Caselli and Coleman, 2001; Porzio et al., 2022; Acemoglu and Guerrieri, 2008; Herrendorf and Schoellman, 2018; Comin et al., 2021; Buera et al., 2022

→ Microfound human capital and structural change feedback

3. Structural change and inequality

Comin et al., 2020; Buera et al., 2022; Lee and Shin, 2017; Bárány and Siegel, 2018; Wiedemann, 2026

→ Non-homothetic pref. + dynamic compl. shape link b/n inequality and structural change

Outline

Introduction

Empirics

Model

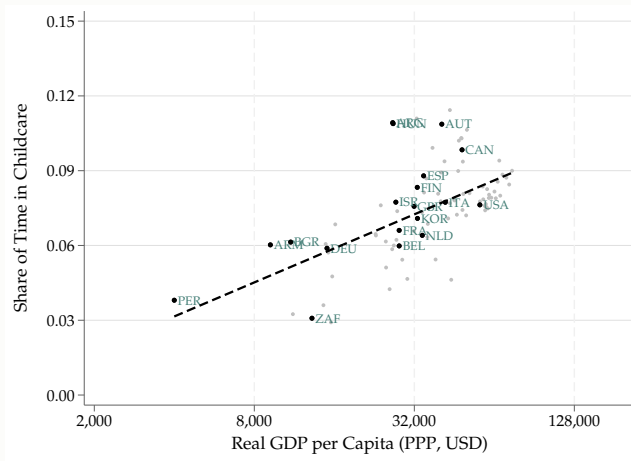
Calibration

Quantitative Exercises

Conclusion

Empirics

Childcare Time Alloc. (≤ 4 Yr. Age) $\uparrow$ w/ Development



Data

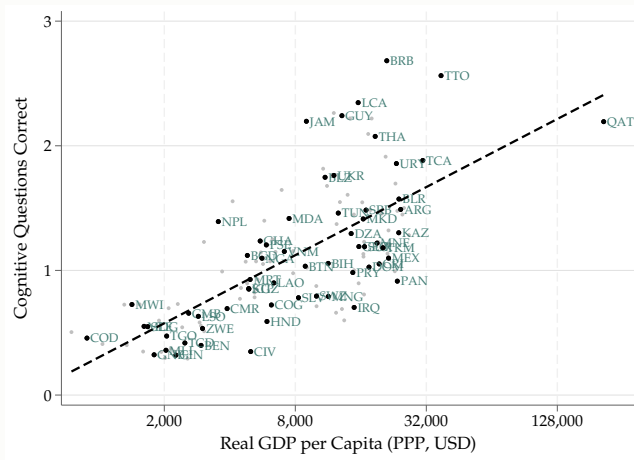
One-Child Households Robustness

MICS Robustness

Within Country Robustness

Female Labor Force Participation Robustness

4 Year-Old Cognitive Scores $\uparrow$ w/ Development



► Data

► 3-Year-Olds Robustness

Model

A Snapshot of the Model

Benchmark Structural Change + Endogenous Human Capital Accumulation

Sectors

- 3 sectors:
 - Goods (G)
 - High-Skill Services (H)
 - Low-Skill Services (L)
- Vary in skill intensity, TFP growth
- Competitive and profit-maximizing
- Hire skilled, unskilled eff. labor $\neq$

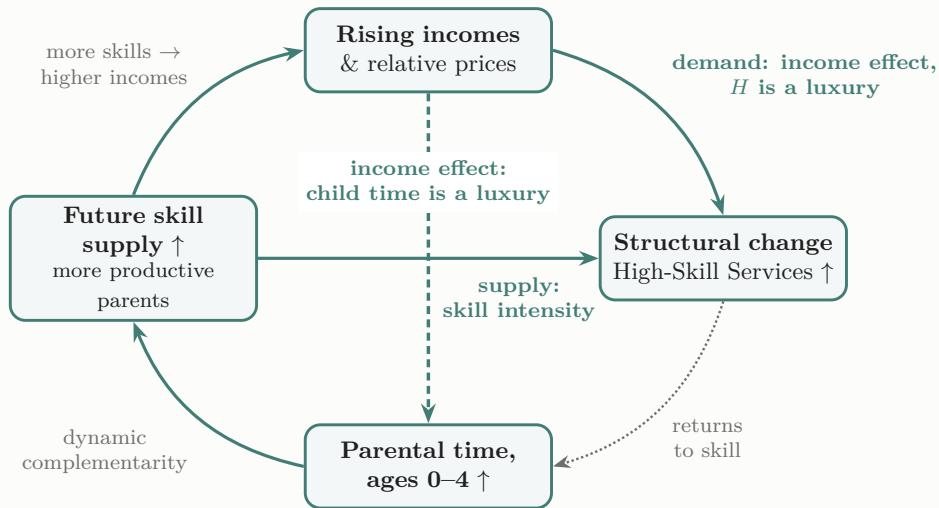
Households

- Parent-child dynasties
- Human capital pairs heterogeneous
- Multi-stage skill tech. for child
- Parent faces 3 problems:
 - Occupation (skilled vs. unskilled)
 - Time alloc. (childcare vs. work)
 - Sectoral consumption (G, L, H)

General Equilibrium

- Goods and labor markets clear

The Main Mechanism



Demographics & Timing

$$\underbrace{g \in \mathbb{N}}_{\text{generation}} \quad \underbrace{i \in [0, \mathcal{L})}_{\text{dynasty}} \quad \underbrace{t \in \mathbb{N}_0}_{\text{time}}.$$

Generation g in dynasty i

$$\begin{array}{ccccc} (g-1)T & \xrightarrow{\text{childhood}} & gT & \xrightarrow{\text{parenthood}} & (g+1)T \\ \text{birth} & & \text{becomes a parent} & & \text{death} \\ & & g+1 \text{ is born} & & \end{array}$$

- Lives for $2T$ years: T as a child and T as a parent
- At age T , the individual's parent dies and generation $g+1$ is born
- Child draws human capital upon birth from distribution $G(\eta_c, \kappa_c)$
- Generations within each dynasty overlap for T years

An Altruistic Parent's Problem

$$V_i^g \left(h_i^g, h_i^{g+1}(gT) \right) = \max_{\{\tau_i^g(t)\}_{t=gT}^{(g+1)T-1}} \left\{ \underbrace{\sum_{t=gT}^{(g+1)T-1} \beta^{t-gT} U(c_i^g(t), \tau_i^g(t))}_{\text{current generation utility}} + \underbrace{\beta^T \beta_g \mathbb{E}_{h_i^{g+2}} \left[V_i^{g+1} \left(h_i^{g+1}((g+1)T), h_i^{g+2}((g+1)T) \right) \right]}_{\text{future generations' utility}} \right\}$$

- **Budget constraint.** Parental time reduces current labor income:

$$(1 - \tau_i^g(t))y_i^g(t) \geq p_i^g(t)c_i^g(t).$$

- **Gross income.** Income depends on sector, occupation, and human capital:

$$y_i^g(t) \in \{w_{j,S}(t)h_i^g, w_{j,N}(t) : j \in \{G, L, H\}\}.$$

Nested Income Effects

- Consumption–labor aggregator

$$U(c_i^g(t), \tau_i^g(t)) = \frac{c_i^g(t)^{1-\nu}}{1-\nu} - \omega \frac{(1 - \tau_i^g(t))^{1+\frac{1}{\chi}}}{1 + \frac{1}{\chi}}.$$

- Sectoral consumption aggregator

$$\sum_{j \in \{G, L, H\}} \theta_j^{\frac{1}{\sigma}} \left(\frac{c_{i,j}^g(t)}{c_i^g(t)^{\lambda_j}} \right)^{\frac{\sigma-1}{\sigma}} = 1.$$

$\underbrace{\nu, \omega}_{\text{time allocation tradeoff}}$

$\underbrace{\theta_j, \sigma, \lambda_j}_{\text{sectoral preferences tradeoff}}$

Multi-Stage Human Capital (HK) Law of Motion

- Let $s \in \{1, \dots, S\}$ denote the stage of childhood development
- Child draws initial human capital $h_i^{g+1}(gT) \sim G(\eta_c, \kappa_c)$
- Draw and time-invariant distribution $G(\eta_c, \kappa_c)$ known to the parent
- Parents access Del Boca et al. (2014)-style HK technology for children

$$h_i^{g+1}(t+1) - h_i^{g+1}(t) = [h_i^{g+1}(t)]^{\zeta_s + q} [h_i^g \tau_i^g(t)]^{1 - \zeta_s}, \quad t \in \{gT, \dots, (g+1)T - 1\}, \\ s = t - gT + 1 \in \{1, \dots, S\}.$$

$$0 < \zeta_s < 1, \quad q \geq 0 \quad \implies \quad \text{Dynamic complementarity}$$

Sectoral Output

- Profit-maximizing, representative producer in each sector $j \in \{G, L, H\}$
- Sectoral productivity grows exogenously at rate g_j

$$Y_j(t) = \underbrace{A_j(0)e^{g_j t}}_{A_j(t)} Z_j(t), \quad j \in \{G, L, H\}$$

- Sectors differ in their skill intensity

$$Z_j(t) = \left[\phi_j N_j(t)^{\frac{\epsilon-1}{\epsilon}} + (1 - \phi_j) S_j(t)^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}$$

$$\underbrace{\phi_G = 1}_{\text{unskilled only}}$$

$$\underbrace{0 < \phi_L < 1}_{\text{both skill types}}$$

$$\underbrace{\phi_H = 0}_{\text{skilled only}}$$

Solution to Parent's Problem

- Parents pick (i) occupation, (ii) time allocation, and (iii) sectoral consumption
- Occupational choice can be separated → **Roy selection** problem

$$y_i^g(t) = \max \{w_{j,S}(t)h_i^g, w_{j,N}(t) : j \in \{G, L, H\}\}$$

- Marshallian demand functions are

$$c_{i,j}^g(t) = \frac{e_{i,j}^g(t)p_i^g(t)c_i^g(t)}{p_j(t)},$$

$$e_{i,j}^g(t) = \theta_j \left(\frac{p_j(t)}{p_i^g(t)} \right)^{1-\sigma} c_i^g(t)^{(\sigma-1)(1-\lambda_j)}.$$

Structural Change

- **Unskilled labor.** Free mobility between G and L implies

$$p_G(t)A_G(t) = \phi_L p_L(t)A_L(t) \left(\frac{Z_L(t)}{N_L(t)} \right)^{1/\epsilon} \equiv w_N(t).$$

- **Skilled labor.** Free mobility between L and H implies

$$p_H(t)A_H(t) = (1 - \phi_L) p_L(t)A_L(t) \left(\frac{Z_L(t)}{S_L(t)} \right)^{1/\epsilon} \equiv w_S(t).$$

- **Occupational choice.** An individual chooses skilled work if

$$w_S(t)h_i^g \geq w_N(t) \quad \Longleftrightarrow \quad \boxed{h_i^g \geq \bar{h}(t) \equiv \frac{w_N(t)}{w_S(t)} = \frac{p_G(t)}{p_H(t)} \frac{A_G(t)}{A_H(t)}}.$$

Market Clearing

Let $h_i^g = h$, $h_i^{g+1}(t) = h'$ with $\mu(h, h'; t)$ being their joint density at time t .

Sectoral output markets

$$A_j(t)Z_j(t) = \mathcal{L} \int_h \int_{h'} c_j(h, h'; t) \mu(h, h'; t) dh' dh, \quad j \in \{G, L, H\}.$$

Skilled labor market

$$\sum_{j \in \{G, L, H\}} S_j^d(t) = \mathcal{L} \int_{\bar{h}(t)}^{\infty} \int_{h'} h (1 - \tau(h, h'; t)) \mu(h, h'; t) dh' dh.$$

Unskilled labor market

$$\sum_{j \in \{G, L, H\}} N_j^d(t) = \mathcal{L} \int_0^{\bar{h}(t)} \int_{h'} (1 - \tau(h, h'; t)) \mu(h, h'; t) dh' dh.$$

Long-Run Equilibrium

- The H -sector expenditure share converges to one:

$$\lim_{t \rightarrow \infty} e_{i,H}^g(t) = 1.$$

- Since $p_H(t) \equiv 1$, the H -sector wage satisfies $w_H^*(t) = A_H(t)$.
- Consumption and output are stationarized by $A_H(t)$:

$$\tilde{c}_H^*(h, h'; t) \equiv \frac{c_H^*(h, h'; t)}{A_H(t)}, \quad \tilde{Y}_H^*(t) \equiv \frac{Y_H^*(t)}{A_H(t)} = S_H^*(t).$$

$$\underbrace{\mathcal{L} \int_h \int_{h'} h (1 - \tau^*(h, h'; t)) \mu^*(h, h'; t) dh' dh}_{\text{skilled-labor supply}} = \underbrace{\mathcal{L} \int_h \int_{h'} \tilde{c}_H^*(h, h'; t) \mu^*(h, h'; t) dh' dh}_{\text{skilled-labor demand}}$$

Calibration

28 Parameters to Calibrate

Preferences

$\beta, \beta_g, \chi, \omega, \nu$
 $\theta_G, \theta_H, \theta_L, \lambda_G, \lambda_H, \lambda_L, \sigma$

Production Technology

ϵ, ϕ_L
 $A_G(0), A_H(0), A_L(0), g_G, g_H, g_L$

Human Capital Distributions

$\eta, \kappa, \eta_c, \kappa_c$

Human Capital Technology

$\zeta_1, \zeta_2, \zeta_3, q$

Calibration strategy: External calibration + Internal SMM

External Calibration: Selected Parameters

Parameter	Notes	Value	Source
A. Preferences			
β_g	Intergenerational discount rate	0.500	Boar and Lashkari (2021)
σ	Elast. of sub. (sectoral goods)	0.100	Buera and Kaboski (2009)
B. Production Technology			
ϕ_L	L -sector unskilled lab. intensity	0.750	Fang and Herrendorf (2021)
C. Sectoral TFP Growth Rates (per 5 years)			
g_G	G -sector	0.053	Elbadri and Vizcaino (2025)
g_H	H -sector	0.005	Elbadri and Vizcaino (2025)
g_L	L -sector	0.037	Elbadri and Vizcaino (2025)

► Full Table

Internal Calibration Strategy

14 parameters jointly estimated by simulated method of moments (SMM)

$$\Theta \equiv \left\{ \begin{array}{c} \theta_G, \theta_H, \lambda_G, \lambda_H, \\ q, \zeta_1, \zeta_2, \zeta_3, \omega, \nu, \eta, \kappa, \eta_c, \kappa_c \end{array} \right\}.$$

Calibrated to Match US: Structural Change + Skill Distribution + Time Use

Structural Change

$$\begin{array}{c} \theta_G, \theta_H \\ \lambda_G, \lambda_H \end{array}$$

Time Allocation

$$\begin{array}{c} \zeta_1, \zeta_2, \zeta_3 \\ \omega, \nu \end{array}$$

Skill Supply

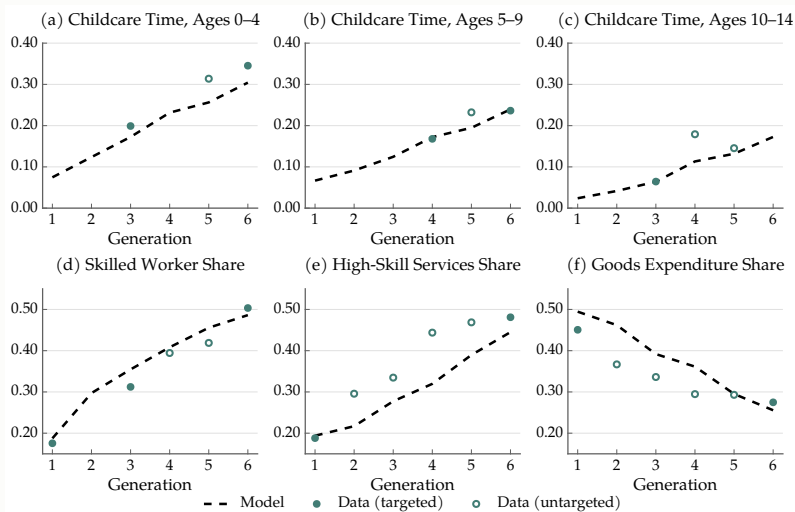
$$\begin{array}{c} q, \eta, \kappa \\ \eta_c, \kappa_c \end{array}$$

Internal Calibration: Selected Estimates

Parameter	Description	Value	Most informative moment
A. Income Elasticity Parameters			
λ_G	G -sector	0.170	G -sector expenditure share
λ_H	H -sector	1.509	H -sector expenditure share
B. Parental Time Elasticity Parameters			
$1 - \zeta_1$	1 st stage time intensity	0.817	Time allocation 1 st stage (ages 0–4)
$1 - \zeta_2$	2 nd stage time intensity	0.296	Time allocation 2 nd stage (ages 5–9)
$1 - \zeta_3$	3 rd stage time intensity	0.001	Time allocation 3 rd stage (ages 10–14)

► Full Table

SMM Fit: Targeted Moments



Cross-Country Validation Check

Experiment. Initial TFP $A_j(0) \in \{0.75, 1.00, 1.25\}$ in all sectors

- US-South Africa and US-Zimbabwe TFP gap in the 1960s

Outcome	$A_j(0) = 0.75$	Baseline	$A_j(0) = 1.25$
A. Childcare time, ages 0–4 (share)			
Gen. 6	0.239	0.304	0.334
B. Human capital of 4-year-olds (baseline = 1.000)			
Gen. 6	0.812	1.000	1.129
C. H-sector expenditure share			
Gen. 6	0.385	0.445	0.492

Takeaway

$\uparrow$ initial TFP = $\uparrow$ childcare time share + $\uparrow$ early childhood human capital + $\uparrow$ H -sector exp. share

Quantitative Exercises

Exercise 1: Childcare Time and Structural Change

Experiment. Hold 1st stage childcare time allocation fixed at its generation 1 level:

$$\tau_{s=1}^g = 0.075 \quad \forall g.$$

- Parents continue choosing childcare time in 2nd and 3rd stages
- **PE**: prices remain on the baseline path; **GE**: prices adjust to clear markets

	Baseline	PE	GE
ΔH -sector share, gen. 1–6	0.251	0.090	0.163
Share of transition remaining	100.0%	35.7%	65.0%
Welfare (CEV, %), gen. 1	0.0	−5.0	−6.4
Welfare (CEV, %), gen. 6	0.0	−39.1	−57.0

Takeaway

↑ in early childcare time alloc. accounts for **35.0%** of structural change in GE and **64.3%** in PE.

Exercise 1: Childcare Time and Skill Supply

- **PE:** both skill quantity and quality decline
- **GE:** price adjustment largely offsets the quantity decline, but not the quality decline

Generation 6 outcome	Baseline	PE	GE
A. Childcare time (share)			
Stage 1, ages 0–4	0.304	0.075	0.075
Stage 2, ages 5–9	0.239	0.146	0.206
Stage 3, ages 10–14	0.173	0.137	0.148
B. Skill quantity (share)			
Skilled-worker share	0.486	0.119	0.468
C. Skill quality (gen. 1 = 1.00)			
Skilled-work HK threshold	3.649	3.649	1.555
HK conditional on skilled work	4.206	2.148	0.992

Exercise 2: Dynamic Comp. and Structural Change

Experiment. Remove dynamic complementarity from past investments:

$$h_i^{g+1}(t+1) - h_i^{g+1}(t) = \underbrace{h_i^{g+1}(gT)}_{\text{draw at birth}} \zeta_s + q (h_i^g \tau_i^g(t))^{1-\zeta_s}.$$

	Baseline	PE	GE
ΔH -sector share, gen. 1–6	0.251	0.091	0.168
Share of transition remaining	100.0%	36.0%	66.9%
Welfare (CEV, %), gen. 1	0.0	−5.9	−11.7
Welfare (CEV, %), gen. 6	0.0	−41.4	−66.9

Takeaway

Dynamic complementarity drives **33.1%** of structural change in GE and **64.0%** in PE.

Exercise 2: Dynamic Comp. and Skill Supply

- **PE:** both skill quantity and quality decline sharply
- **GE:** only the quantity margin recovers

Generation 6 outcome	Baseline	PE	GE
A. Childcare time (share)			
Stage 1, ages 0–4	0.304	0.079	0.181
Stage 2, ages 5–9	0.239	0.136	0.151
Stage 3, ages 10–14	0.173	0.134	0.153
B. Skill quantity (share)			
Skilled-worker share	0.486	0.047	0.415
C. Skill quality (gen. 1 = 1.00)			
Skilled-work HK threshold	3.649	3.649	1.090
HK conditional on skilled work	4.206	2.142	0.689

Exercise 3: Inequality and Structural Change

Experiment. Mean-preserving change in the dispersion of human capital distr.:

$$\hat{\kappa} = \psi\kappa, \quad \hat{\kappa}_c = \psi\kappa_c, \quad \psi \in \{0.65, 1.00, 1.35\},$$

	Low inequality $\psi = 0.65$	Baseline $\psi = 1.00$	High inequality $\psi = 1.35$
Δ <i>H</i> -sector share, gen. 1–6	0.277	0.251	0.203
Relative to baseline	110.4%	100.0%	80.7%
Welfare (CEV, %), gen. 1	2.8	0.0	−9.6
Welfare (CEV, %), gen. 6	10.1	0.0	−16.6

Takeaway

Higher inequality slows down structural change by **19.3%**.

Exercise 3: Inequality and Skills

- Greater initial inequality reduces early childcare investment
- It lowers the skilled-worker human capital level

Generation 6 outcome	Low inequality	Baseline	High inequality
A. Childcare time (share)			
Stage 1, ages 0–4	0.312	0.304	0.285
Stage 2, ages 5–9	0.239	0.239	0.233
Stage 3, ages 10–14	0.171	0.173	0.171
B. Skill quantity (share)			
Skilled-worker share	0.494	0.486	0.473
C. Skill quality (gen. 1 = 1.00)			
Skilled-work HK threshold	3.837	3.649	3.425
HK conditional on skilled work	5.593	4.206	1.924

Conclusion

Conclusion

1. **New evidence:** Childcare time and 4-year-old cognitive outcomes $\uparrow$ w/ development
2. **New mechanism:** ECD $\rightarrow$ skill supply $\rightarrow$ structural change
3. **Quantitative importance:** Dynamic complementarity $\rightarrow$ 1/3 of transition to HSS

Skill formation in early childhood matters for structural change

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References VII

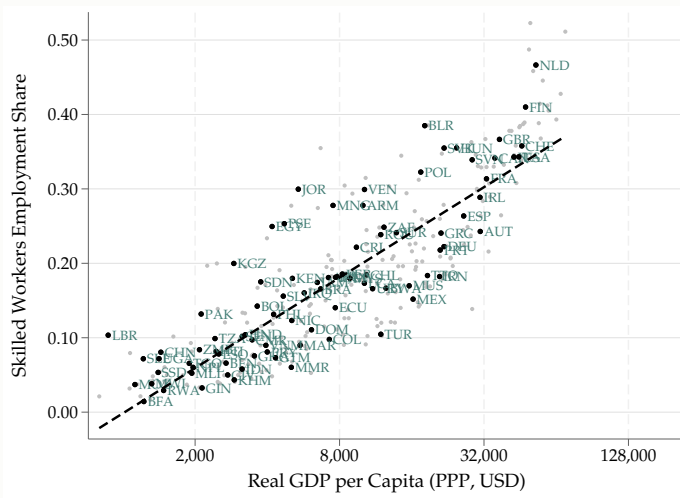
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Appendix

Services Industries by Skill Intensity

Sector	Industry	1960	1970	1980	1990	2000	2005	2010	2015	2020	1960–2020
High-Skill Services	Education	0.69	0.64	0.65	0.66	0.69	0.77	0.76	0.77	0.78	0.71
	Health and Social Work	0.52	0.47	0.48	0.54	0.56	0.55	0.53	0.70	0.77	0.57
	Financial Services and Insurance	0.40	0.40	0.45	0.55	0.59	0.69	0.72	0.53	0.59	0.55
	Business Services and Real Estate	0.46	0.44	0.49	0.50	0.52	0.54	0.53	0.63	0.68	0.53
Low-Skill Services	Other Services	0.32	0.33	0.42	0.47	0.45	0.39	0.33	0.23	0.25	0.35
	Public Administration and Defense	0.15	0.19	0.26	0.29	0.35	0.40	0.37	0.39	0.42	0.31
	Wholesale and Retail Trade	0.20	0.17	0.22	0.26	0.27	0.29	0.29	0.13	0.15	0.22
	Transportation, Storage, and Communications	0.10	0.10	0.14	0.17	0.18	0.14	0.29	0.28	0.28	0.19
	Hotels and Restaurants	0.17	0.14	0.15	0.17	0.14	0.20	0.19	0.13	0.14	0.16
	Private Household Services	0.03	0.01	0.03	0.03	0.02	0.01	0.01	0.03	0.21	0.04

Skill Supply and Development



Why Parental Time Allocation?

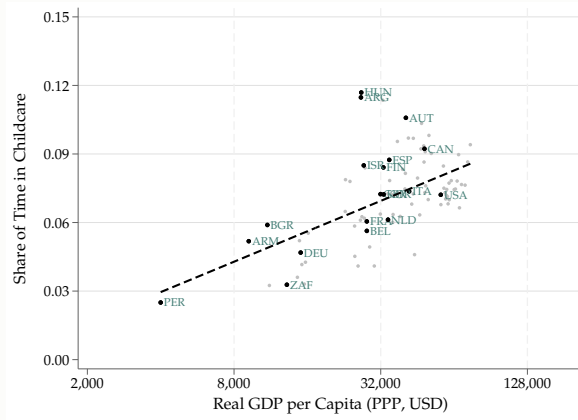
1. Parental time is particularly important early in childhood

- Parental time is key for cognitive development when young, (declines with age)
Del Boca et al., 2014
- Poor substitutability with other inputs when young
Yum, 2023
- A broader empirical literature confirms its importance relative to other inputs
Francesconi and Heckman, 2016; Del Bono et al., 2016; Bernal, 2008; Fiorini and Keane, 2014

2. Parental time directly shapes early human capital

- **Language and cognitive stimulation**
Hart and Risley, 1995; Villena-Roldan and Ríos-Aguilar, 2012
- **Problem-solving skills**
Vygotsky, 1978; Pratt et al., 1988; Neitzel and Stright, 2003
- **Stress regulation and executive function**
Blair and Raver, 2012; Belsky and Fearon, 2002

Time Allocation in One-Child Households

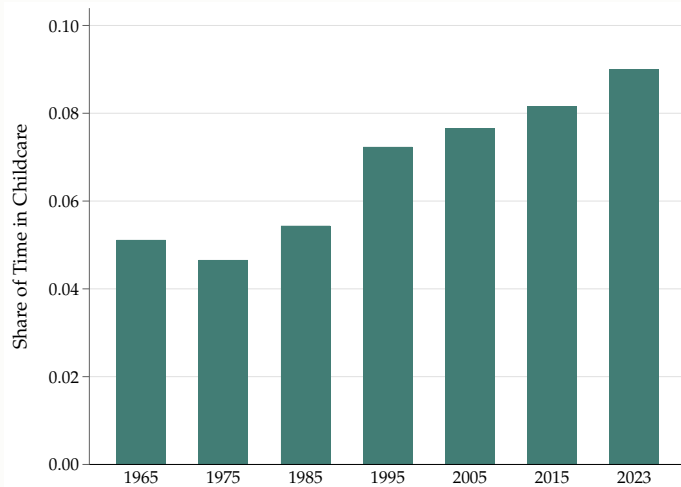


IPUMS-MICS Parental Time Investment (Data)

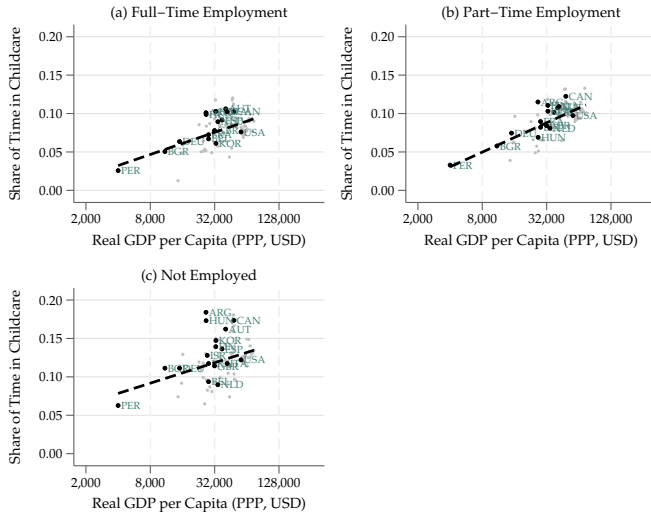
Activity with the child in the last 3 days	Mother	Father
Read books to the child	✓	✓
Told stories to the child	✓	✓
Sang songs to the child	✓	✓
Took the child outside	✓	✓
Played with the child	✓	✓
Named, counted or drew things with the child	✓	✓
Parental time investment index	0–12	

- **Sample:** children aged 0–4; each question asked separately for both parents
- **Index:** sum of “yes” answers, averaged by country-year using survey weights

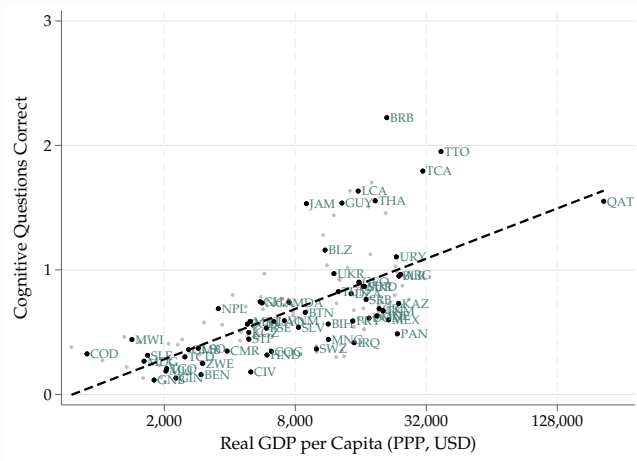
Time Allocation Trends Hold Within Country (US)



Robust To Female Labor Force Participation



3 Year-Old Cognitive Scores $\uparrow$ w/ Development



Childcare Time Allocation (Data)

- **Source:** Multinational Time Use Study, v11 ([Lamote de Grignon Pérez et al., 2024](#))
 - Harmonized time diaries covering a single day per person
- **Sample:** working-age adults (18–64) living with a child aged 0–4
 - Childcare: physical care, teaching, reading, playing, supervising
 - Measured as the share of the day spent on childcare
- **Aggregation:** country-year averages using survey weights
 - Plotted against PPP real GDP per capita ([Feenstra et al., 2015](#))

Early Childhood Cognitive Scores (Data)

- **Source:** UNICEF Multiple Indicator Cluster Surveys via IPUMS-MICS ([Bolgrien et al., 2024](#))
 - Early childhood development module for children aged 0–4
- **Measure:** caretaker reports whether the 4-year-old can...
 - read four simple words, identify 10 letters, recognize numbers 1–10
 - Score = number of “yes” answers, from 0 to 3
- **Aggregation:** country-year averages using under-5 sample weights
 - Plotted against PPP real GDP per capita ([Feenstra et al., 2015](#))

Proposition 1 (Separability)

Proposition 1 (Separability)

Suppose occupational choice affects the parent's problem only through potential gross income, and neither the feasible set nor the continuation problem otherwise depends on occupation. Then the parent's problem can be solved sequentially.

First, the parent chooses the occupation that maximizes potential gross income. Second, conditional on this occupation, the parent jointly chooses time allocation and sectoral consumption quantities to maximize intertemporal utility subject to the budget and time constraints.

[< Back](#)[► Proof](#)

Proof of Proposition 1 – Setup

Fix parental human capital, prices, and the wage schedule.

After optimizing over sectoral consumption quantities, define the parent's objective conditional on τ as

$$\mathcal{V}(y, \tau; t) = \log \left(\frac{y(1 - \tau)}{p(t)} \right) - \omega \frac{(1 - \tau)^{1 + \frac{1}{\chi}}}{1 + \frac{1}{\chi}} + \Phi(\tau; t).$$

The optimized value function is

$$V^*(y; t) = \max_{\tau \in \mathcal{T}(t)} \mathcal{V}(y, \tau; t) \quad \text{with associated policy} \quad \tau^*(y; t) \in \arg \max_{\tau \in \mathcal{T}(t)} \mathcal{V}(y, \tau; t).$$

Here, $\Phi(\tau; t)$ collects subsequent flow utilities and the discounted utility of future generations induced by the current childcare decision.

Proof of Proposition 1 – Monotonicity

Consider two income levels satisfying $y' > y$, and let

$$\tau^* = \tau^*(y; t).$$

Because occupation affects the problem only through income, τ^* remains feasible under y' . Holding τ^* fixed, labor disutility and the continuation value remain unchanged. Therefore,

$$\mathcal{V}(y', \tau^*; t) - \mathcal{V}(y, \tau^*; t) = \log \left(\frac{y'(1 - \tau^*)/p(t)}{y(1 - \tau^*)/p(t)} \right) = \log \left(\frac{y'}{y} \right) > 0.$$

Because the parent can reoptimize under y' ,

$$V^*(y'; t) \geq \mathcal{V}(y', \tau^*; t) > \mathcal{V}(y, \tau^*; t) = V^*(y; t).$$

Thus, $V^*(y; t)$ is strictly increasing in gross income. If occupation o generates $y(o)$, then

$$\arg \max_o V^*(y(o); t) = \arg \max_o y(o).$$

□

Equilibrium Definition

Definition (Competitive equilibrium)

Normalize the price of high-skill services:

$$p_H(t) \equiv 1 \quad \forall t \geq 0.$$

Given sequences of prices, wages, and technologies,

$$\{p_k(t), w_{j,o}(t), A_j(t)\}_{\substack{t \geq 0; \\ k \in \{G,L\}, j \in \{G,L,H\}, o \in \{S,N\}}},$$

a competitive equilibrium is an allocation such that:

1. Each parent in dynasty i and generation g , given $(h_i^g, h_i^{g+1}(t))$, maximizes dynastic utility by choosing occupation, sector, consumption, and parental time, subject to the time and budget constraints.
2. Each sector- j representative firm maximizes profits by choosing skilled and unskilled labor inputs $\{S_j(t), N_j(t)\}$.
3. All sectoral goods and labor markets clear at every t .

Proposition 2 (Dominance)

Proposition: Asymptotic Dominance of the H -Sector

Suppose that $\lambda_H > \lambda_L, \lambda_G, g_L, g_G > g_H > 0$, and $0 < \sigma < 1$. For each $k \in \{L, G\}$, define

$$x_k \equiv -\sup_{t \geq 0} \left[(1 - \sigma)(g_H - g_k) + (1 - \sigma)(\lambda_k - \lambda_H) \frac{\dot{c}_i^g(t)}{c_i^g(t)} \right] > 0.$$

- If $\epsilon = \infty$: these parameter restrictions are sufficient for asymptotic dominance of the H sector.
- If $\epsilon < \infty$: the H sector attains asymptotic dominance provided that, for each $k \in \{L, G\}$,

$$\limsup_{t \rightarrow \infty} \frac{1}{t} \int_0^t \frac{1 - \sigma}{\epsilon} \left(\frac{\dot{S}_L(s)}{S_L(s)} - \frac{\dot{X}_L^k(s)}{X_L^k(s)} \right) ds < x_k,$$

where $X_L^L \equiv Z_L$ and $X_L^G \equiv N_L$.

Proof of Proposition 2 – Preliminaries

Proof. Sector- j expenditure shares are

$$e_{i,j}^g(t) = \theta_j \left(\frac{p_j(t)}{p_i^g(t)} \right)^{1-\sigma} c_i^g(t)^{(\sigma-1)(1-\lambda_j)}.$$

Free mobility of unskilled labor implies

$$p_G(t)A_G(t) = \phi_L p_L(t)A_L(t) \left(\frac{Z_L(t)}{N_L(t)} \right)^{1/\epsilon},$$

while free mobility of skilled labor implies

$$A_H(t) = (1 - \phi_L) p_L(t)A_L(t) \left(\frac{Z_L(t)}{S_L(t)} \right)^{1/\epsilon}.$$

These conditions determine the relative-price dynamics used below.

Proof of Proposition 2 – Relative-Price Dynamics

Log-differentiating the skilled-labor mobility condition gives

$$\frac{\dot{p}_L(t)}{p_L(t)} = g_H - g_L + \frac{1}{\epsilon} \left(\frac{\dot{S}_L(t)}{S_L(t)} - \frac{\dot{Z}_L(t)}{Z_L(t)} \right).$$

Combining this with the unskilled-labor mobility condition gives

$$\frac{\dot{p}_G(t)}{p_G(t)} = g_H - g_G + \frac{1}{\epsilon} \left(\frac{\dot{S}_L(t)}{S_L(t)} - \frac{\dot{N}_L(t)}{N_L(t)} \right).$$

Define

$$X_L^L \equiv Z_L, \quad X_L^G \equiv N_L.$$

Thus, for either $k \in \{L, G\}$,

$$\frac{\dot{p}_k(t)}{p_k(t)} = g_H - g_k + \frac{1}{\epsilon} \left(\frac{\dot{S}_L(t)}{S_L(t)} - \frac{\dot{X}_L^k(t)}{X_L^k(t)} \right).$$

Proof of Proposition 2 – Expenditure-Share Dynamics

For each $k \in \{L, G\}$, define

$$R_k(t) \equiv \frac{e_{i,k}^g(t)}{e_{i,H}^g(t)} = \frac{\theta_k}{\theta_H} \left(\frac{p_k(t)}{p_H(t)} \right)^{1-\sigma} c_i^g(t)^{(1-\sigma)(\lambda_k - \lambda_H)}.$$

Since $p_H(t) \equiv 1$, log differentiation yields

$$\frac{\dot{R}_k(t)}{R_k(t)} = (1 - \sigma) \frac{\dot{p}_k(t)}{p_k(t)} + (1 - \sigma)(\lambda_k - \lambda_H) \frac{\dot{c}_i^g(t)}{c_i^g(t)}.$$

Substituting the relative-price dynamics,

$$\frac{\dot{R}_k(t)}{R_k(t)} = \underbrace{(1 - \sigma)(g_H - g_k) + (1 - \sigma)(\lambda_k - \lambda_H) \frac{\dot{c}_i^g(t)}{c_i^g(t)}}_{\text{TFP growth and income effects}} + \underbrace{\frac{1 - \sigma}{\epsilon} \left(\frac{\dot{S}_L(t)}{S_L(t)} - \frac{\dot{X}_L^k(t)}{X_L^k(t)} \right)}_{\text{labor-allocation effect}}.$$

Proof of Proposition 2 – Bounding the Share Ratio

Define the labor-allocation effect as

$$\Delta_k(t) \equiv \frac{1-\sigma}{\epsilon} \left(\frac{\dot{S}_L(t)}{S_L(t)} - \frac{\dot{X}_L^k(t)}{X_L^k(t)} \right).$$

By the definition of x_k ,

$$(1-\sigma)(g_H - g_k) + (1-\sigma)(\lambda_k - \lambda_H) \frac{\dot{c}_i^g(t)}{c_i^g(t)} \leq -x_k.$$

Let $f_k(t) \equiv \log R_k(t)$. It follows that

$$\dot{f}_k(t) = \frac{\dot{R}_k(t)}{R_k(t)} \leq -x_k + \Delta_k(t).$$

Integrating from 0 to t ,

$$f_k(t) - f_k(0) \leq -x_k t + \int_0^t \Delta_k(s) ds.$$

Hence, $f_k(t) \rightarrow -\infty$ whenever the negative linear term dominates.

Proof of Proposition 2 – Asymptotic Dominance

Finite elasticity. If $\epsilon < \infty$, then

$$\limsup_{t \rightarrow \infty} \frac{1}{t} \int_0^t \Delta_k(s) ds < x_k \implies f_k(t) \rightarrow -\infty \implies R_k(t) \rightarrow 0.$$

Perfect substitutes. If $\epsilon = \infty$, then

$$\Delta_k(t) \equiv 0 \implies f_k(t) \leq f_k(0) - x_k t \rightarrow -\infty \implies R_k(t) \rightarrow 0.$$

Thus, for both $k \in \{L, G\}$,

$$R_k(t) = \frac{e_{i,k}^g(t)}{e_{i,H}^g(t)} \rightarrow 0.$$

Since expenditure shares sum to one,

$$\boxed{e_{i,H}^g(t) = \frac{1}{1 + R_L(t) + R_G(t)} \rightarrow 1.} \quad \square$$

External Calibration: Full Table

Parameter	Notes	Value	Source
A. Preferences			
β	Period discount factor	0.904	Barro and Sala-i-Martin (2004)
β_g	Intergenerational discount factor	0.500	Boar and Lashkari (2021)
σ	Elast. of sub. (sectoral goods)	0.100	Buera and Kaboski (2009)
χ	Frisch elasticity parameter	0.500	Boppart et al. (2024)
B. Production Technology			
ϵ	L -sector EoS b/n S_L and N_L labor	2.900	Acemoglu and Autor (2011)
ϕ_L	L -sector unskilled labor intensity	0.750	Fang and Herrendorf (2021)
C. Sectoral TFP			
$A_G(0)$	G -sector initial TFP level	1.000	Normalization
$A_H(0)$	H -sector initial TFP level	1.000	Normalization
$A_L(0)$	L -sector initial TFP level	1.000	Normalization
g_G	G -sector growth rate	0.053	Elbadri and Vizcaino (2025)
g_H	H -sector growth rate	0.005	Elbadri and Vizcaino (2025)
g_L	L -sector growth rate	0.037	Elbadri and Vizcaino (2025)

Internal Calibration: Full Table (1/2)

Parameter	Description	Value	Most informative moment
A. Preferences			
ω	Work disutility constant	1.374	Time allocation (stage 1, gen. 6)
ν	CRRA parameter	1.110	Time allocation (stage 2, gen. 6)
θ_G	G -sector weight	0.575	G -sector exp. share (gen. 1 av.)
θ_H	H -sector consumption weight	0.256	H -sector exp. share (gen. 1 av.)
λ_G	G -sector income elasticity parameter	0.170	G -sector exp. share (gen. 6 av.)
λ_H	H -sector income elasticity parameter	1.509	H -sector exp. share (gen. 6 av.)
B. Human Capital Technology			
$1 - \zeta_1$	Stage 1 time investment intensity	0.817	Time allocation (stage 1, gen. 3)
$1 - \zeta_2$	Stage 2 time investment intensity	0.296	Time allocation (stage 2, gen. 4)
$1 - \zeta_3$	Stage 3 time investment intensity	0.001	Time allocation (stage 3, gen. 3)
q	Persistence parameter	0.010	Skilled workers share (gen. 3 av.)

Internal Calibration: Full Table (2/2)

Parameter	Description	Value	Most informative moment
C. Skill Distribution			
η	Initial human capital distr. (location)	0.321	Skilled workers share (gen. 1)
κ	Initial human capital distr. (shape)	1.623	90–10 log wage gap skilled (gen. 1)
η_c	Child human capital distr. (location)	0.399	Skilled workers share (gen. 6)
κ_c	Child human capital distr. (shape)	1.000	90–10 log wage gap skilled (gen. 6)
D. Normalizations			
θ_L	L -sector consumption weight	0.169	Backed out as $1 - \theta_G - \theta_H$
λ_L	L -sector income elasticity parameter	1.000	Reference for λ_G and λ_H

Targeted Moments – Time Allocation

- Multinational Time Use Survey (Lamote de Grignon Pérez et al., 2024); US (1965–onward)
- Full-time, employed of ages 21–64 living in a household with at least one child below age 15
- Diarist-day observations weighted using survey weights

$$\text{Childcare time share} = \frac{\text{Childcare time}}{\text{Childcare time} + \text{Paid work time}}.$$

- Construct synthetic parental cohorts using age-restricted cross sections
- Average across available calendar years within each generation-stage window

Generation	Stage	Calendar years	Age of child
3	1	1972–1976	0–4
6	1	2017–2021	0–4
4	2	1992–1996	5–9
6	2	2022–2026	5–9
3	3	1982–1986	10–14

Targeted Moments – Skill Distribution

- IPUMS USA microdata ([Ruggles et al.](#))
- Employed individuals ages 21–64 who work at least 30 hours per week and 40 weeks per year
- Observations weighted using person weights
- Skilled workers: managerial, professional, technical occupations ([Acemoglu and Autor, 2011](#))
- Hourly wages constructed using HRSWORK1 where available and UHRSWORK otherwise
- Skills are fixed after childhood; moments are therefore generation-specific
- Average across available calendar years within each generation

Generation	Calendar years	Targeted moments
1	1942–1956	Skilled workers share Log 90–10 hourly wage ratio of skilled workers
3	1972–1986	Skilled workers share
6	2017–present	Skilled workers share Log 90–10 hourly wage ratio of skilled workers

Targeted Moments – Structural Change

- Measured by consumption component of sectoral value added
- Sectoral consumption value added constructed following [Herrendorf et al. \(2013\)](#)
- Industries are aggregated into Goods, High-Skill Services, and Low-Skill Services
- Where data permit, observations are averaged over each 15-year generation window
 - Removes stage-specific movements and isolates intergenerational variation in sectoral expenditure shares

Generation	Calendar years	Targeted moments
1	1942–1956	High-Skill Services expenditure share Goods expenditure share
6	2017–present	High-Skill Services expenditure share Goods expenditure share

Consumption Value Added – Construction (1/2)

Use I-O tables to extract consumption component of sectoral value added (Herrendorf et al., 2013)

Notation

- m = number of commodities; n = number of industries

Inputs

1. From the Use table, extract final consumption expenditure by commodity:

$$\mathbf{e}_c \in \mathbb{R}^{m \times 1}.$$

Element i is final consumption expenditure on commodity i .

2. Compute the value added share of output for each industry:

$$v_j = \frac{\text{Value added of industry } j}{\text{Output of industry } j}, \quad \mathbf{v} \in \mathbb{R}^{n \times 1}.$$

3. Extract the total requirements matrix:

$$\mathbf{R} \in \mathbb{R}^{n \times m}.$$

R_{ji} : Industry j output to deliver \$1 of domestically produced commodity i to final use.

Consumption Value Added – Construction (2/2)

Consumption value added

$$\mathbf{c} = \langle \mathbf{v} \rangle \mathbf{R} \mathbf{e}_c \quad \mathbf{c} \in \mathbb{R}^{n \times 1},$$

where $\langle \mathbf{v} \rangle$ is the diagonal matrix with $\mathbf{v}$ on its diagonal.

- $\mathbf{R} \mathbf{e}_c$ gives the industry output required to satisfy final consumption expenditure.
- Premultiplication by $\langle \mathbf{v} \rangle$ converts required industry output into industry value added.
- Element c_j is the consumption value added generated by industry j .

Data

- BEA Historical Benchmark Input-Output Tables: 1947, 1958, 1963, 1972, 1977, 1987, 1992
- BEA Annual Input-Output Accounts: 1997–2024