Technological Changes and Industrial Transformation

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A. Introduction

Lewis (1955), Rostow (1960) and Tsiang (1964) emphasized staged growth and development for a country to be transformed from a *traditional* agricultural economy to a *modern* industrialized economy.

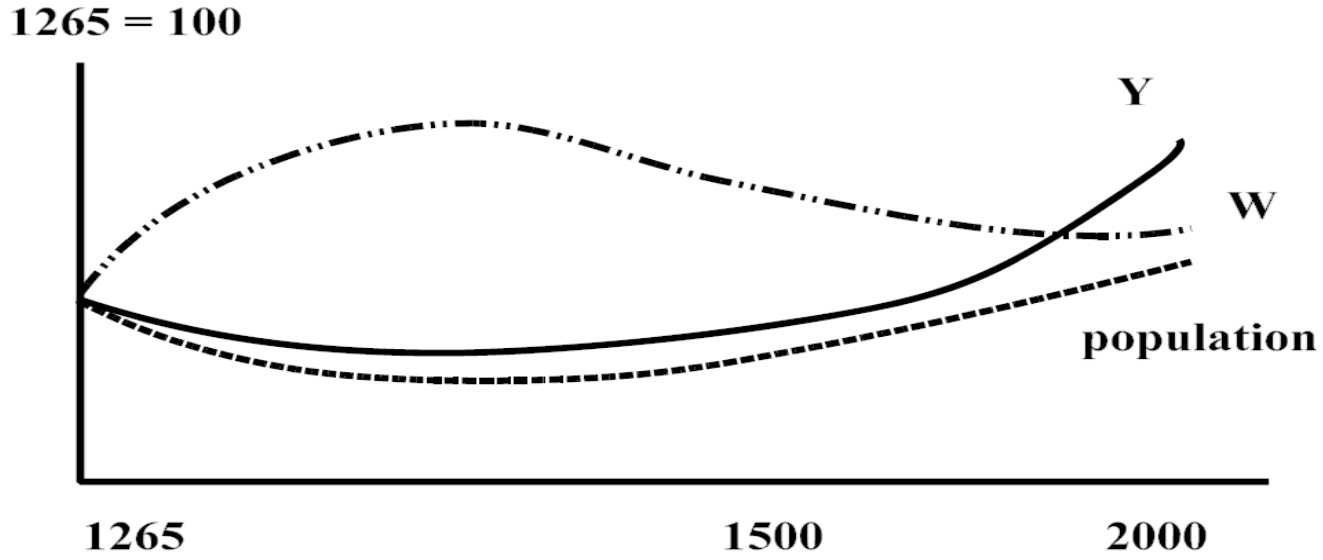
- **During such a transformation process, it is necessary to shift labor as well as other resources from the tradition to the modern sector.**
- **A successful process will lead an economy from agricultural to manufacturing and eventually to service (FIRE) activities.**
- **At the later stage of economic development, it features *mass consumption*, which is crucial for enhancing the welfare of well beings.**

Although big push theory suggests coordinated investment (by firms or by workers and entrepreneurs jointly) is the basis of industrialization, it is silent about the underlying process of creating a modern industry. To facilitate better understanding of such a process is the primary purpose of this note. We will focus on addressing two issues:

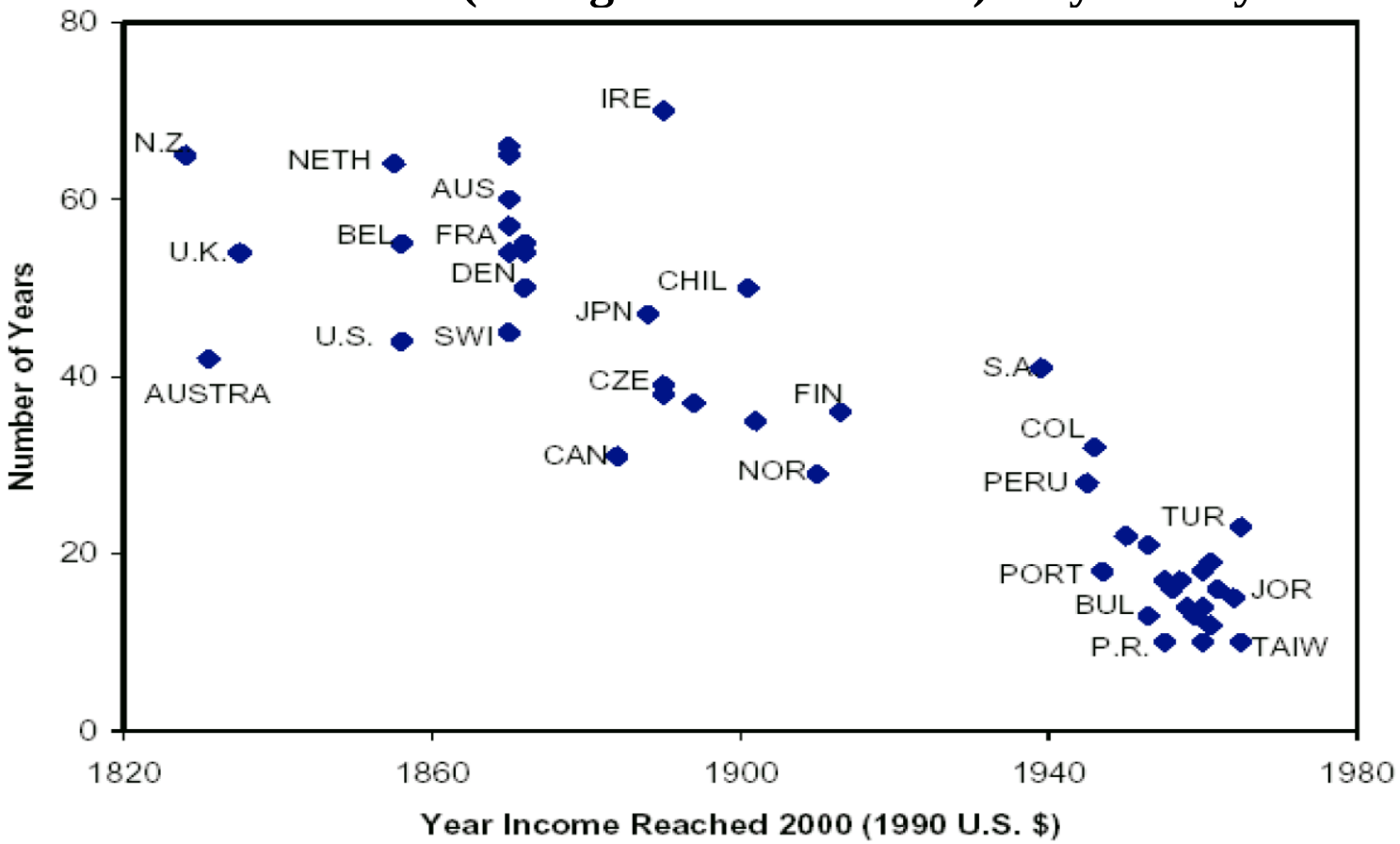
- **to explore the channels through which a modern industry is activated,**
- **to explain the speed of transition from agricultural to modern economy.**

B. Stylized Facts

- **Sustained growth is only a recent phenomenon:**
  - **prior to 1780: output/consumption per capita and wage rate were roughly constant over time**
  - **after 1780: all these aggregates were growing over time**
  - **measuring output (Y) by real farm land rent and wage (W) by real farm wage in UK, Hansen-Prescott (2002) find that while population increased only 5 times from 11 to 57 millions from 1780 to 1989, Y per hour increased 22 times:**



- **The speed of transition to modern growth is increasing over time**
  - **it took Netherlands/UK/US/Canada (early development) 65/55/45/35 years to grow from $2,000 (10% of US) to $4,000 (doubling), in 1990 US$**
  - **it took Korea/Taiwan (taking off in mid-1960s) only 15/10 years**



- **The industrialization processes are highly diversified:**
  - **East Asian newly industrialized countries (NICs) have experienced rapid growth and industrial transformation**
  - **many African, South American and South Asian countries are still in low-growth trap with primarily traditional industries**

- **Sharply different development stories abound:**
  - **Korea and Taiwan took off successfully in mid-1960, joining with Hong Kong and Singapore to become Asian Tigers (Balassa 1972, Kuo 1983, Amsden 1989 and Thorbecke and Wan 1999)**
  - **While Argentina was ahead of most countries in 1900 except 10 or so world leaders and Philippines was ahead of most Asian countries except Japan right in the 1950s, they fell behind afterward**
  - **The emperor's new clothes were not made in Colombia (Morawetz 1981)**
  - **Morogoro Shoe Factory in Tanzania was shut down not too long after opening**
  - **Both foreign-assisted Akosombo Dam in Ghana and $2 billion US Aid in Zambia were failed (Easterly 2001)**

C. Transition from Agricultural to Industrialized Economy: Gollin, Parente and Rogerson (2003, 2007)

To study transition speed from agricultural to model, consider:

- **production in agricultural sector requires only labor but production in the modern industry requires both labor and capital**
- **both agricultural and modern technologies grow over time**
- **there is a subsistence consumption level of agricultural goods**

1. The Organizing Framework

- **Two sectors (i=a,m):**
  - **sector 1: agricultural, using only labor**
  - **sector 2: manufacturing, using labor and possibly capital**
- **Production technologies:**
  - **Agricultural production (AP):** $Y_a = A_a \cdot e^{\gamma_a t} \cdot N_a$
    - **the initial level of the agricultural technology is at A_a**
    - **agricultural technology grows at rate γ_a**

- Manufacturing: $Y_m = A_m\left[K^{\alpha}\left(e^{\gamma_m t}\cdot N_m\right)^{1-\alpha} + \phi N_m\right]$
  - the initial level of the manufacturing technology is at A_m
  - manufacturing technology grows at rate $\gamma_m > \gamma_a$ (Harrod-neutral)
  - with $\phi > 0$, capital is not necessary for production

- Capital accumulation: $\dot{K} = I - \delta K$
- Labor allocation: $N_a + N_m = 1$
- Goods market equilibrium conditions:
  - agricultural: $a = Y_a$
  - manufacturing: $c + I = Y_m$
- Preference: lifetime utility = $\int_0^{\infty} U(c,a)e^{-\rho t}dt$
  - $U = a$ if $a \leq \bar{a}$ (below subsistence, consuming only a)
  - $U = \ln(c) + \bar{a}$ if $a \geq \bar{a}$ (above subsistence, consuming both a and c)
- Optimization: maximize lifetime utility subject to:
  - the two technologies
  - the two market equilibrium conditions
  - the labor allocation equation
  - the capital accumulation equation

2. Equilibrium

- Before reaching the subsistence level $\bar{a}$, all labor must be used to produce a and no capital would be accumulated
- After reaching the subsistence level $\bar{a}$, we have $Y_a = \bar{a}$, which can be substituted into (AP) to solve N_a immediately
- At $\bar{a}$, $Y_a = \bar{a}$ and (AP) with $N_a = 1$ => takeoff time $T_c = (1/\gamma_a)\ln(\bar{a}/A_a)$
- Equilibrium allocation of labor:

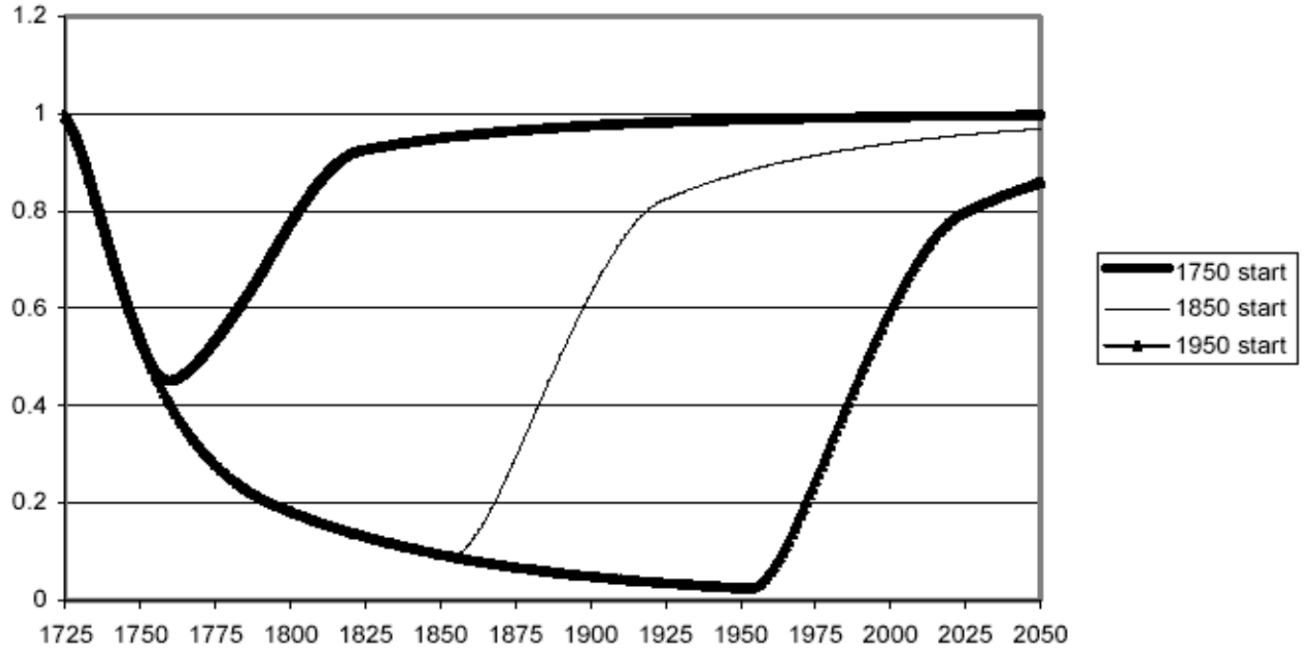
$$N_a = \min\left\{\frac{\bar{a}}{A_a e^{\gamma_a t}}, 1\right\}, \quad N_m = 1 - \min\left\{\frac{\bar{a}}{A_a e^{\gamma_a t}}, 1\right\}$$

- Modern sector is developed faster with lower subsistence level $\bar{a}$, or
  - higher initial agricultural productivity A_a (UK)
  - higher agricultural productivity growth γ_a (US)

3. Numerical Analysis (calibrating UK):

- Set $\gamma_m = 1.013$, $\delta = 0.065$ and $\rho = 0.05$ to fit the observations
- Select $\alpha = 0.5$ and $\phi = 0.0001$ and then choose $(\bar{a}, \gamma_a)$ such that:
  $N_a(1800) = 35\%$ and $N_a(1950) = 5\%$ (cf. Kuznets 1966)

- **Results:**
  - **staged development of countries (flying geese)**
  - **slow process of early development, with late comers growing faster**
  - **A_a = 1, 0.19 and 0.05 yielding transitions to modern growth started in 1750 (UK), 1850 (Japan) and 1950 (Taiwan/Korea), respectively (depicting relative outputs in their long-run BGP values):**



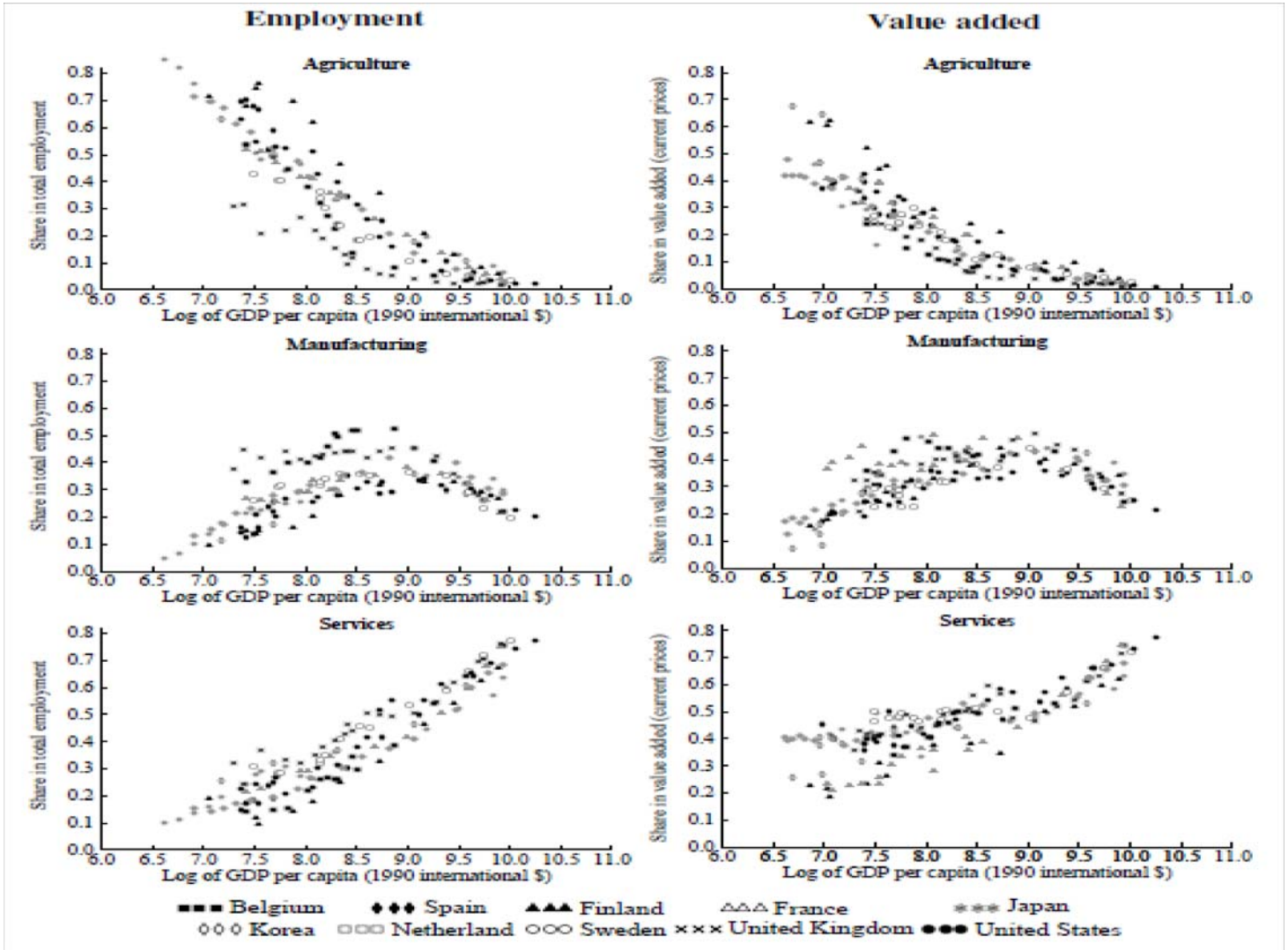
  - **at a given year (say, 1975), early developed countries grow at slower rates than the late comers.**

D. A Global View of Industrial Transformation: Herrendorf-Rogerson-Valentinyi (2013)

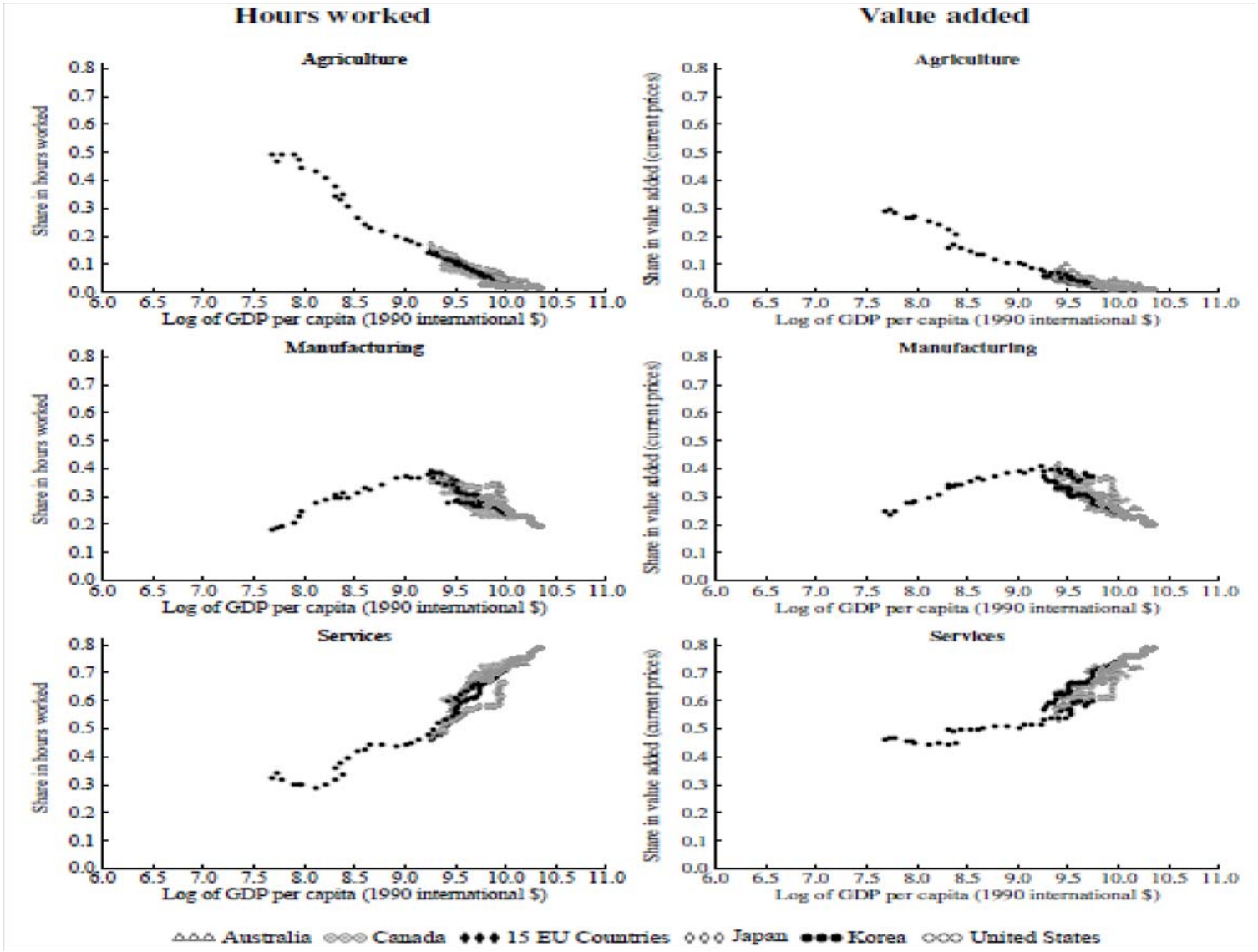
- **Key indicators:**
  - **performance measure: real GDP per capita (not per worker)**
  - **structural transformation measure:**
    - **employment shares**
    - **value-added or consumption shares**
      - **benchmark: nominal shares – local currency for production or consumption**
      - **alternative: real shares – international goods/services flows**

- **Stylized Facts**
  - **Systematic sectoral shifts for most countries over their respective development stages**
  - **agriculture continually down**
  - **manufacture hump-shaped: rising at earlier stage but declining at later stage with declining speed varying by countries**
  - **service up**

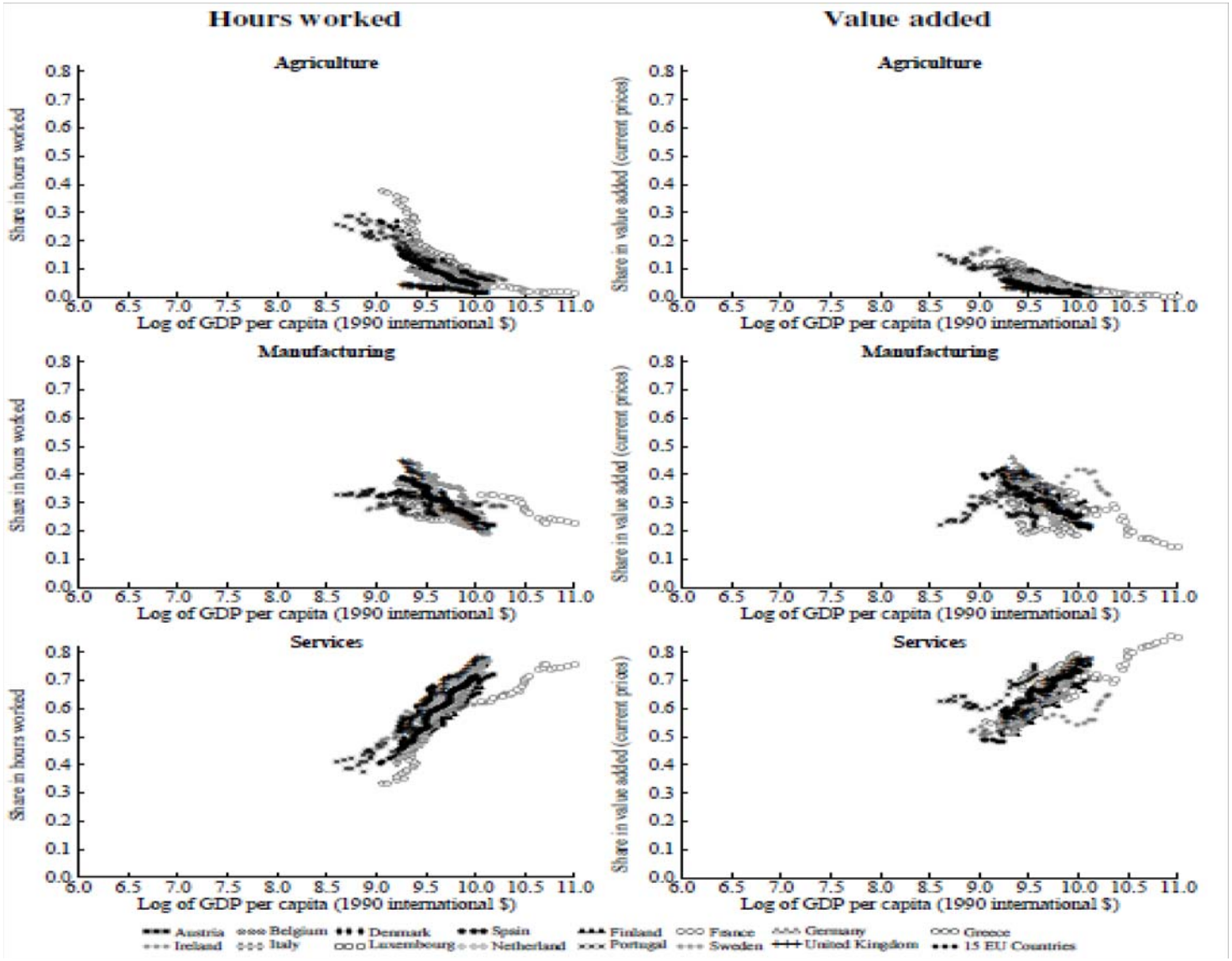
- **Developed countries: 1800-2000**



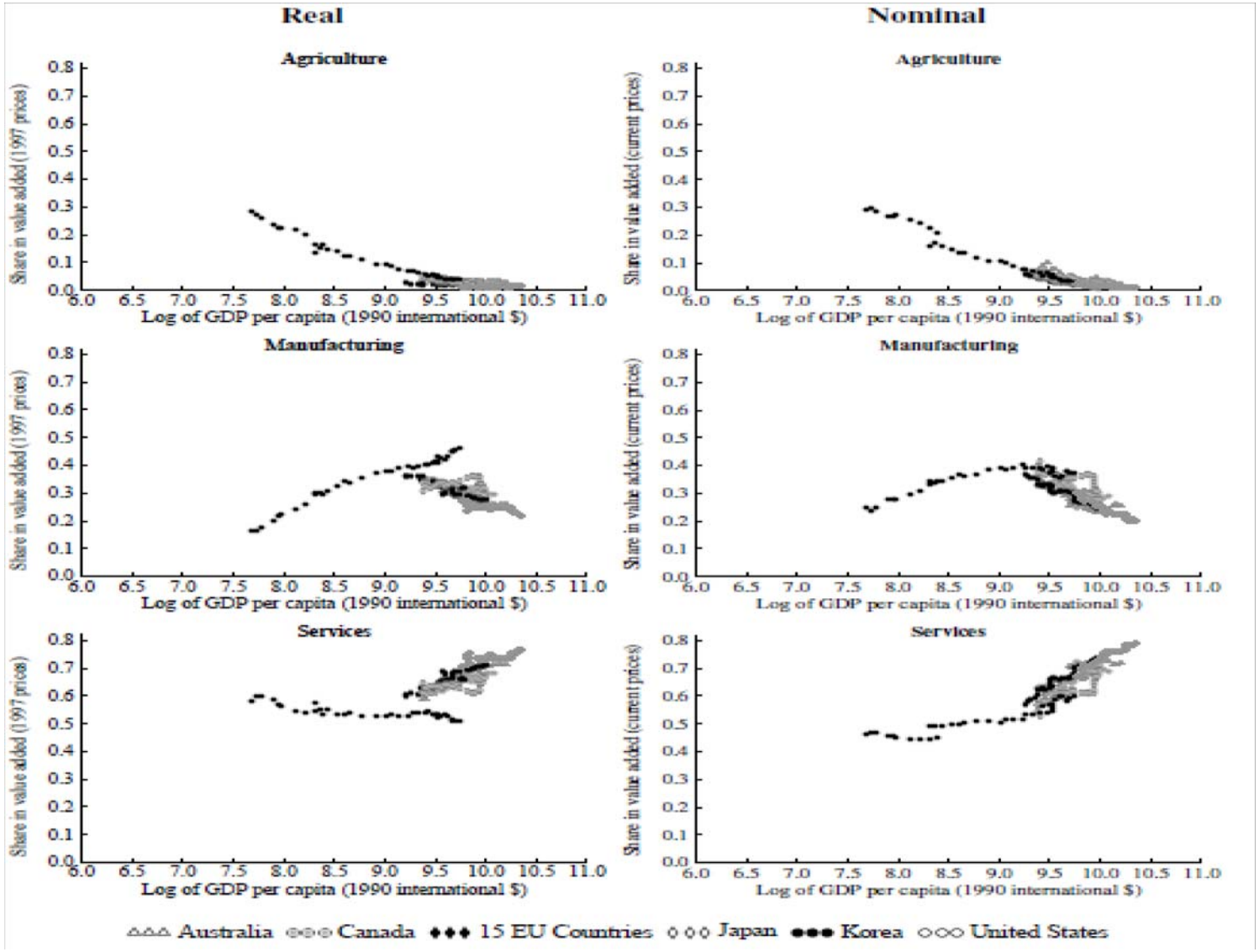
- **5 Non-EU and aggregate of 15 EU: 1970-2007**



- **15 EU: 1970-2007**

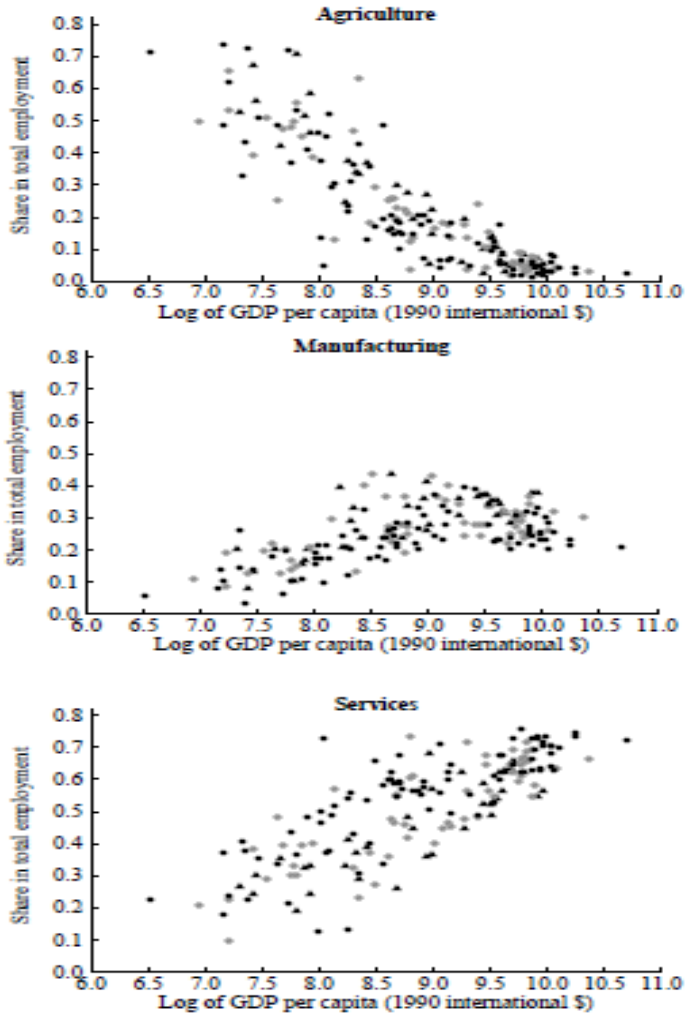


- **Real vs. Nominal: 5 Non-EU and aggregate of 15 EU (1970-2007)**

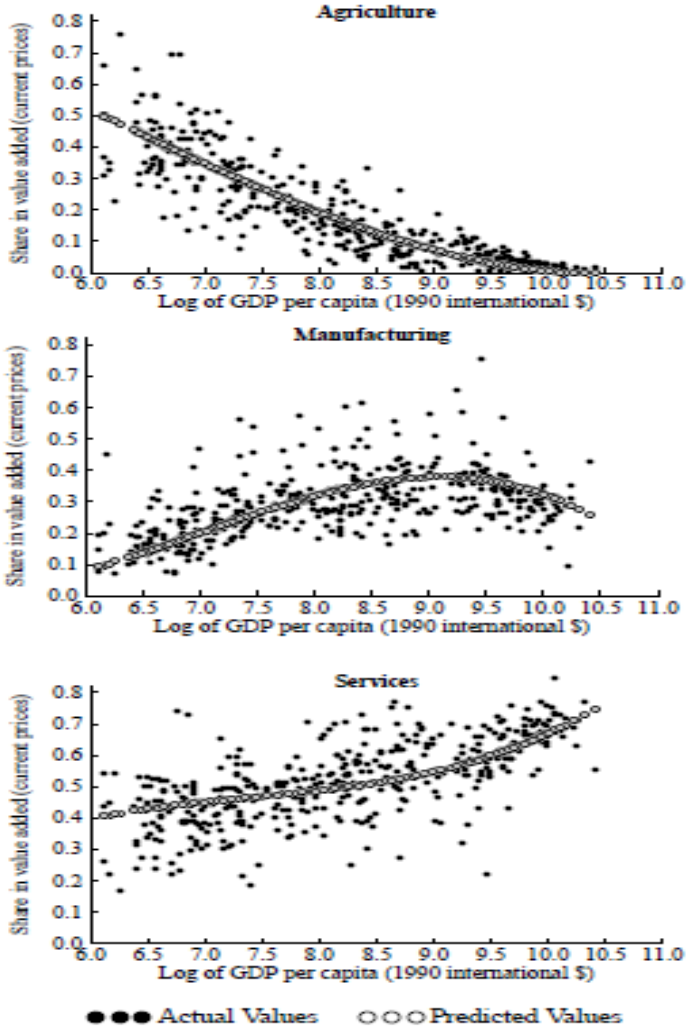


- **World Bank vs. UN-PWT 6.3**

World Bank

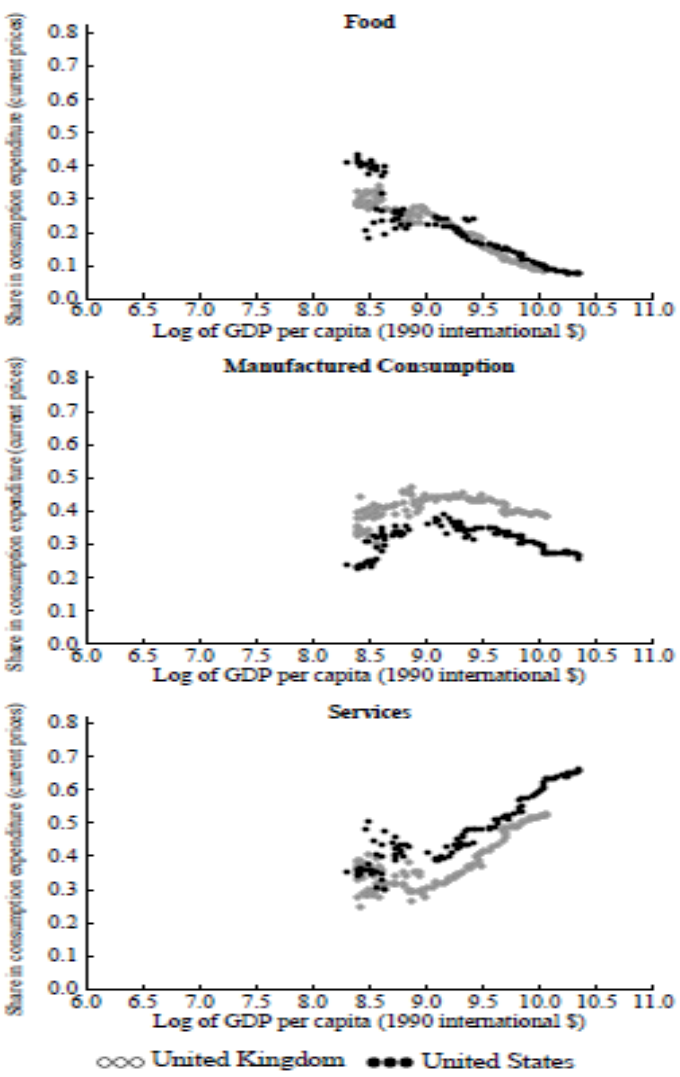


UN-PWT 6.3

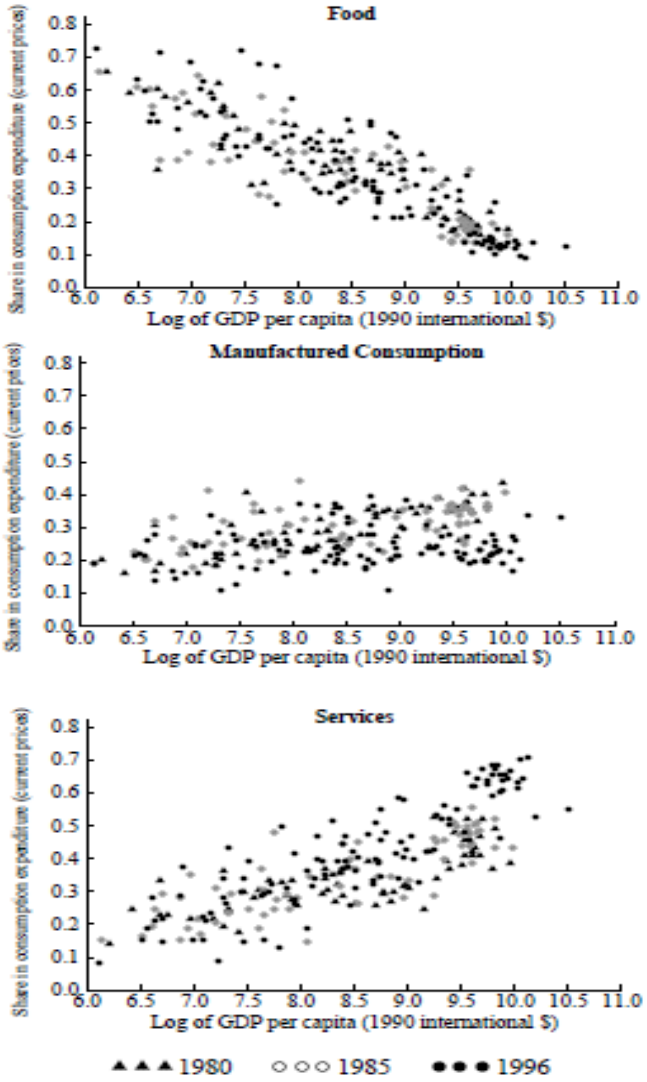


- **Consumption measures:**

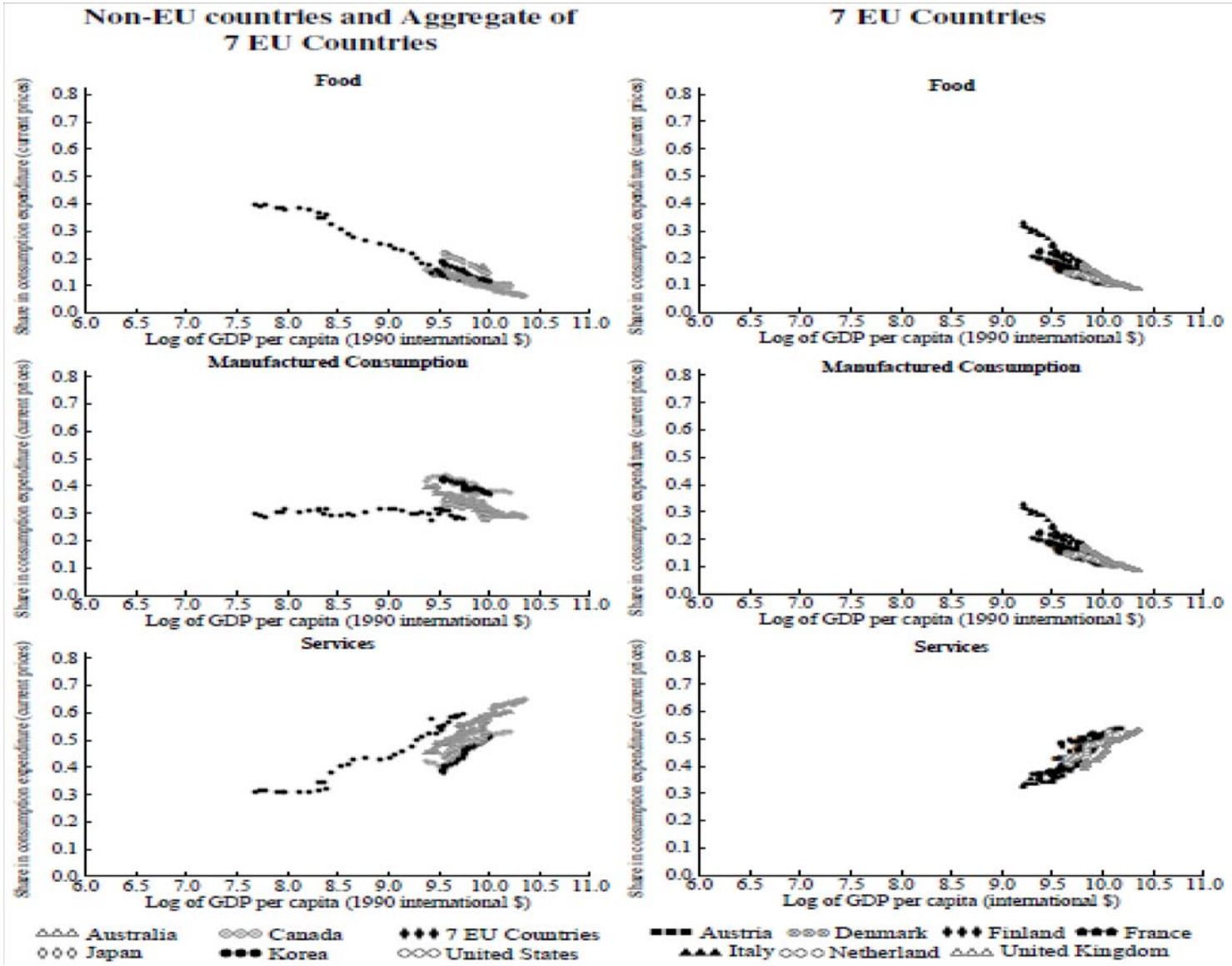
US/UK



ICP-PWT 6.3



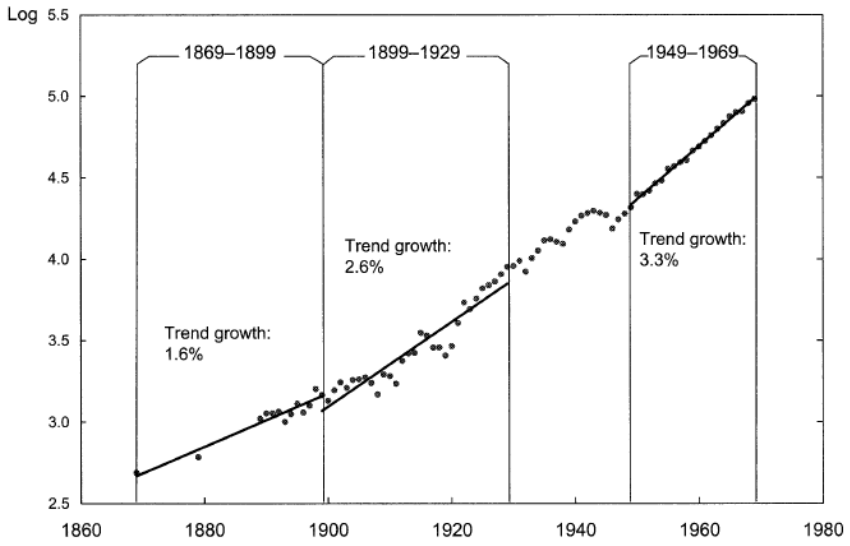
- **OECD: 1970-2007**

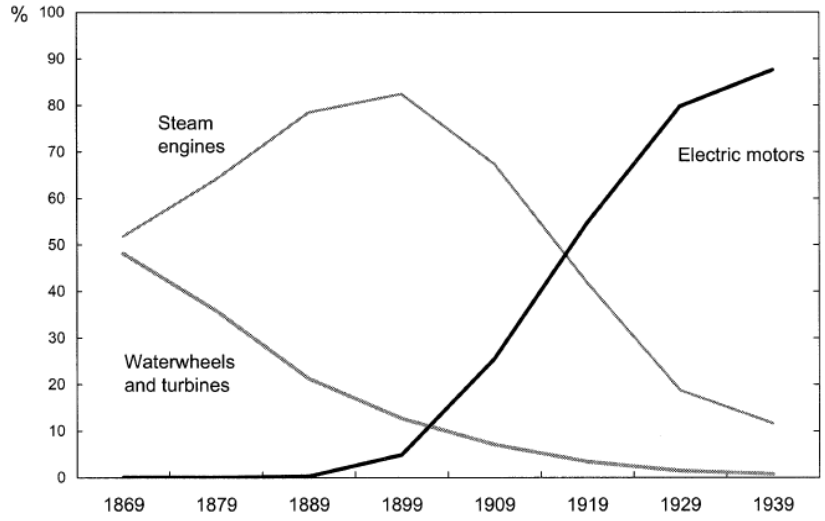


E. Technological Revolutions and Economic Transition: Atkeson-Kehoe (2007)

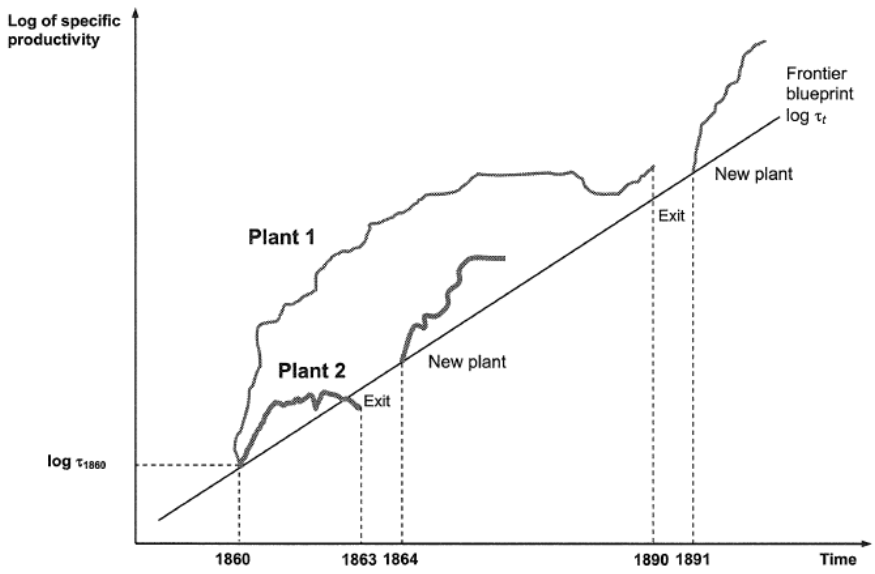
- **A tale of two revolutions:**
  - **the second industrial revolution:1860-1900**
  - **the recent information technology (IT) revolution:1970-2000**
- **Key observations:**
  - **new plants usually embody new technologies**
  - **improvements in technologies for new plants are on-going, via gradual learning**

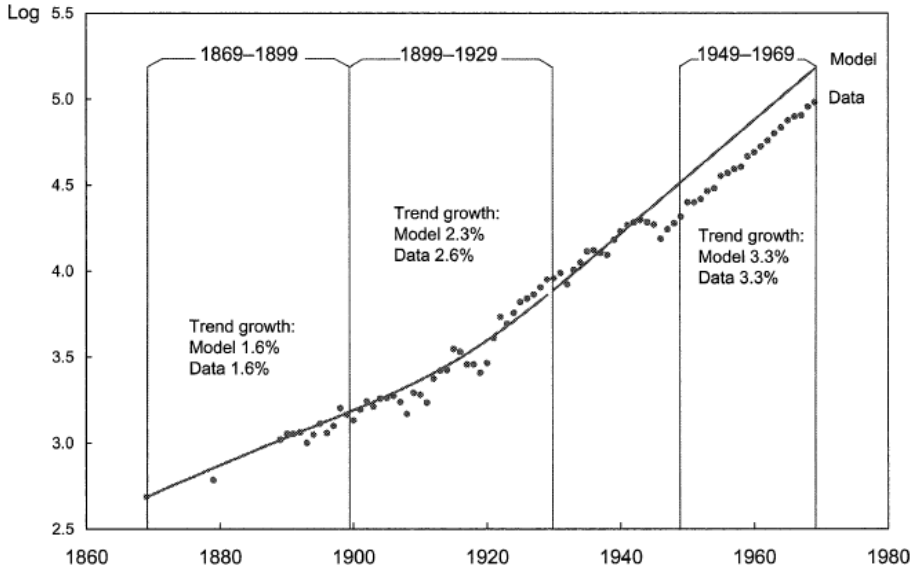
- **Organizational capital of firms:**
  - **age s (year of establishment)**
  - **firm-specific technology A**
  - **organization capital (A, s)**
  - **note: year of entry should matter, but ignored herein**





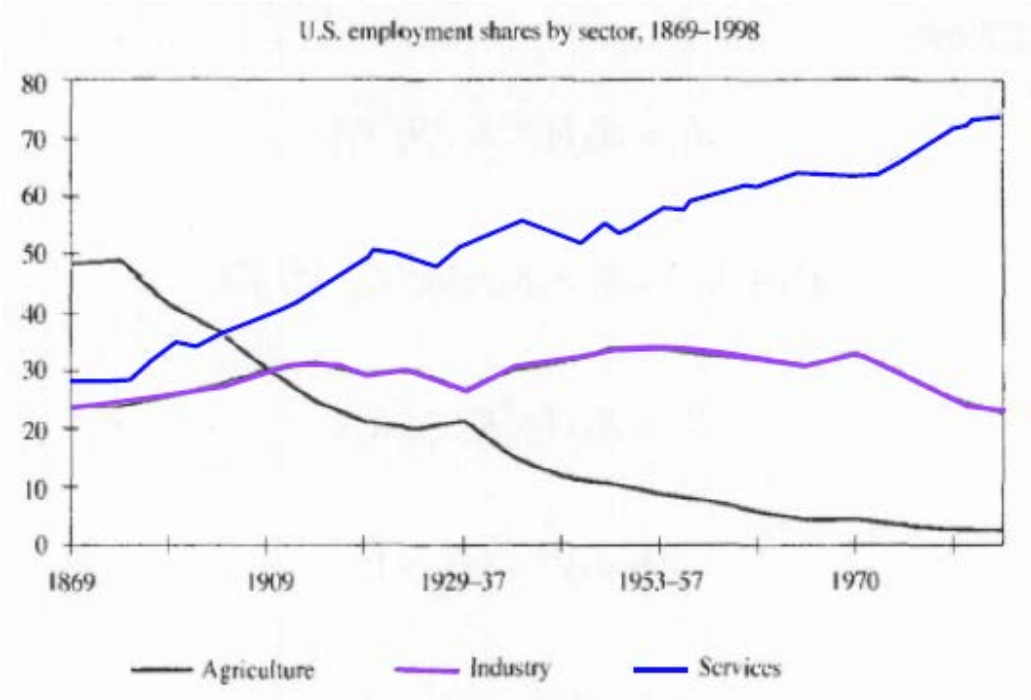
- **There exists an age-dependent cutoff $A_t^*(s)$:**
  - **a plant (A, s) with $A \geq A_t^*(s)$ continues operating**
  - **a plant (A, s) with $A < A_t^*(s)$ stops operating and exits**
  - **older plants are more likely to exit unless they advance the technology to stay closer to the frontier**
- **With different organizational capitals facing by different firms/plants, the model fits reasonably well the data, showing:**
  - **a slow increase in productivity growth**
  - **a slow diffusion of new technology**





F. Labor-Biased Technical Progress and Transition to a Service Society: Acemoglu-Guerrieri (2008)

- **Transition to modern growth usually features a shift from agriculture to manufacture and then to service**
- **3 stylized facts:**
  - **declining agriculture employment share**
  - **inverted-U manufacture employment share**
  - **rising service employment share**
- **The shift from manufacture to service features:**
  - **a shift from "home production" to market goods consumption (e.g., cooking, day care, professional service)**
  - **an on-going upgrade in the technology**



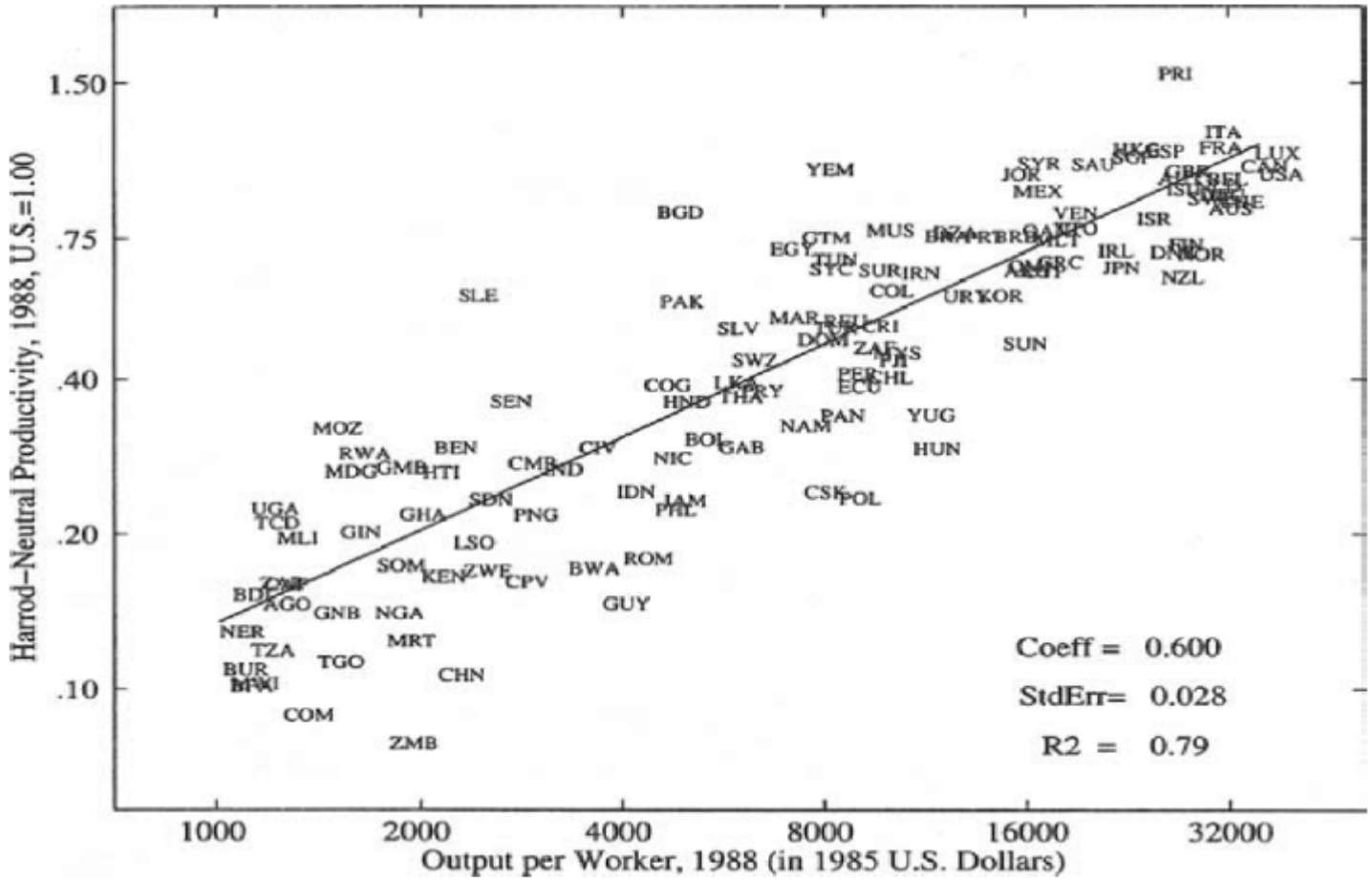
- **Industry capital intensities (U.S. 1948-2005):**

Industry	Sector	Capital Share
Educational services	1	.10
Management of companies and enterprises	1	.20
Health care and social assistance	1	.22
Durable goods	1	.27
Administrative and waste management services	1	.28
Construction	1	.32
Other services, except government	1	.33
Professional, scientific, and technical services	1	.34
Transportation and warehousing	1	.35
Accommodation and food services	2	.36
Retail trade	2	.42
Arts, entertainment, and recreation	2	.42
Finance and insurance	2	.45
Wholesale trade	2	.46
Nondurable goods	2	.47
Information	2	.53
Mining	2	.66
Utilities	2	.77

- **Key finding: more labor-intensive industries have faster employment growth and slower output growth**

G. TFP and Barriers to Productivity Growth

- **Cross-country differences in income and TFP are large and widened (Hall- Jones 1999)**



Country	Y/L	Contribution from $(K/Y)^{\alpha/(1-\alpha)}$	Contribution from H/L	Contribution from A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
Italy	0.834	1.063	0.650	1.207
West Germany	0.818	1.118	0.802	0.912
France	0.818	1.091	0.666	1.126
United Kingdom	0.727	0.891	0.808	1.011
Hong Kong	0.608	0.741	0.735	1.115
Singapore	0.606	1.031	0.545	1.078
Japan	0.587	1.119	0.797	0.658
Mexico	0.433	0.868	0.538	0.926
Argentina	0.418	0.953	0.676	0.648
U.S.S.R.	0.417	1.231	0.724	0.468
India	0.086	0.709	0.454	0.267
China	0.060	0.891	0.632	0.106
Kenya	0.056	0.747	0.457	0.165
Zaire	0.033	0.499	0.408	0.160
Average, 127 countries:	0.296	0.853	0.565	0.516
Standard deviation:	0.268	0.234	0.168	0.325
Correlation with Y/L (logs)	1.000	0.624	0.798	0.889
Correlation with A (logs)	0.889	0.248	0.522	1.000

- **Hsieh and Klenow (2009): misallocation of resources (capital and labor) across firms can have large effects on aggregate TFP**

1. The Basic Framework

- **Firms face different production efficiency and output/capital distortions**
- **A single final good is produced with a basket of industrial goods:**
  - **it takes a Cobb-Douglas form:** $Y = \prod_{s=1}^{S} Y_s^{\theta_s}$ **, with** $\sum_{s=1}^{S} \theta_s = 1$
  - **each industry's output is a CES aggregate of M_s differentiated products:**

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma-1}{\sigma}}$$ **, with** $Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}$

- **Profit of firm i in industry s yields:** $\pi_{si} = \left(1-\tau_{Ysi}\right) P_{si} Y_{si} - wL_{si} - \left(1+\tau_{Ksi}\right) RK_{si}$
  - **(τ_{Ysi}, τ_{Ksi}) measure output/capital distortions tied to institutions and policies**
    - **τ_{Ysi} captures entry barriers, good market imperfections, income taxes/tariffs, and/or transport costs**
    - **τ_{Ksi} capture capital barriers, credit market imperfections, capital taxes and/or intermediation costs**
- **Factor Allocation:** $L \equiv \sum_{s=1}^{S} L_s$ **and** $K \equiv \sum_{s=1}^{S} K_s$

- **Aggregate output:** $Y = \prod_{s=1}^{S} \left(TFP_s \cdot K_s^{\alpha_s} \cdot L_s^{1-\alpha_s} \right)^{\theta_s}$ **, with** $P \equiv \prod_{s=1}^{S} \left(\frac{P_s}{\theta_s} \right)^{\theta_s}$
- **Measurement of TFP of firm i in industry s:**
  - **physical:** $\text{TFPQ}_{si} \triangleq A_{si}$
  - **revenue:** $\text{TFPR}_{si} \propto (\text{MRPK}_{si})^{\alpha_s} (\text{MRPL}_{si})^{1-\alpha_s} \propto \frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}$ **,** ***increasing in both distortions***
- **If TFPQ (A) and TFPR are jointly log-normally distributed, then:**

$$\log \text{TFP}_s = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{M_s} A_{si}^{\sigma - 1} \right) - \frac{\sigma}{2} \text{var} (\log \text{TFPR}_{si})$$

  - **higher firm-level TFP (A_{si}) raises industry-level TFP (TFP_s)**
  - **greater dispersion of firm-level TFPR (var(logTFPR$_{si}$)) indicates larger resources misallocation between firms, thus lowering industrial TFP**

2. Applications: China/India versus U.S.

- **Based on the theory developed above, we can back out the two distortion measures as well as productivity measures at firm, industry and country levels**

- **Sources of TFPR variation within industries**

	Ownership	Age	Size	Region
India	0.58	1.33	3.85	4.71
China	5.25	6.23	8.44	10.01

- **TFP gains from equalizing TFPR within industries**
  - **China: 115.1% in 1998 86.8% in 2005**
  - **India: 100.4% in 1987 127.5% in 1994**
  - **U.S.: 36.1% in 1977 42.9% in 1997**

- **TFP gains from equalizing TFPR relative to 1997 U.S. gains**
  - **China: 50.5% in 1998 30.5% in 2005**
  - **India: 40.2% in 1987 59.2% in 1994**

- **China and India have lower TFPQ and higher TFPR than the U.S.:**

Figure 1: Distribution of TFPQ

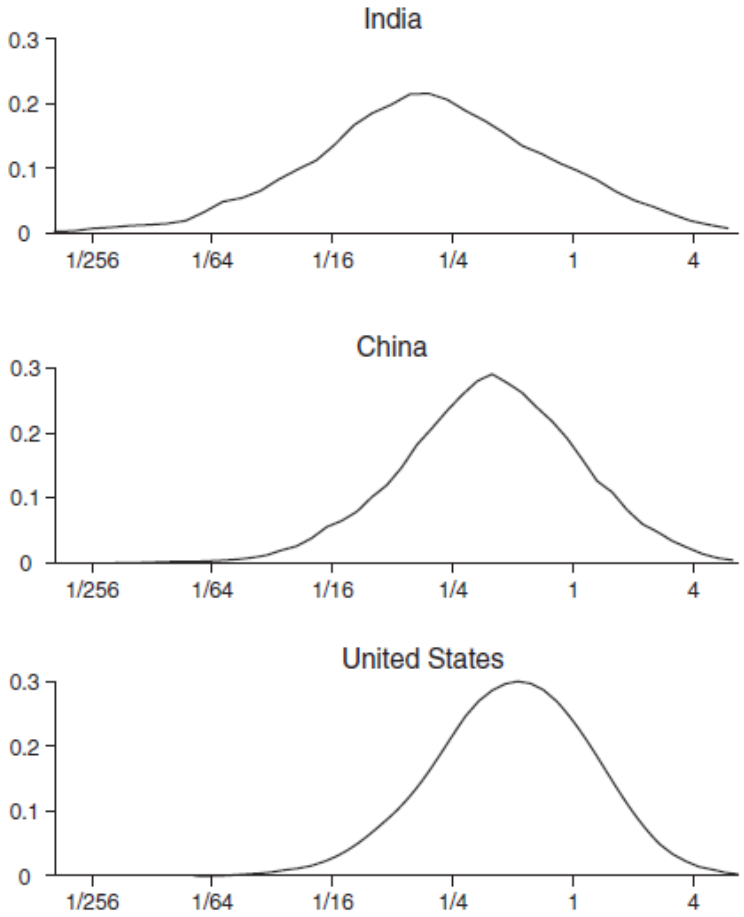
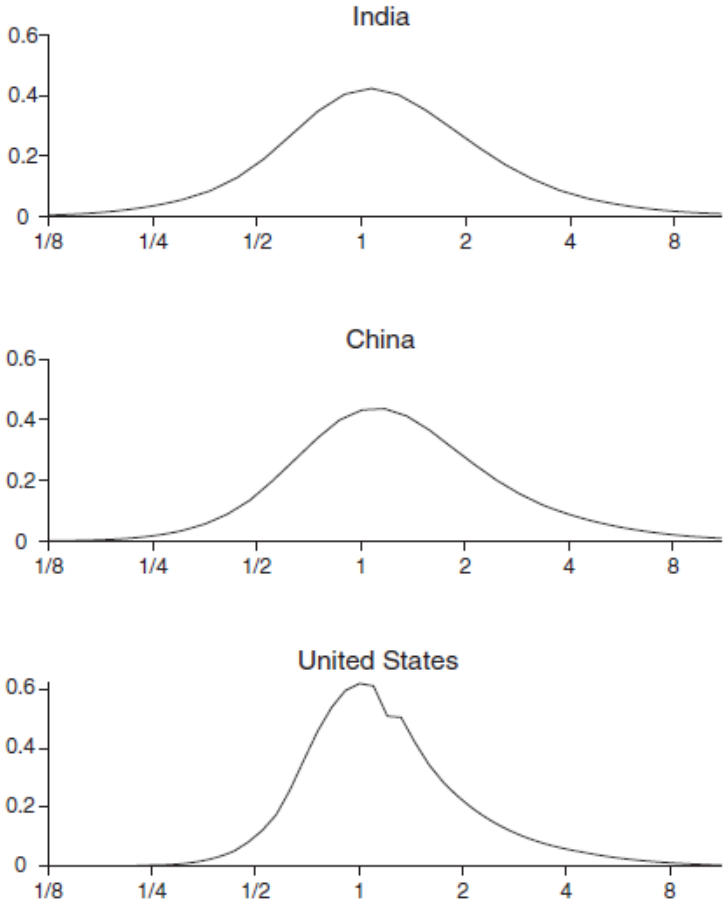
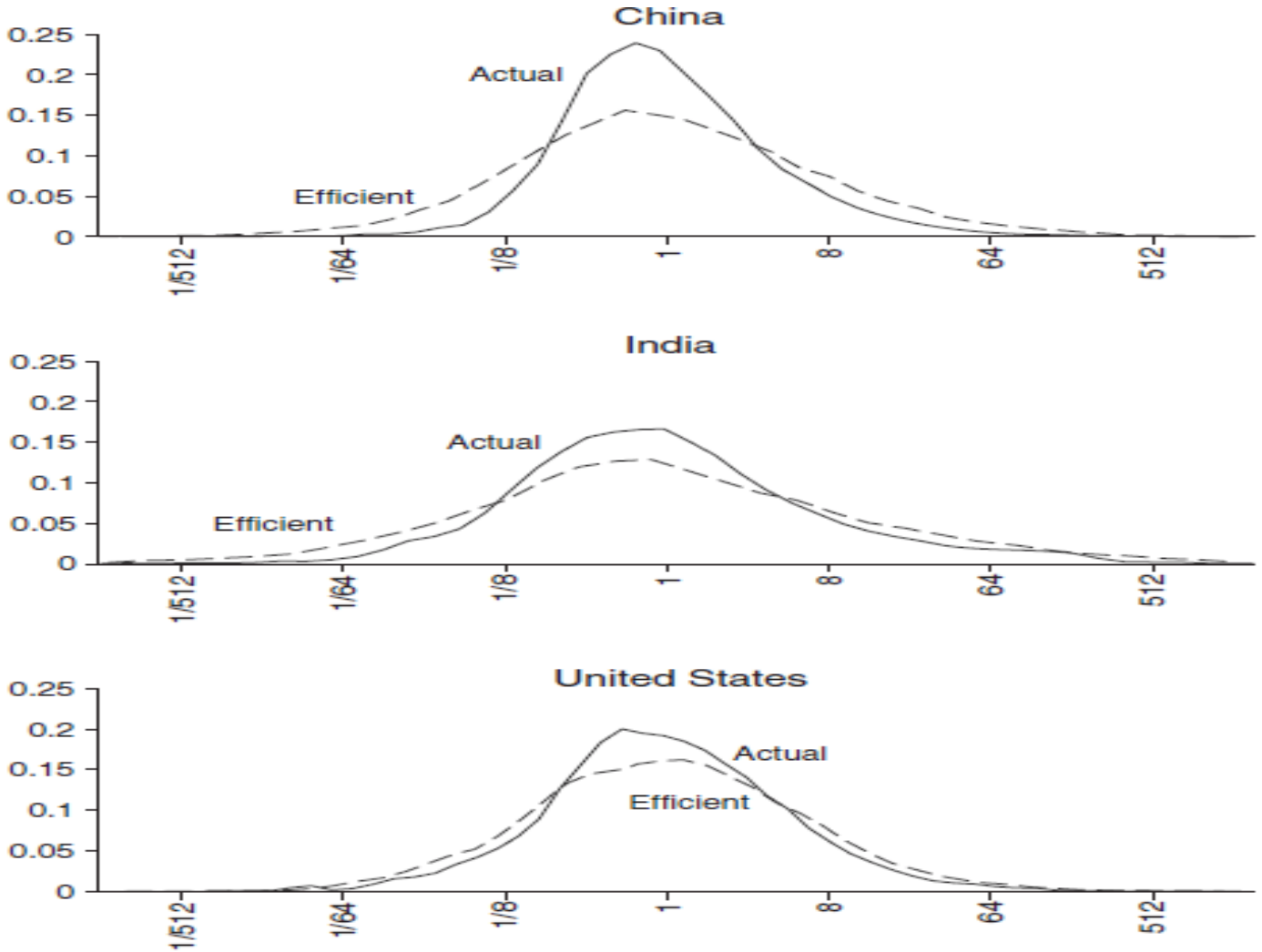


Figure 2: Distribution of TFPR



- **China and India have overly concentrated plan size distribution than the efficient one**

Figure 3: Distribution of Plant Size



- **Experienced and larger firms in the U.S. have lower TFPR (less barriers)**
  - **in India, the results are *opposite***
  - **in China, experienced and *small* firms have lower TFPR**

Figure 7: TFR and Age

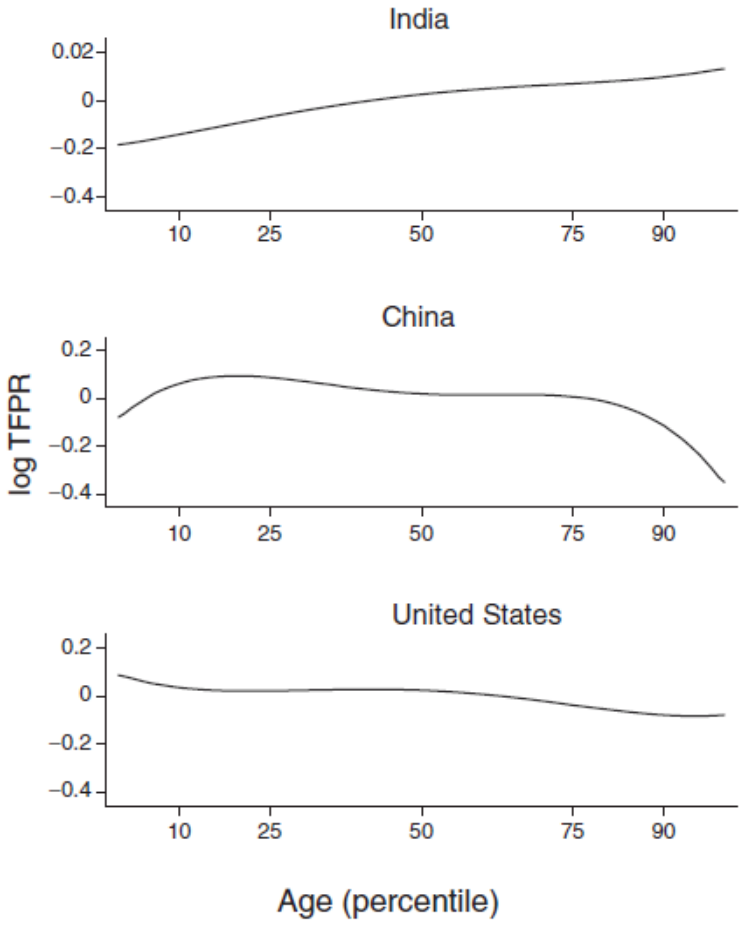
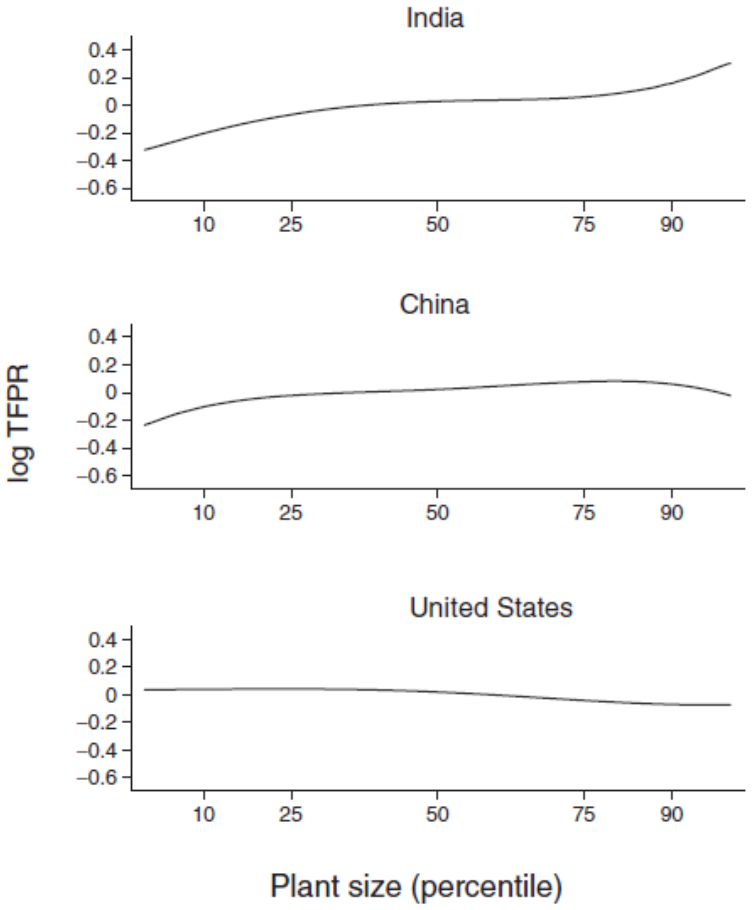


Figure 6: TFR and Size



H. Venture Capital and High Tech Industrial Development

- **In the U.S., since American Research and Development was established in 1946, venture capital (VC) has played a key role in promoting high tech industries.**
  - **Kortum-Lerner (2000): VC accounts for 8% of industrial innovations**
  - **Lu-Wang (2013):**
    - **with over 50% of its disbursements to the IT industry, venture capital has supported many highly successful companies, including Apple, Cisco, Microsoft, e-Bay, Yahoo, Google, Facebook and many others**
    - **this trend reversed, however, since the burst of the internet bubbles**
- **Issues:**
  - **Bank loans vs. VC or business angels**
  - **The role of VC in funding new ventures**
  - **Uncertainty**
  - **The role of monitoring**
  - **Information asymmetry**
  - **Institutions and business culture**
    - **Business Environment Survey: World Bank**
    - **Global Competitiveness Report: World Economic Form**
    - **World Governance Index: Kaufmann-Kraay-Mastruzzi, measuring effectiveness of government bureaucracy and regulatory policies**

- **Cross-country comparison (Li-Zahra 2012, based on VentureXpert data):**

Country	Years of data	Mean annual #	Mean annual amount ($mil)	Country	Years of data	Mean annual #	Mean annual amount ($mil)
Argentina	11	3.0	29.3	Kuwait	9	0.0	0.0
Australia	10	110.1	399.9	Luxembourg	10	2.1	25.3
Austria	10	10.2	82.7	Malaysia	11	7.2	33.3
Bangladesh	11	0.1	1.7	Mexico	10	1.9	15.6
Belgium	10	25.9	197.1	Morocco	11	0.1	0.1
Brazil	11	23.9	277.5	Netherlands	10	28.3	261.0
Bulgaria	11	0.6	15.1	New Zealand	10	9.3	24.1
Canada	10	104.6	815.5	Nigeria	11	1.6	0.8
Chile	11	1.4	7.2	Norway	10	15.2	88.7
China	11	43.5	597.8	Pakistan	11	0.5	3.8
Colombia	10	0.4	6.7	Panama	11	0.2	0.4
Costa Rica	11	0.3	0.3	Peru	11	0.1	0.2
Czech Republic	10	4.7	25.6	Philippines	10	2.3	22.7
Denmark	10	28.1	117.5	Poland	11	13.5	43.0
Ecuador	11	0.4	2.8	Portugal	10	8.8	13.7
Egypt	11	0.3	2.0	Romania	11	4.6	18.6
El Salvador	11	0.3	1.1	Russia	11	4.8	30.6
Estonia	11	1.2	5.4	Sierra LeonE	11	0.1	0.1
Finland	10	32.8	69.4	Singapore	10	20.9	200.0
France	10	131.7	1092.2	Slovakia	11	1.4	4.0
Germany	10	84.2	705.0	South Africa	11	3.5	37.9
Ghana	11	0.7	2.0	Spain	10	28.2	256.8
Greece	10	1.0	5.8	Sweden	10	58.0	240.3
Guatemala	10	0.1	0.1	Switzerland	10	19.9	133.9
Hong Kong	10	16.9	289.2	Tanzania	11	0.1	10.4
Hungary	10	6.8	13.3	Thailand	11	6.7	34.9
India	10	76.2	448.4	Trinidad and Tobago	11	0.2	1.5
Indonesia	10	2.7	82.7	Turkey	11	0.3	2.8
Ireland	10	30.6	212.4	United Arab Emirates	8	0.1	2.9
Israel	10	52.1	335.5	United Kingdom	10	237.5	1873.2
Italy	10	13.5	113.1	United States	10	3380.8	35246.8
Japan	10	51.1	717.4	Venezuela	10	0.3	1.6
Kenya	11	0.5	2.7	Vietnam	11	1.6	1.6
Korea, South	10	181.0	801.0	Zambia	11	0.3	36.2
				Total	708	69.4	634.6

- **Factors affecting VC numbers and amounts**

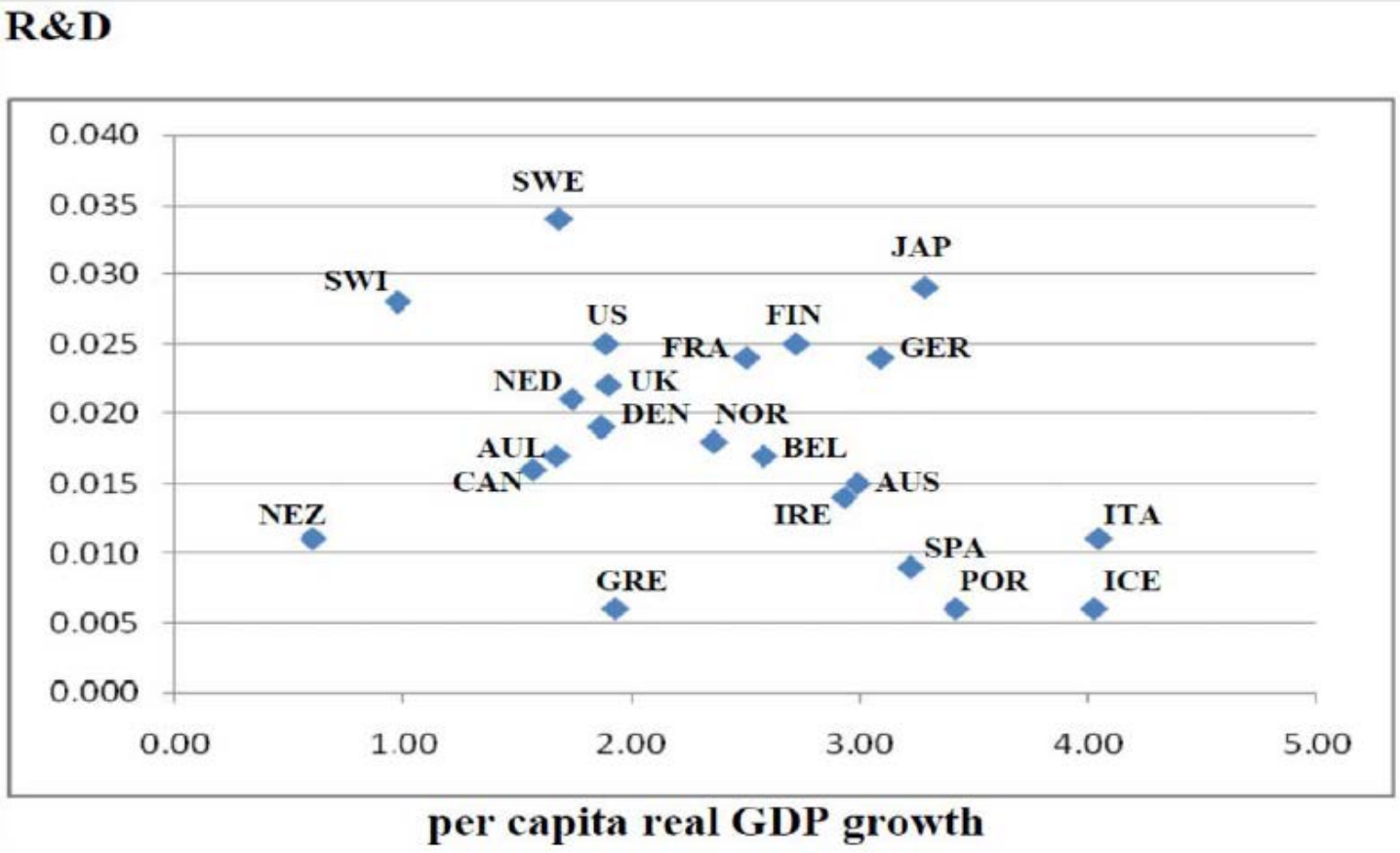
No.	Variables	Mean	S.D.	Min	Max	(1)	(2)
(1)	Number of VC investments	0.59	0.87	0.00	3.55	1.00	
(2)	Amount of VC investments	1.23	1.58	0.00	6.48	0.92	1.00
(3)	Uncertainty avoidance	0.00	21.88	−57.23	46.77	−0.30	−0.29
(4)	Collectivism‡	0.00	1.00	−2.05	1.50	−0.60	−0.60
(5)	Formal institutions‡	0.00	1.00	−2.08	2.99	0.36	0.37
(6)	GDP growth	0.00	3.55	−21.19	23.81	−0.01	−0.05
(7)	Market capitalization	0.00	2.89	−1.22	74.89	0.16	0.13
(8)	No. VC firms	0.00	4.99	−2.02	59.03	0.65	0.59
(9)	Scientific articles	0.00	0.03	−0.03	0.13	0.38	0.34
(10)	Self-employment rate	0.00	12.21	−17.13	39.44	−0.43	−0.43
(11)	New firm creation	0.00	1.85	−5.18	6.11	0.41	0.41
(12)	Early-stage entrepreneurial activity	0.00	8.59	−8.72	70.28	−0.27	−0.37
(13)	Trend	5.72	3.02	1.00	11.00	0.11	0.13
(14)	Bubble	0.19	0.39	0.00	1.00	0.10	0.12

  - **Institutions, creativity (scientific articles) and start-ups are most important factors driving the VC market**
  - **Economic growth is not an important driver**
- **Should the government intervene?**
  - **Yes because of positive spillovers, information provision and monitoring**
  - **No because of misallocation of subsidies due to limited knowledge, lobbying and other local considerations**

- **Case studies:**
  - **Taiwan (Lee-Wang 2012)**
    - **Started since 1983 by the Ministry of Finance (KT Li and LT Hsu)**
    - **Up to 20% tax incentive when investing in ventures**
    - **Tied closely to startups in Silicon Valley (20-30%, to those started by Taiwanese engineers/scientists) and Hsinchu Science Park**
    - **Strategically guided by Industrial Technology Research Institute (ITRI)**
    - **Number of VC grew from 1 in 1983 to 170 by 2000**
    - **VC fund grew 10 million US$ in 1983 to 4600 by 2000**
  - **Israel (Avnimelech-Teubal 2001)**
    - **Started later since 1990, but growing strongly becoming one of the highest in the VC investment/GDP ratio**
    - **Key policy institutionalized: Innovation & Technology Policy (ITP) – learning about innovation process, implementation and marketing**
    - **Creation of a government-funded organization, Yozma**
    - **Creation of High Tech Cluster**
    - **Number of startups grew from 300 in 1990 to 3000 by 2000**
    - **Number of VC from 2 to 100; fund raised from 49 million$ to 3400; capital invested from 45 million$ to 1270**
    - **Accumulated number of high tech IPOs from 9 to 130**
    - **By 2000, share of foreign VC is about 2/3 and M&A up to 10 billion$**
- **In general, public intervention may fail (Lerner, Boulevard of Broken Dreams)**

I. The IT Industry and the Asian Development Miracle

- **Cross-country relationship between R&D intensity and growth is ambiguous**



- **R&D and technological advancements are key to the success of Asia**

- **The industrialization reforms:**
  - **Hong Kong: key supplier to Korean War in 1952 and the technology and production line design were commercialized afterward**
  - **Taiwan: the T.C. Liu-S.C. Tsiang-K.T. Lee plan started 1958, with land/tax/education reforms and market-oriented and openness policy, plus implementation of the Ten Major Public Development Projects, improvement of automation with GI and creation of the IT industry with RCA in the Hsinchu National Science Park**
  - **Korea: deregulation by Park in 1962 to justify coup and formation of Chaebols, followed by establishment of key industries (steel, ship-building, and then electronics)**
  - **Singapore: promotion of export-oriented industries and multinational corporations led by K.Y. Lee started 1965, followed by the establishment of the IT industry and the biotech industry**
  - **China: openness policy initiated by X.P. Deng in 1978, followed by the further privatization policy and FDI policy set during his Southern Trip in 1992, where the special zones in Pearl River Delta, Yangtze River Delta, and Haidien District played locomotor roles**

- **Technology transfer and spillover:**
  - **Japan: high tech inventions induced by U.S. technologies (Wan 2004):**
    - **transistor radio (American transistor)**
    - **camera with view finder (American e-sensor)**
    - **Nintendo (American interactive and simulating dos software)**
    - **cars by Nissan/Toyota (Datsun/Dodge); bicycles (Schwinn)**
    - **home electronics by Toshiba and others (RCA/Westinghouse)**
  - **Newly industrialized countries (NICs):**
    - **Korea (Stern-Kim-Perkins-Yoo 1995, Kim 2000):**
      - **auto by Hyundai (Ford, Mitsubishi)**
      - **electronics by Samsung/LG (Sanyo/Sony/Micron)**
    - **Taiwan (Kuo 1981, Tung 2001, Lee-Wang 2010):**
      - **auto by Yulong (Toyota)**
      - **electronics by Tatung/UMC/TSMC (Panasonic/RCA/TI)**
    - **Hong Kong (Morawetz 1981, Watanabe 1980):**
      - **garment industry (UK/US)**
      - **digital watch (US car radio)**
    - **Singapore (Chia 1986): hard disk by Seagate (US tech + skilled workers laid off by German camera firm, Rollei**

- **Small & median enterprises (SMEs) vs. large conglomerates:**
  - **Taiwan: under Chiang and KMT,**
    - **land reforms were done with landlords compensated with shares to firms**
    - **union strikes were strongly discouraged**
    - **interest rates were kept high to ensure domestic supply of funds, accompanied by investment incentives such as ITC/ITR**
    - **favored loan terms were provided to SMEs**
    - **tariffs were set low to ensure strong international competition that usually favored more flexible small-sized firms**
    - **export process zones and national science parks were established to promote export and encourage technology upgrading**
  - **Korea: under Park,**
    - **union officers were appointed to control wage demands**
    - **interest rates were set low that even resulted in negative real deposit rates to households**
    - **favored loan terms were provided to large chaebols**
    - **nationally steered projects were toward heavy industries**
    - **luxurious goods were imposed with large domestic markups (cheaper to buy top Korean electronic products abroad)**

- **Market orientation vs. central planning:**
  - **Hong Kong: under Britain,**
    - **entrepot facility was fully developed, enabling it as world trade center**
    - **banking system was well-established**
    - **South China refugees from the civil war provided abundant workers**
    - **over 100,000 capitalists migrated from Shanghai provided talented entrepreneurs with funding**
    - **production blue prints from Korean war provided effective technology and organizational capital**
    - **markets would run smoothly without the need for government interventions**
  - **Singapore: upon involuntarily separated from Malaysia and under the PAP led by K.Y. Lee,**
    - **it suffered doubt digit unemployment with threat by the forthcoming closure of the British Navy base, making fast creation of jobs as the government's primary goal**
    - **multinational corporations (MNCs) became the model: by 2000, MNCs created 40% of Singaporean jobs, 60% of outputs and 80% of exports**

- **fast creation and MNC establishment require large-scale government interventions to ensure better coordination and profitable outcomes**
  - **the workforce was educated and trained according to the demand by MNCs, with strikes being largely prohibited**
  - **large number of foreign skilled workers were invited as citizens with strong fringes including public housing**
  - **world class airport/harbor were built to make it an international transportation hub**
  - **subsidized public utility was provided to attract firms**
  - **large tax subsidies and long tax holidays were offered to MNCs**
  - **favored loan terms were provided to MNCs**
  - **quality international schools were established to reassure the residency of foreign skilled labor**
- **such a strong government remained super-efficiency without corruption and with the highest pay, higher than U.K. (and U.S.)**

- **The kingdom of IT:**
  - **Korea: DRAM, LCD**
  - **Singapore: hard disk drives and other mass storage devices, card readers**
  - **Taiwan: foundry, DRAM, LCD, notebook computer**

J. Post-WWII World Development

As the Second World War ended and the Cold War started, there have been several crucial developments around the globe.

- **With a few exceptions, the colonial empires that monopolized the resources of the New World came to an end. The end of colonization:**
  - **allowed emerging economies to grow**
  - **helped removing the disadvantage of resource-poor countries, such as Japan and the 4 Asian Tigers**

- **Technologies continued to advance rapidly. Many technologies benefited from defense inventions during the war and throughout the Cold War, including several micro-electronics that can serve as general purpose technology (GPT):**
  - **audio technology (radio, media & telecommunication)**
  - **video technology (camera, type recorder, CD player)**
  - **computing technology (calculator/TI, computer)**
  - **machine tools**
  - **commercialization of satellite and the rise of internet**

- **The basic infrastructure continued to improve rapidly:**
  - **highway**
  - **railroad**
  - **shipping**
  - **air transportation**
  - **water supply and sewer**

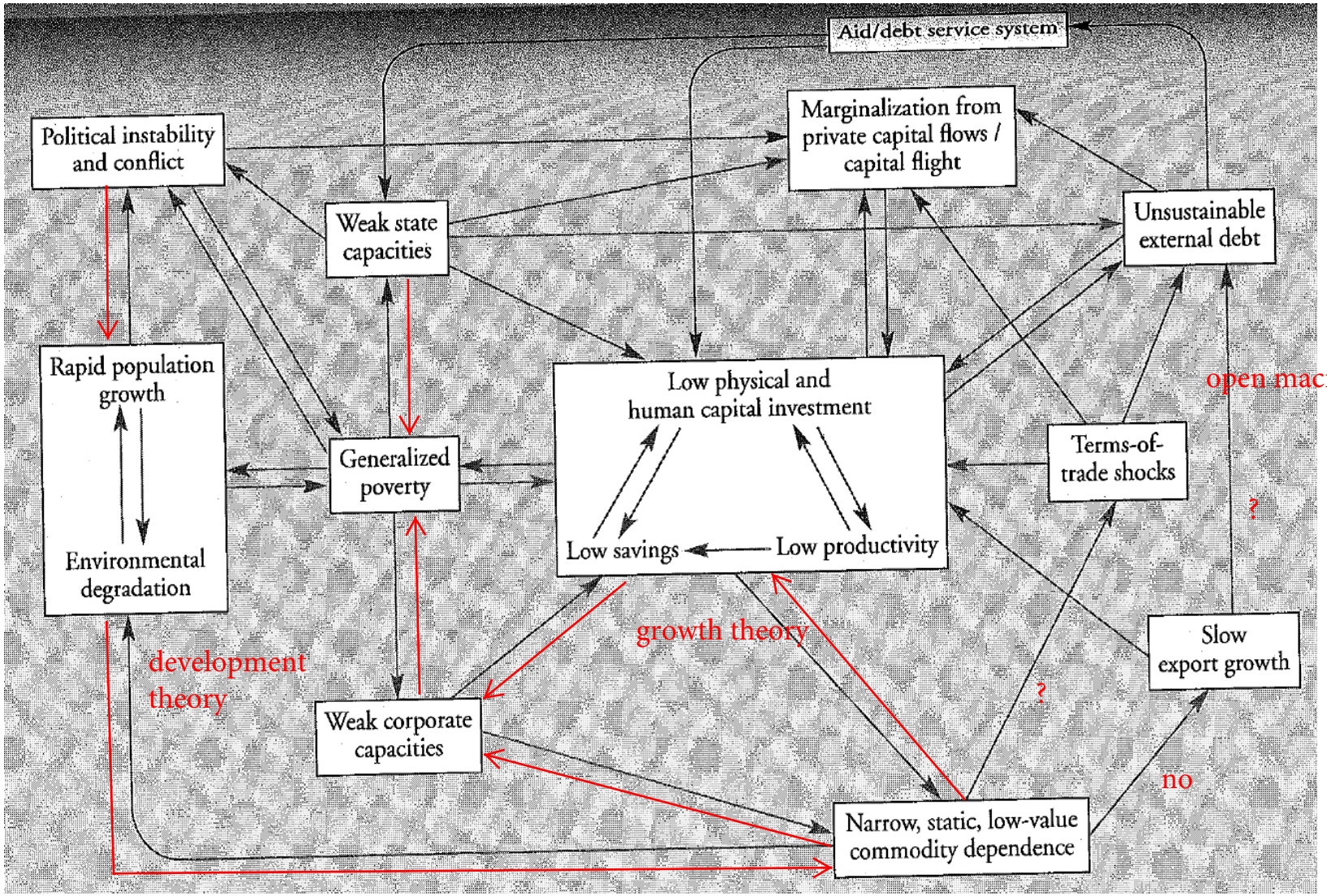
- **The basic education continued to improve:**
  - **in most emerging economies, elementary schooling became mandatory**
  - **in some fast growing countries:**
    - **mandatory education has been up to 9 or even 12 years**
    - **adultery education and skill training have been offered**

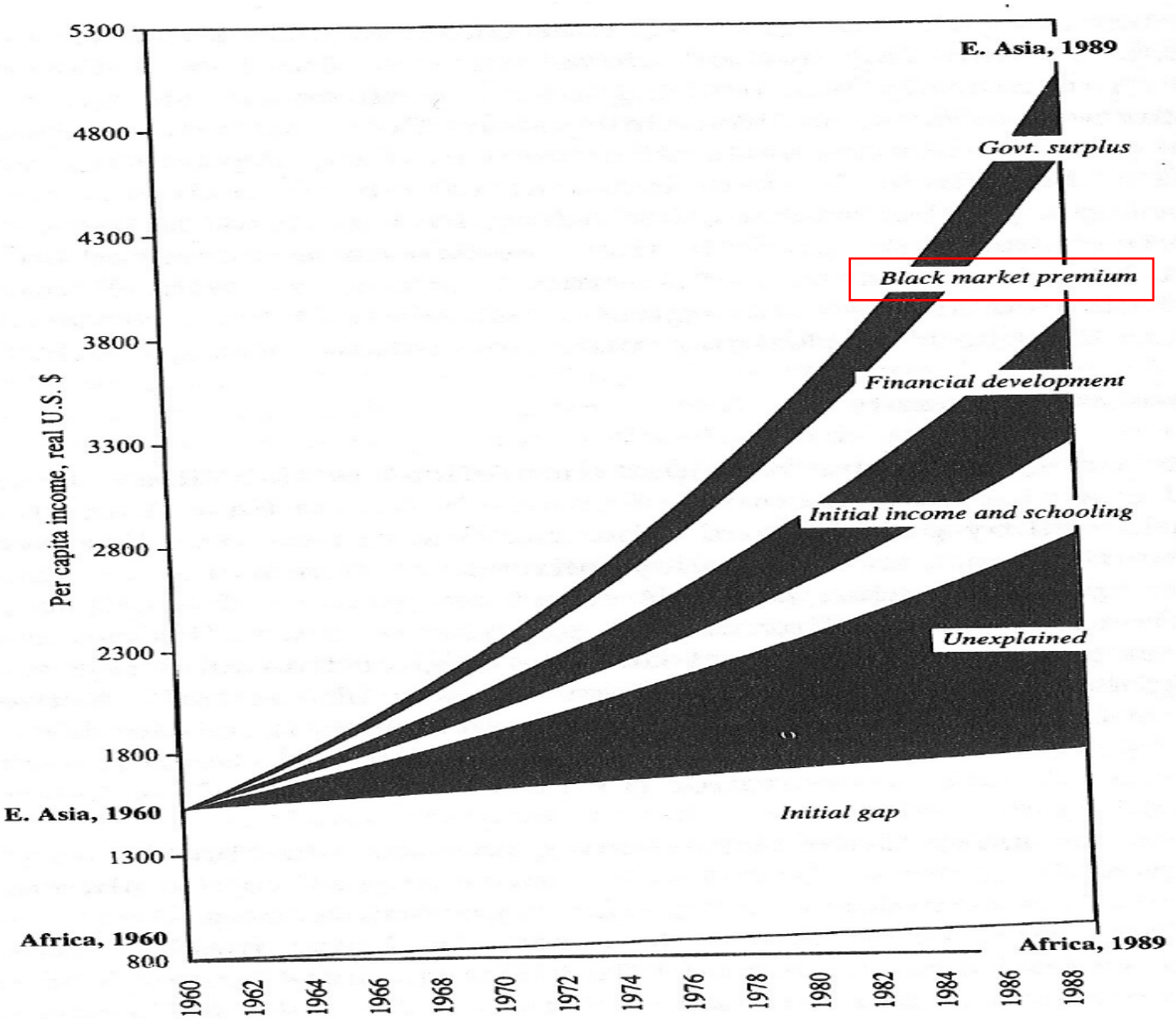
- **The laws and institutions continued to set up globally:**
  - **private property ownership**
  - **IPR protection**
  - **international business law**
  - **GATT**
  - **WTO**

- **With rising domestic wages and reduced trade costs (transport costs and tariffs), leading advanced economies, particularly the U.S., have exercised not global trade but product fragmentation:**
  - **global trade created world demand for goods produced in emerging economies, learning by exporting (Bond-Jones-Wang 2005)**
  - **product fragmentation enabled emerging economies to participate in the world production chain, learning by producing (Lucas 1993)**
  - **some fast growing countries eventually moved up along the world production chain, chaining roles from subsidiaries/subcontractors to MNEs/outsourcers**

- **As a strategic consequence of the Cold War, many Asian countries gained geographic advantage as part of the alliance, receiving USAid as well as other institutional and infrastructural assistance:**
  - **East Asia: Korea, Japan, Taiwan, Hong Kong**
  - **Southeast Asia: Philippines, Indonesia, Thailand, Malaysia, Singapore**
  - **South Asia: Bangladesh, India, Pakistan**

- **A tale of two continents: Asia vs. Africa (Easterly 2001, own notes in red)**




5300
4800
4300
3800
3300
2800
2300
1800
1300
800
Per capita income, real U.S. $
E. Asia, 1989
Govt. surplus
Black market premium
Financial development
Initial income and schooling
Unexplained
Initial gap
E. Asia, 1960
Africa, 1960
Africa, 1989
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
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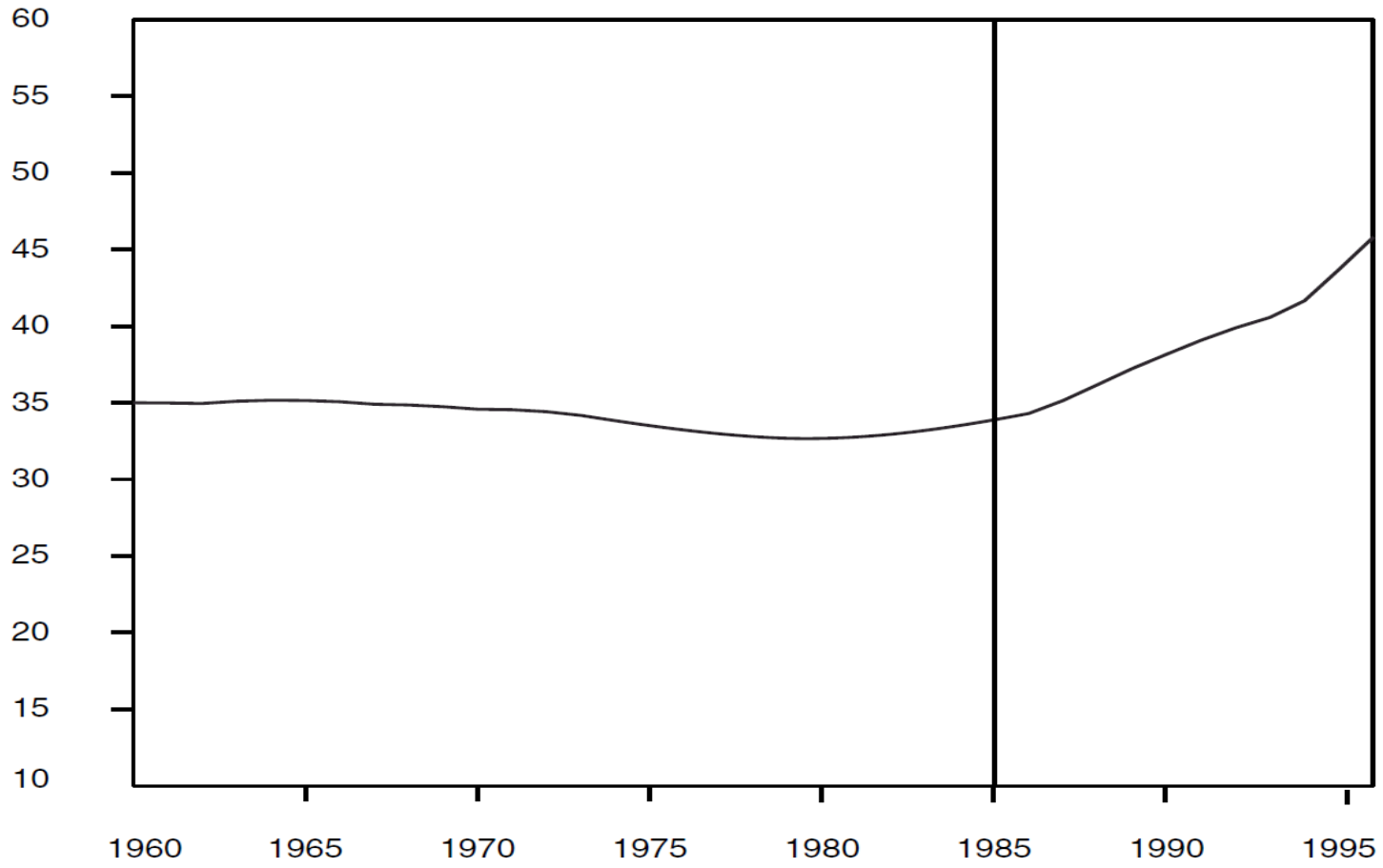
1986
1988

- **Widened productivity gap (Duarte-Rustuccia 2006):**
  - **Ratio of output per worker – richest five to poorest five countries over 1960-96:**

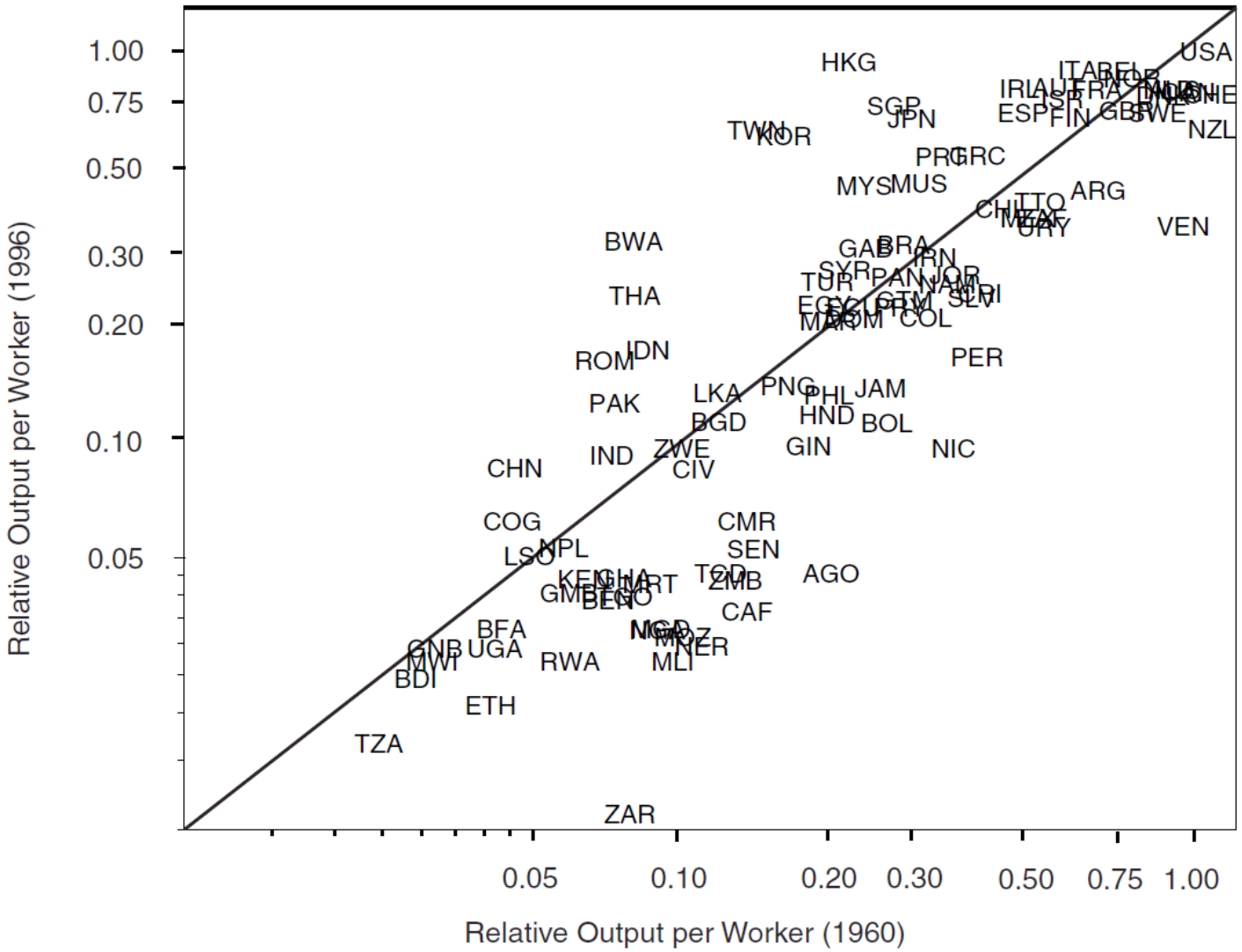


o Relative output per worker:

	1960	1970	1980	1990	1996
Deciles:			(percent)		
D1	3.4	3.3	3.4	2.8	2.4
D2	6.0	5.8	5.5	4.6	3.7
D3	7.8	7.9	7.7	6.4	5.4
D4	11.0	10.6	12.2	11.4	10.6
D5	16.7	18.1	20.1	17.8	17.4
D6	21.2	22.8	27.8	25.1	23.9
D7	27.2	32.8	34.5	31.7	32.5
D8	38.6	44.1	50.2	48.0	51.0
D9	56.6	65.3	70.2	69.5	72.7
D10	89.6	89.7	88.3	85.2	86.0
Ratios:					
D10/D1	26.3	27.1	25.9	30.9	35.6
D9/D2	9.5	11.3	12.7	15.2	19.6

	1960	1970	1980	1990	1996
Quintiles:			(percent)		
Q1	4.7	4.5	4.5	3.7	3.1
Q2	9.4	9.3	10.0	8.9	8.0
Q3	19.1	20.7	24.1	21.6	20.8
Q4	34.1	39.9	43.8	41.8	43.8
Q5	74.5	78.7	80.4	78.0	80.0
Ratios:					
Q5/Q1	15.8	14.5	18.0	21.3	26.1
Q4/Q2	3.6	4.3	4.4	4.7	5.5

o Mobility of countries over 1960-1996:



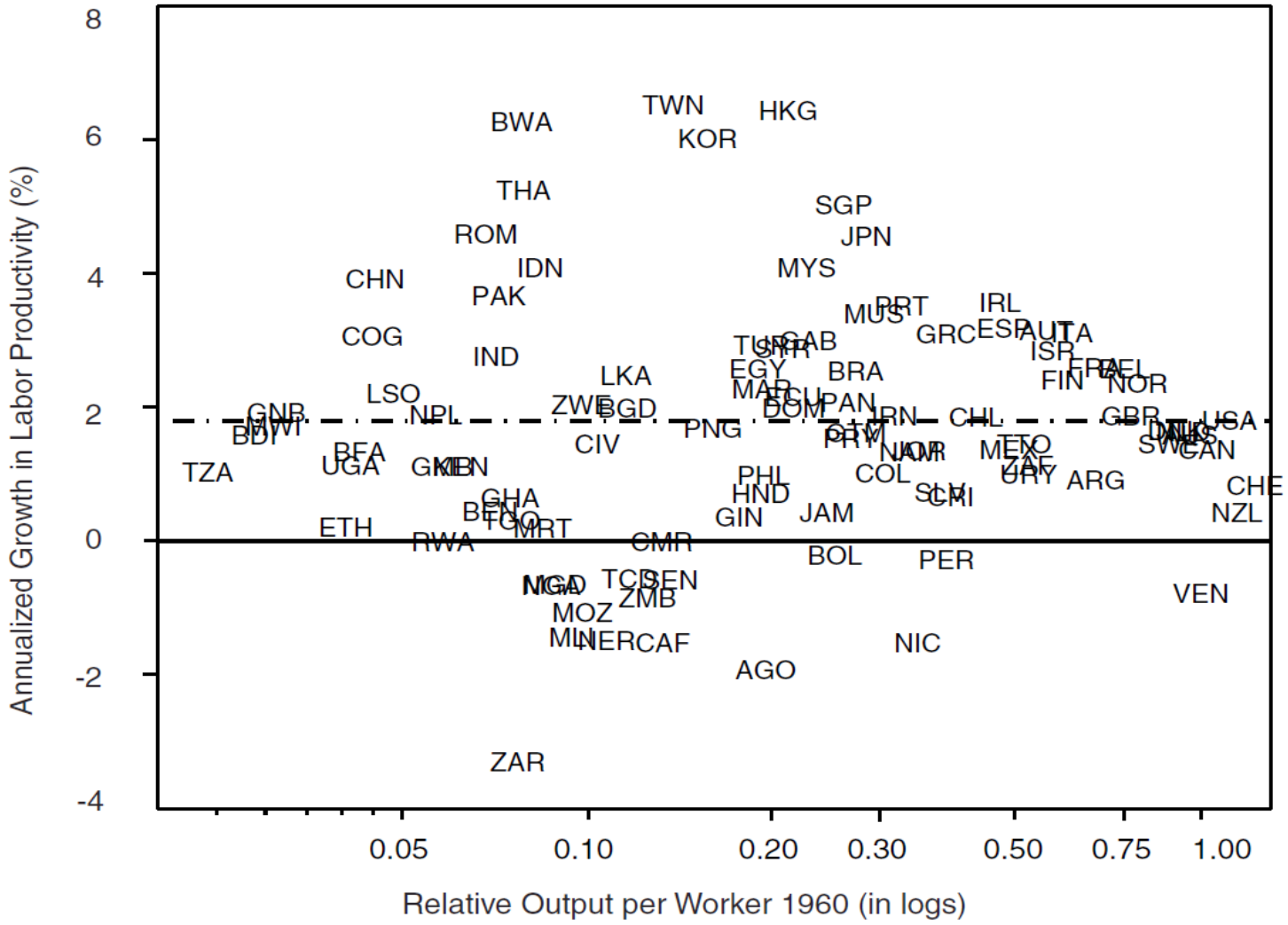
- **Mobility of countries by quintile (20 years over 1960-1996 window):**

		$t+20$				
		Q1	Q2	Q3	Q4	Q5
t	Q1	0.78	0.21	0.01	0	0
	Q2	0.22	0.64	0.11	0.03	0
	Q3	0	0.14	0.62	0.24	0
	Q4	0	0.02	0.24	0.58	0.16
	Q5	0	0	0	0.16	0.84

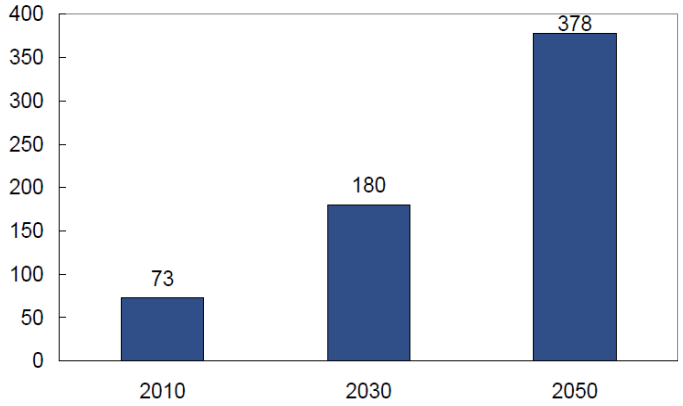
- **Relative output per worker by regions:**

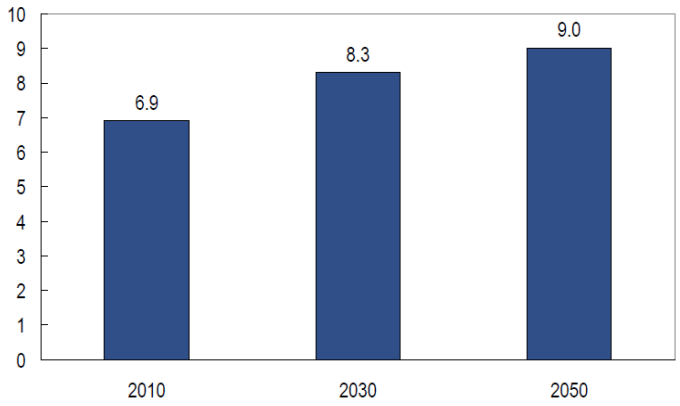
	1960	**1970**	**1980**	**1990**	**1996**
Asia	0.14	0.18	0.23	0.28	0.34
Latin America	0.34	0.35	0.35	0.28	0.25
Africa	0.12	0.13	0.14	0.12	0.12
Western Europe	0.62	0.71	0.77	0.75	0.75
Canada	0.92	0.90	0.88	0.83	0.79
Oceania	0.68	0.65	0.60	0.54	0.52

- **Output per worker growth (1960-1996):**

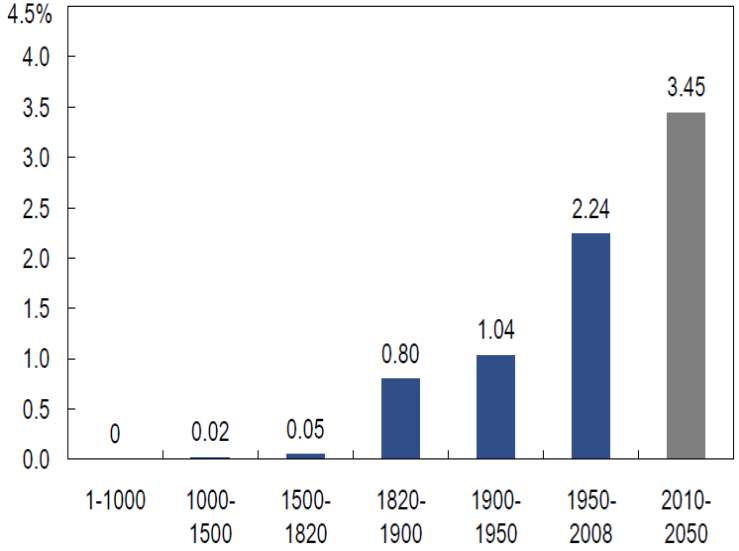


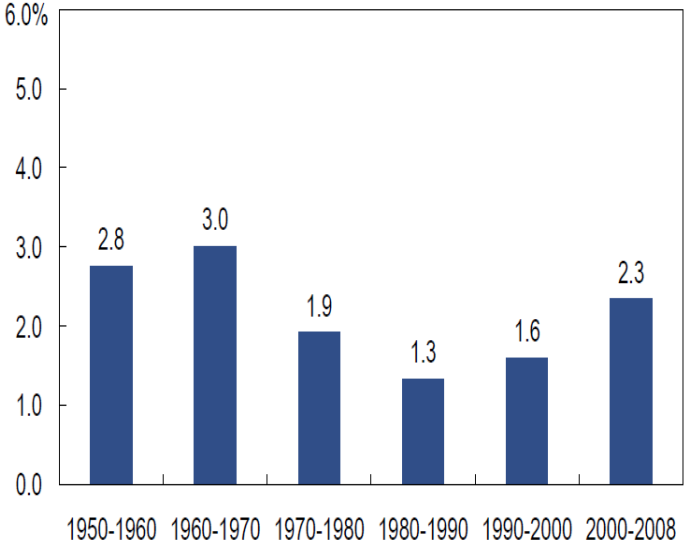
- **Global growth (Buiter 2011):**
  - **World GDP and population**



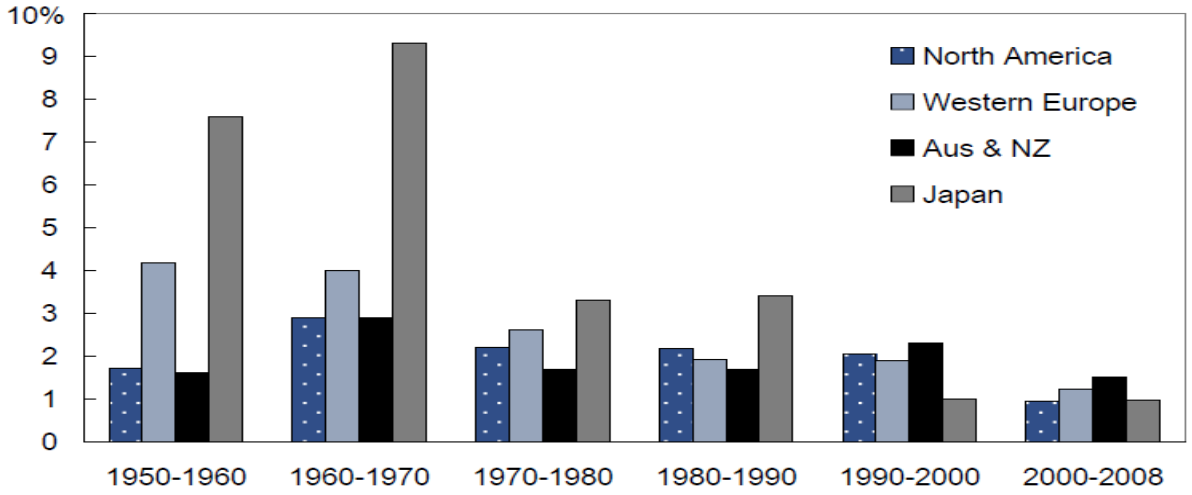


  - **Average world per capita GDP growth:**

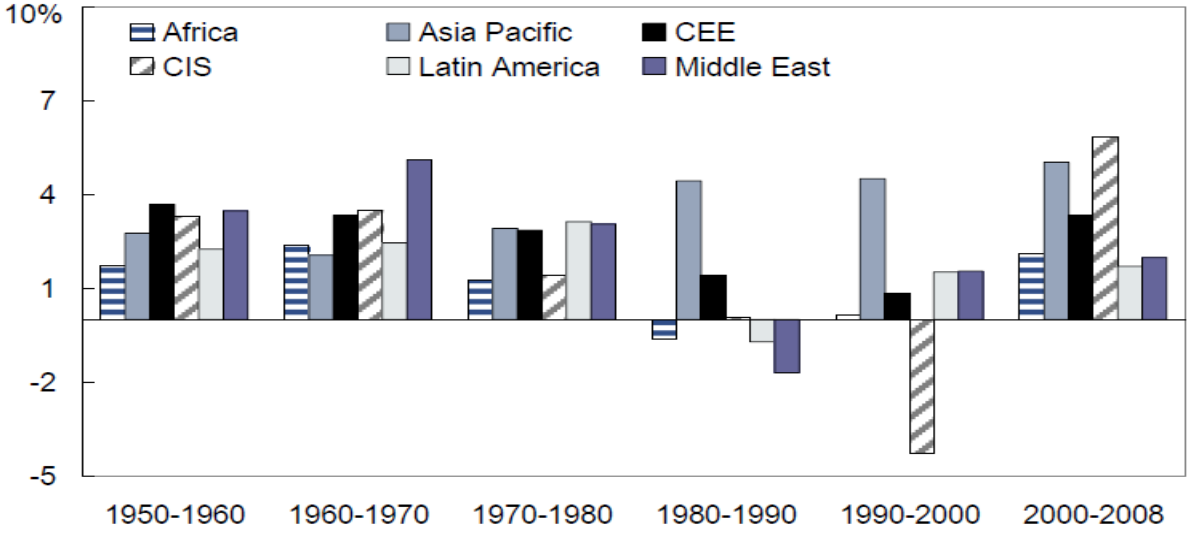




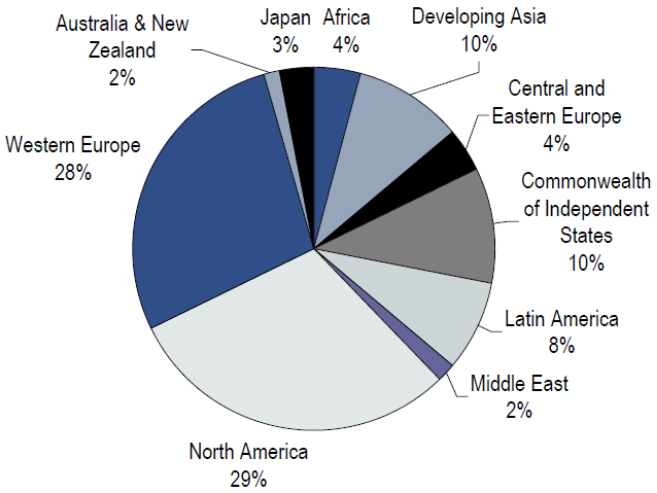
- **Growth of advanced economies:**

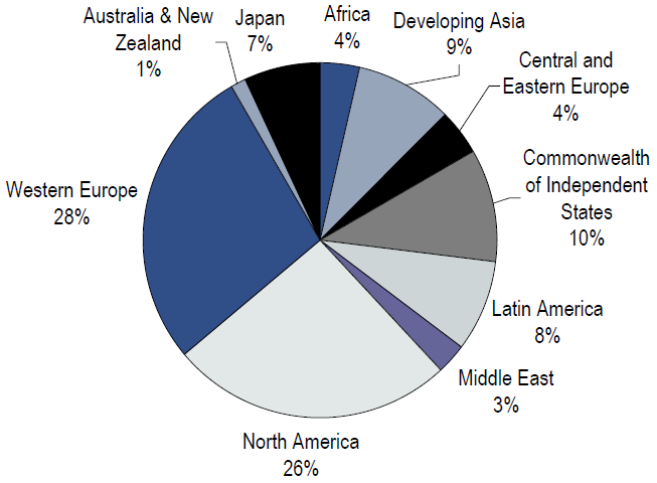


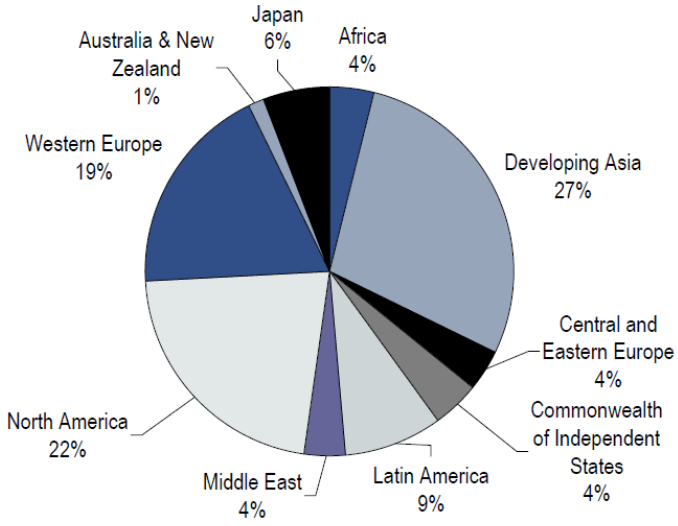
- **Growth of emerging economies (CEE=Central & Eastern Europe; CIS=Commonwealth of Independent States):**

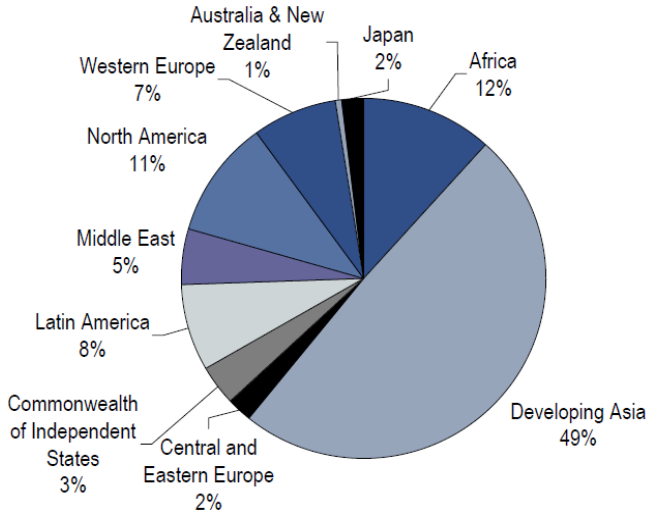


o Composition of world real GDP (1950, 1970, 2010, 2050):



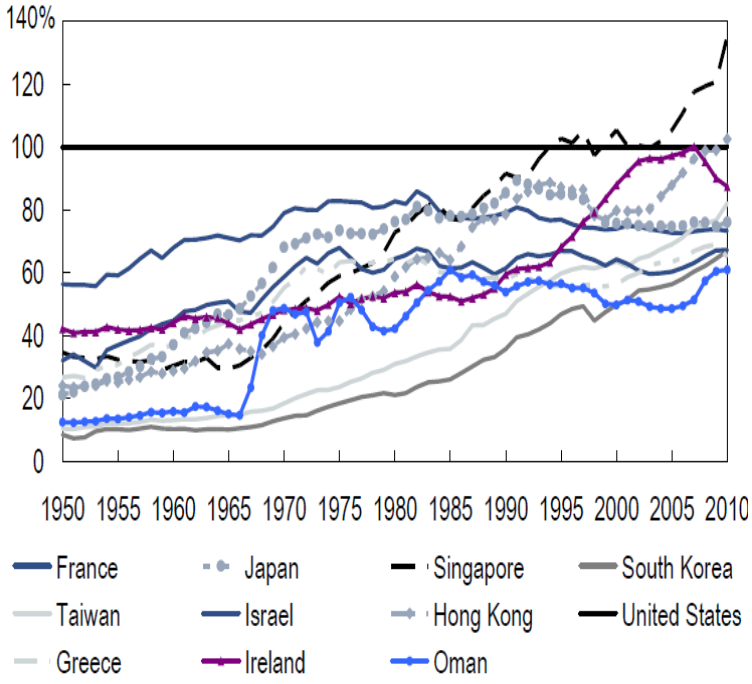


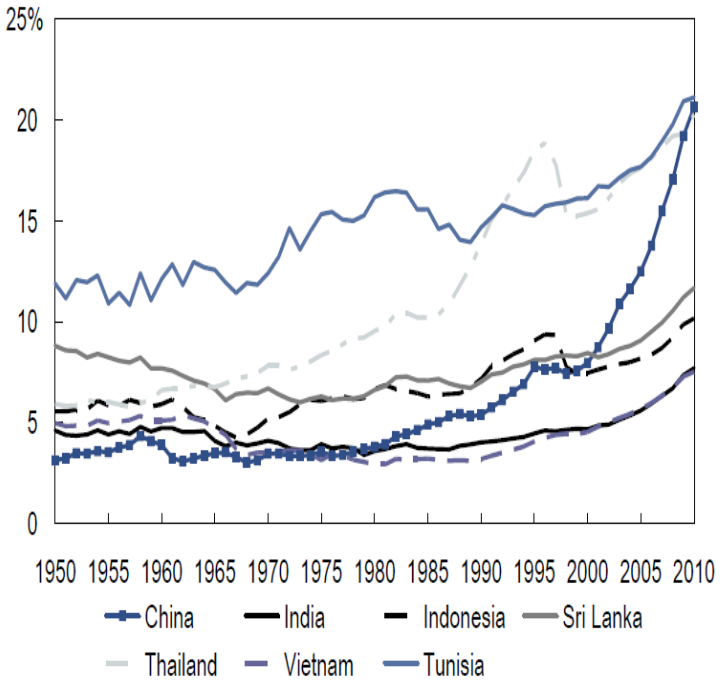




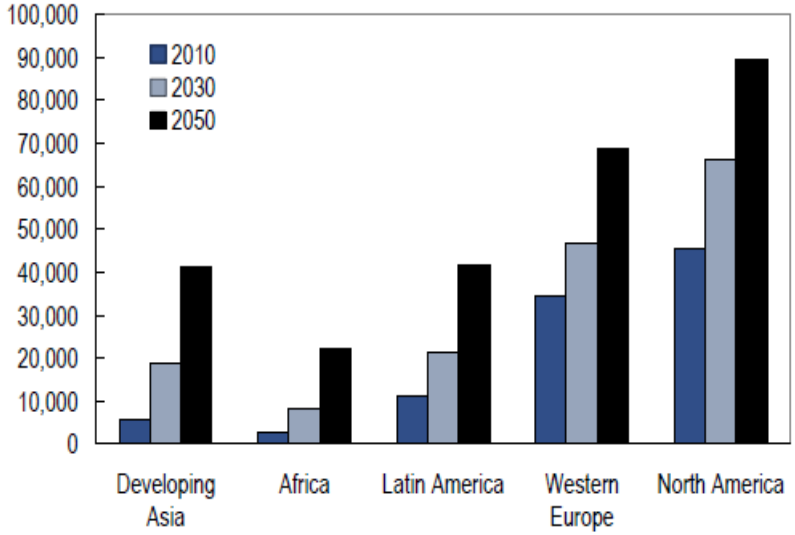
o Relative per capita real GDP growth to the U.S.:

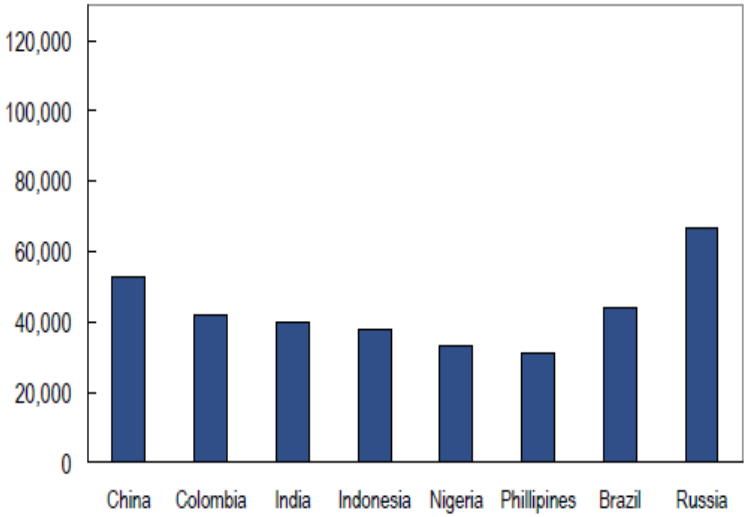
	Number of countries that grew faster than US	Total Number of Countries	% of Countries that grew faster than US
1950-1960	63	90	71
1960-1970	46	90	52
1970-1980	45	90	51
1980-1990	22	90	25
1990-2000	35	111	32
2000-2010	99	111	90

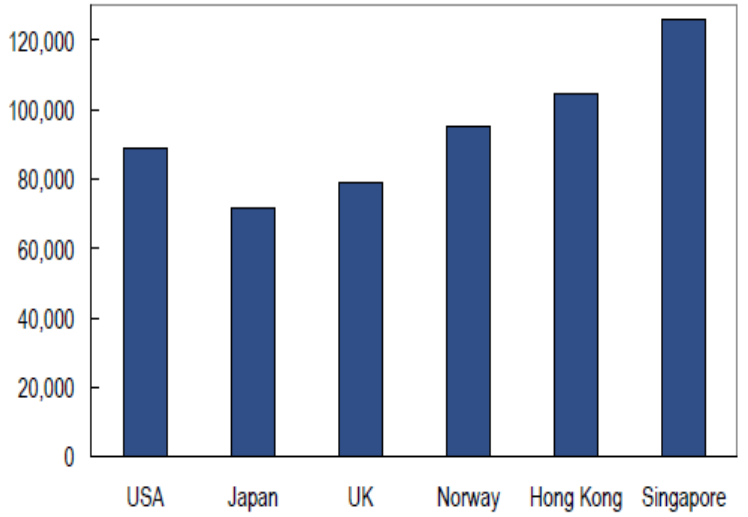




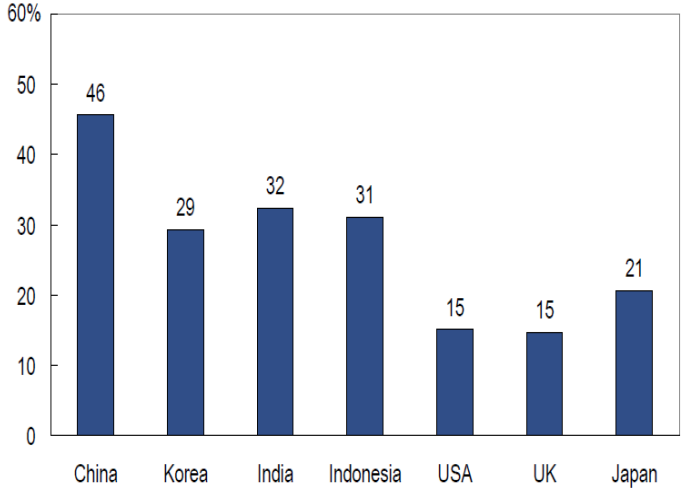
- **Per capita real GDP projection in 2050:**

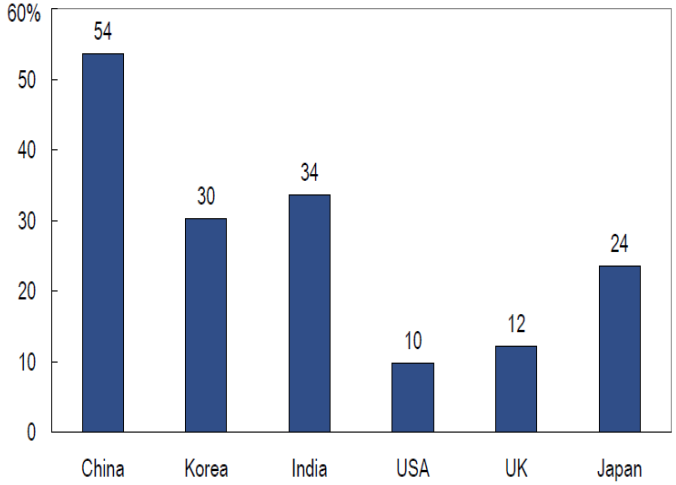




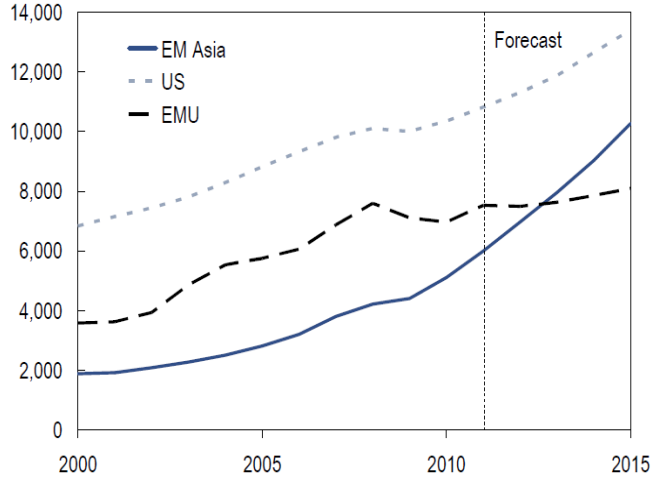


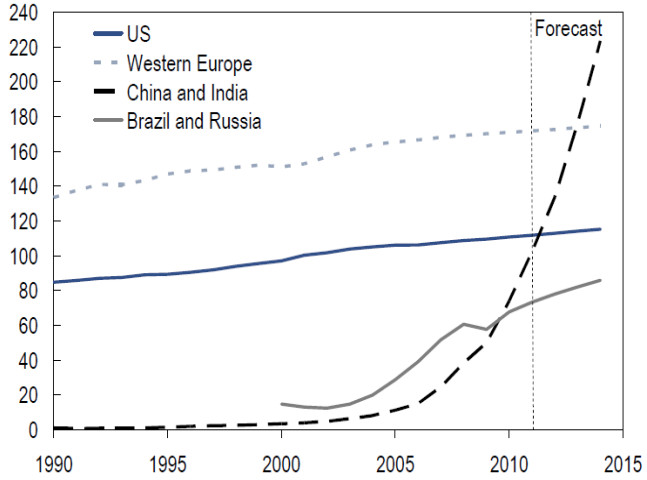
- **Key to future growth:**
  - **investment and savings (% of GDP):**



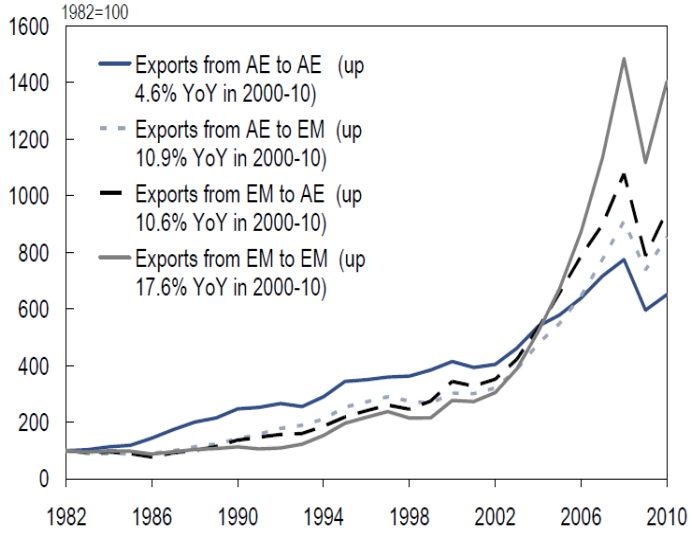


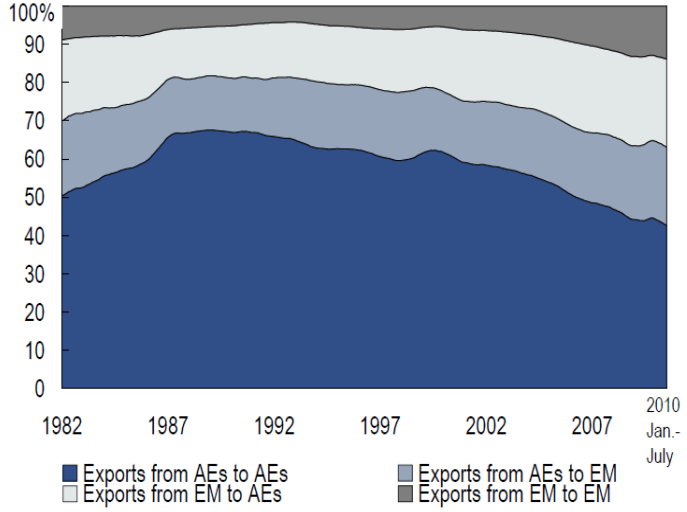
  - **the power of consumption (consumption spending and number of households with income exceeding US$10,000):**

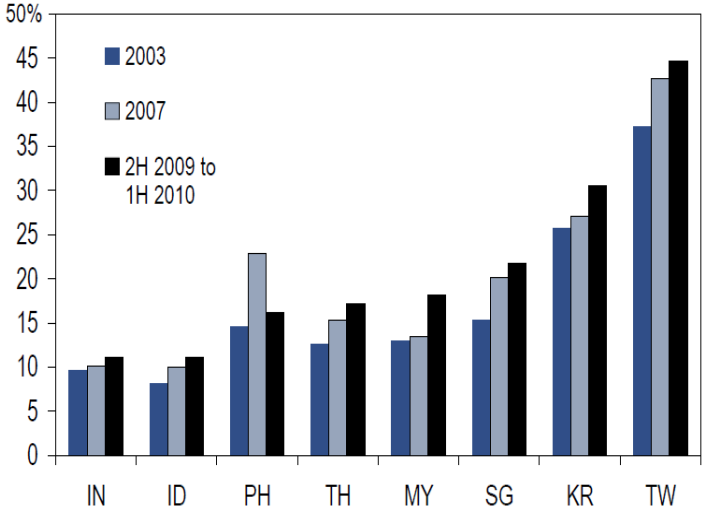


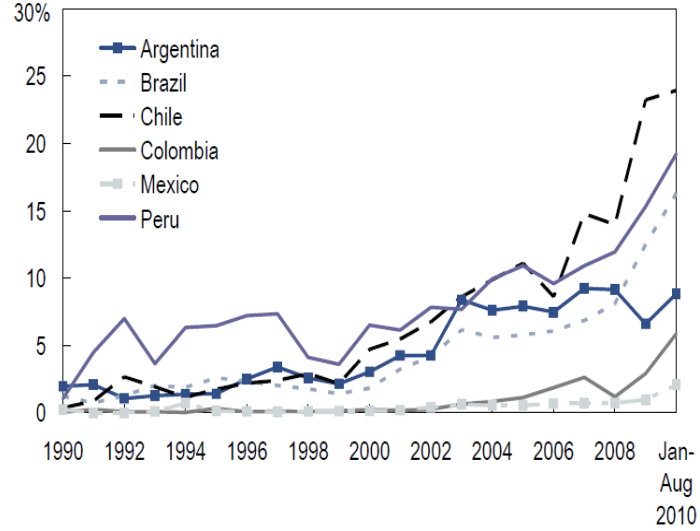


- **the rise world trade and the increasing exports to China:**

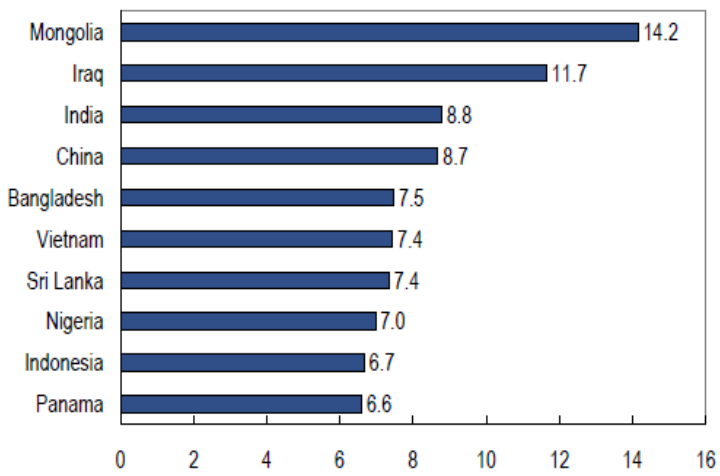


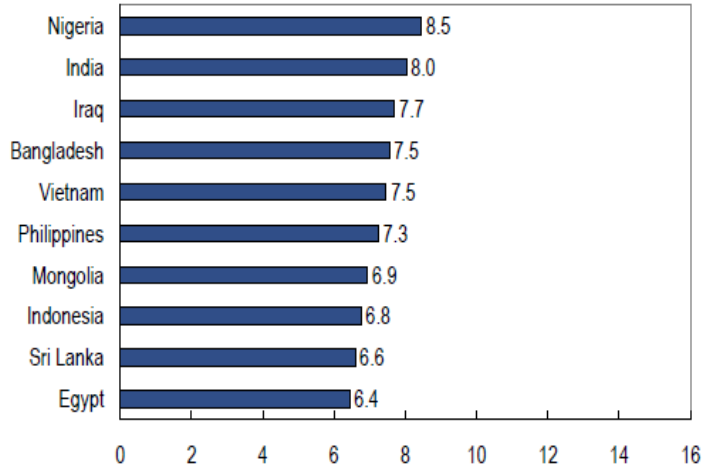






- **new emerging economies (2010-15 vs. 2010-50 by growth %):**





- **the future giants (by real GDP in trillion 2010 PPP US$):**

Rank	Country	2010	Rank	Country	2015	Rank	Country	2050
1	US	14.12	1	US	16.65	1	India	85.97
2	China	9.98	2	China	15.13	2	China	80.02
3	Japan	4.33	3	India	5.97	3	US	39.07
4	India	3.92	4	Japan	4.71	4	Indonesia	13.93
5	Germany	2.91	5	Germany	3.22	5	Brazil	11.58
6	Russia	2.20	6	Russia	2.70	6	Nigeria	9.51
7	Brazil	2.16	7	Brazil	2.70	7	Russia	7.77
8	UK	2.16	8	UK	2.48	8	Mexico	6.57
9	France	2.12	9	France	2.28	9	Japan	6.48
10	Italy	1.75	10	Italy	1.84	10	Egypt	6.02

- **the future richest (by per capita real GDP in 2010 PPP US$):**

Rank	Country	2010	Rank	Country	2015	Rank	Country	2050
1	Singapore	56,532	1	Singapore	68,112	1	Singapore	137,710
2	Norway	51,226	2	Hong Kong	53,882	2	Hong Kong	116,639
3	US	45,511	3	US	51,149	3	Taiwan	114,093
4	Hong Kong	45,301	4	Norway	48,015	4	South Korea	107,752
5	Switzerland	42,470	5	Switzerland	45,833	5	US	100,802
6	Netherlands	40,736	6	Netherlands	44,108	6	Saudi Arabia	98,311
7	Australia	40,525	7	Taiwan	44,074	7	Canada	96,375
8	Austria	39,073	8	Canada	43,155	8	UK	91,130
9	Canada	38,640	9	Austria	42,248	9	Switzerland	90,956
10	Sweden	36,438	10	Australia	40,325	10	Austria	90,158

- **Remark:**

2016 real gdp pp	US$	relative to US
US	57,638	100.0
Japan	42,203	73.2
Germany	48,860	84.8
France	41,343	71.7
UK	42,608	73.9
Singapore	87,832	152.4
Hong Kong	58,618	101.7
Korea	36,532	63.4
Taiwan	48,196	83.6
China	15,529	26.9
India	6,570	11.4
World Average	16,214	28.1

* World Bank PPP