The Facts of Economic Growth

汇报人：孙诗怡 王子月 王振鹏 唐雨帆

Handbook of Macroeconomics

- The paper is published on ***Handbook of Macroeconomics*** (section 1:The Facts of Economic Growth and Economic Fluctuation)

- The aim of the *Handbooks in Economics* series is to produce Handbooks for various branches of economics, each of which is a definitive source, reference, and teaching supplement for use by professional researchers and advanced graduate students

- The main goal is to provide comprehensive and accessible surveys

Author

Charles I. Jones

Professor, Stanford GSB

Research Statement:
Charles I. Jones is an economist noted for his research on **long-run economic growth**. In particular, he has examined theoretically and empirically the fundamental sources of growth in incomes over time and the reasons underlying the enormous differences in standards of living across countries. In recent years, he has used his expertise in macroeconomic methods to study the economic causes behind **the rise in health spending and top income inequality**.

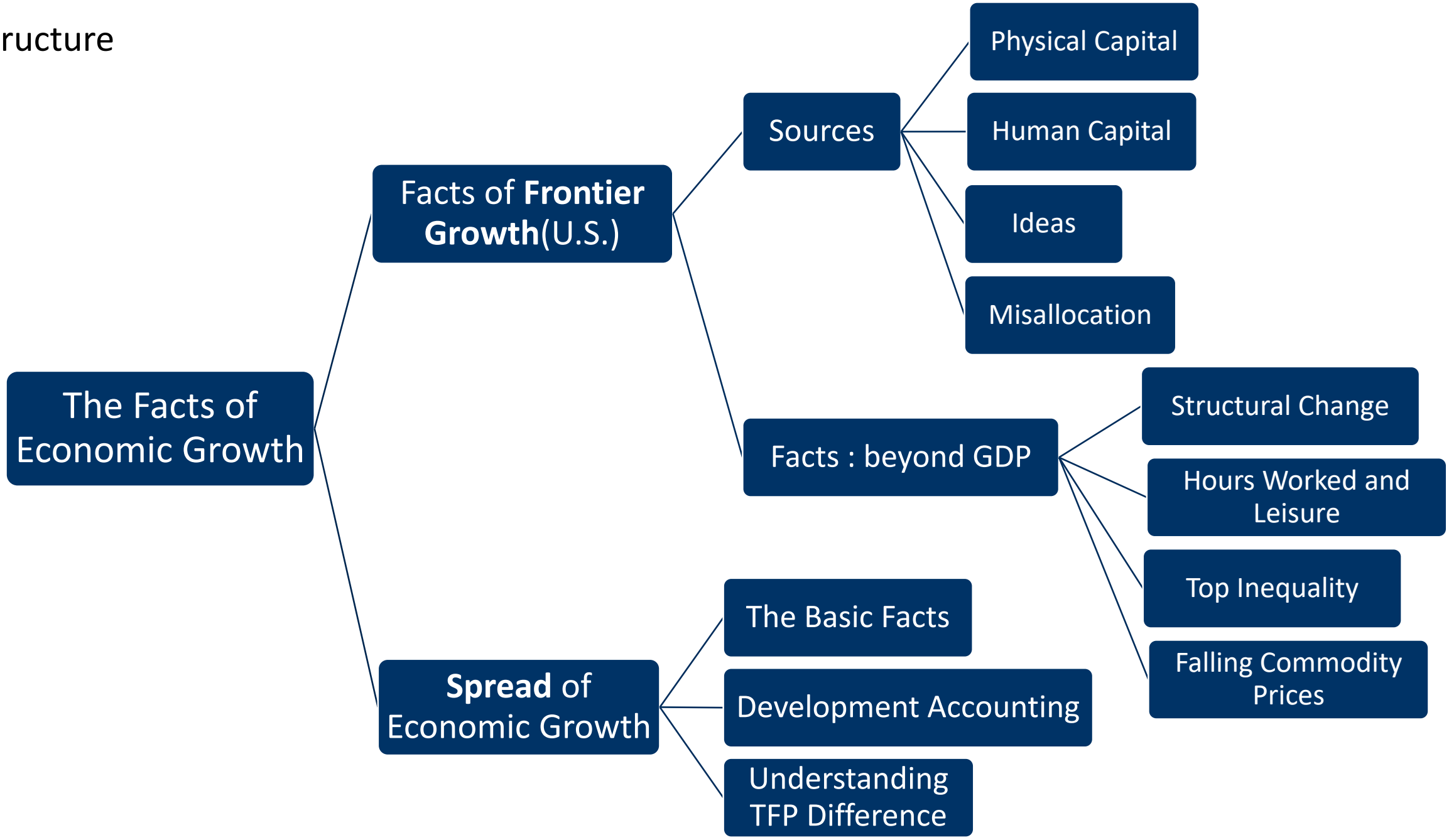
Papers and Publications:

- "The Shape of Production Functions and the Direction of Technical Change" Quarterly Journal of Economics, May 2005, Vol. 120 (2), pp. 517-549.
- "Sources of U.S. Economic Growth in a World of Ideas" American Economic Review, March 2002, Vol. 92 (1), pp. 220-239.
- "R&D-Based Models of Economic Growth" Journal of Political Economy, August 1995, Vol. 103, pp. 759-784.
- "Beyond GDP? Welfare across Countries and Time" (with Pete Klenow), American Economic Review, September 2016, Vol. 106 (9), pp. 2426-2457.
- "The Value of Life and the Rise in Health Spending" (with Robert E. Hall), Quarterly Journal of Economics, February 2007, Vol. 122 (1), pp. 39-72.

Motivation

The purpose of the paper is to provide **an encyclopedia of the fundamental facts of economic growth** upon which our theories are built, gathering them together in one place and updating them with the latest available data.

Structure


The Facts of Economic Growth
Facts of **Frontier Growth**(U.S.)
Sources
Physical Capital
Human Capital
Ideas
Misallocation
Facts : beyond GDP
Structural Change
Hours Worked and Leisure
Top Inequality
Falling Commodity Prices
Spread of Economic Growth
The Basic Facts
Development Accounting
Understanding TFP Difference

Growth at the Frontier

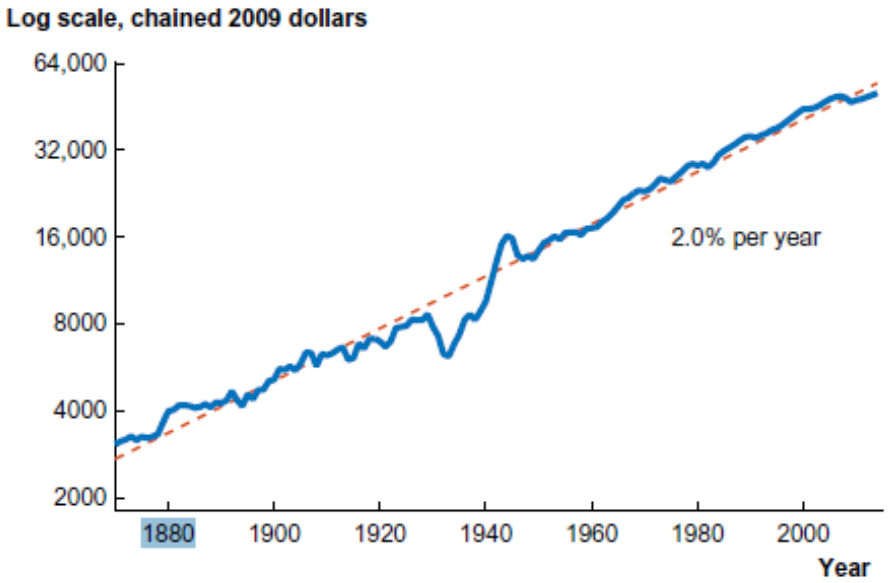


Fig. 1 GDP per person in the United States. Source: *Data for 1929–2014 are from the U.S. Bureau of Economic Analysis, NIPA table 7.1. Data before 1929 are spliced from Maddison, A. 2008. Statistics on world population, GDP and per capita GDP, 1-2006 AD. Downloaded on December 4, 2008 from http://www.ggdc.net/maddison/.*

Modern Economy Growth

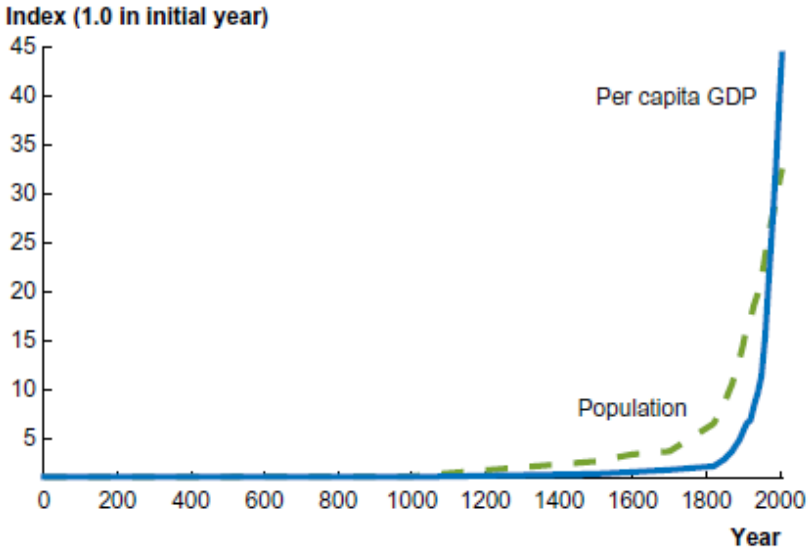


Fig. 2 Economic growth over the very long run. Source: *Data are from Maddison, A. 2008. Statistics on world population, GDP and per capita GDP, 1-2006 AD. Downloaded on December 4, 2008 from http://www.ggdc.net/maddison/ for the "West," ie, Western Europe plus the United States. A similar pattern holds using the "world" numbers from Maddison.*

Growth Over the Very Long Run

Growth at the Frontier

- Steady, sustained exponential growth for the last 150 years is a key characteristic of the frontier
- Various growth models have been developed to explain the transition from Malthusian stagnation（马尔萨斯陷阱) for thousands of years to the modern era of economic growth:
  - **Malthusian diminishing returns**: more people to the land reduces the MPL
  - Lee (1988), Kremer (1993), and Jones (2001) emphasize the positive feedback loop between “people produce ideas” with the Malthusian “ideas produce people” channel to counter the Malthusian diminishing returns
  - Lucas (2002) emphasizes the role of human capital accumulation
  - Hansen and Prescott (2002) focus on a structural transformation from agriculture to manufacturing

Sources of Frontier Growth

Growth Accounting

A Cobb-Douglas production function:

$$Y_t = \underbrace{A_t M_T} K_t^{\alpha} H_t^{1-\alpha}$$

TFP

Y_t : final output
K_t : physical capital
H_t : human capital
A_t : the economy's stock of knowledge
M_T : anything else that influences total factor productivity (misallocation)

However, some of the accumulation of physical capital is caused by growth in total factor productivity, to credit such growth to total factor productivity, first divide both sides of the production function by Y_t^{α} and solve for Y_t to get

$$Y_t = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} H_t Z_t$$

where $\boldsymbol{Z_t} = (\boldsymbol{A_t M_T})^{\frac{1}{1-\alpha}}$ is total factor productivity measured in labor-augmenting units

Finally, dividing both sides by **the aggregate amount of time worked $\boldsymbol{L_t}$**, gives

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} \frac{H_t}{L_t} Z_t$$

Growth Accounting

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} \frac{H_t}{L_t} Z_t$$

the capital-output ratio $(\boldsymbol{K_t/Y_t})$ is proportional to the investment rate in the long-run and does not depend on total factor productivity

$\boldsymbol{Y_t/L_t}$: growth output per hour

In a simple model with one type of labor, one can think of $\boldsymbol{H_t = h_t L_t}$, where h_t is human capital per worker (labor composition : a rise in educational attainment, a shift from manufacturing to services, and the increased labor force participation of women) which increases because of education

Growth Accounting

Table 3 Growth accounting for the United States

Period	Output per hour	Contributions from		
		K/Y	Labor composition	Labor-Aug. TFP
1948–2013	**2.5**	**0.1**	**0.3**	**2.0**
1948–1973	3.3	−0.2	0.3	3.2
1973–1990	1.6	0.5	0.3	0.8
1990–1995	1.6	0.2	0.7	0.7
1995–2000	3.0	0.3	0.3	2.3
2000–2007	2.7	0.2	0.3	2.2
2007–2013	1.7	0.1	0.5	1.1

Note: Average annual growth rates (in percent) for output per hour and its components for the private business sector, following Eq. (3).
Source: Authors calculations using Bureau of Labor Statistics, *Multifactor Productivity Trends*, August 21, 2014.

Facts:

1. Growth in output per hour at 2.5% is slightly faster than the growth in GDP per person that we saw earlier
2. The capital-output ratio is relatively stable over this period, contributing almost nothing to growth
3. Labor composition contributes 0.3 percentage points per year to growth
4. The “residual” of total factor productivity accounts for the bulk of growth

1948-1973: rapid growth
1973-1995: productivity slowdown
1995-2007: a substantial recovery of growth (reason: information technology), but the slowdown in TFP is troubling

Physical Capital

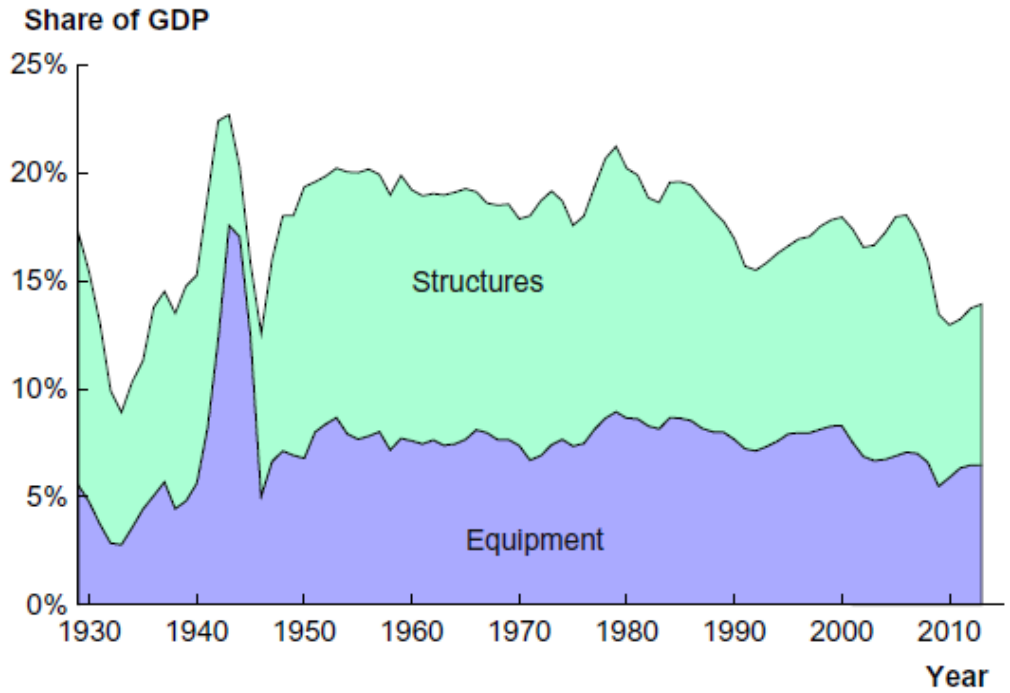


Fig. 4 Investment in physical capital (private and public), United States. Source: *National Income and Product Accounts, U.S. Bureau of Economic Analysis, table 5.2.5. Intellectual property products and inventories are excluded. Government and private investment are combined. Structures includes both residential and nonresidential investment. Ratios of nominal investment to GDP are shown.*

Factor Shares

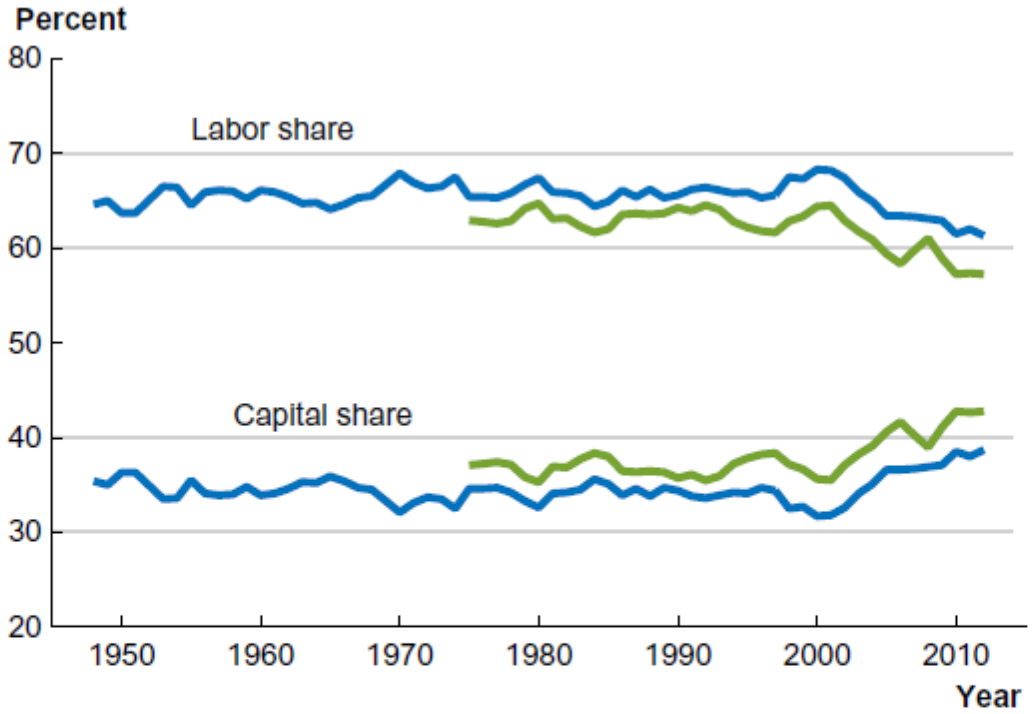


Fig. 6 Capital and labor shares of factor payments, United States. Source: *The series starting in 1975 are from Karabarbounis, L., Neiman, B. 2014. The global decline of the labor share. Q. J. Econ. 129 (1), 61–103. http://ideas.repec.org/a/oup/qjecon/v129y2014i1p61-103.html and measure the factor shares for the corporate sector, which the authors argue is helpful in eliminating issues related to self-employment. The series starting in 1948 is from the Bureau of Labor Statistics* Multifactor Productivity Trends, *August 21, 2014, for the private business sector. The factor shares add to 100%.*

1. Between 1948 and 2000, the factor shares were indeed quite stable (Kaldor (1961) stylized facts of growth)
2. Since 2000 or so, there has been a marked decline in the labor share and a corresponding rise in the capital share
   Karabarbounis and Neiman (2014), Elsby et al. (2013), Bridgman(2014), Koh et al. (2015), and Rognlie (2015)

Human Capital

Human Capital: education, work experience(assume each year of work experience leads to a constant increase in human capital)……

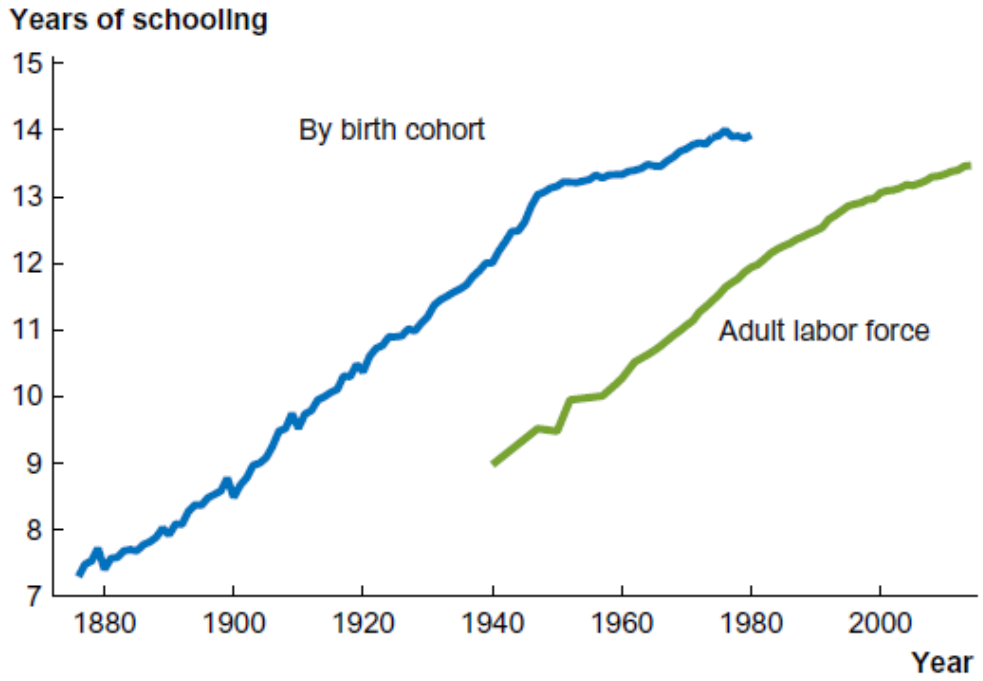


Fig. 7 Educational attainment, United States. Source: *The* blue *(*dark gray *in the print version) line shows educational attainment by birth cohort from Goldin, C., Katz, L.F. 2007. Long-run changes in the wage structure: narrowing, widening, polarizing. Brook. Pap. Econ. Act. 2, 135–165. The* green *(*gray *in the print version) line shows average educational attainment for the labor force aged 25 and over from the Current Population Survey.*

1.For 75 years, educational attainment rose steadily, at a rate of slightly less than 1 year per decade
2.The leveling-off of educational attainment: For cohorts born after 1950, educational attainment rose more slowly than before

Human Capital

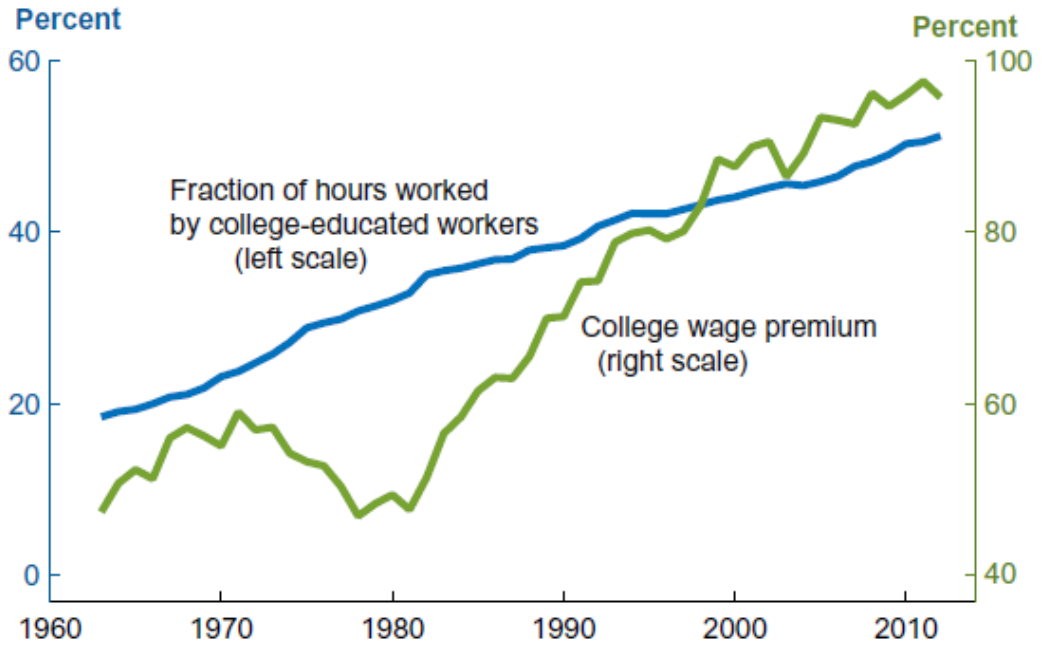


Fig. 8 The supply of college graduates and the college wage premium, 1963–2012. *Note:* The supply of US college graduates, measured by their share of total hours worked, has risen from below 20% to more than 50% by 2012. The US college wage premium is calculated as the average excess amount earned by college graduates relative to nongraduates, controlling for experience and gender composition within each educational group. Source: *Autor, D.H. 2014. Skills, education, and the rise of earnings inequality among the "other 99 percent". Science 344 (6186), 843–851, fig. 3.*

Though the supply of college graduates was growing rapidly, the wage premium for college graduates was increasing sharply as well
Explanation: Katz and Murphy (1992)

$$H = \left(\left(A_{coll} L_{coll} \right)^{\rho} + \left(A_{hs} L_{hs} \right)^{\rho} \right)^{1/\rho}$$

Ideas / Stock of Knowledge

idea production function

- Input: intellectual property products(traditional research and development, spending on computer software, and finally spending on “entertainment,” which itself includes movies, TV shows, books, and music
- Output: patent

“idea production function” is hard to measure precisely because we do not have great measures of ideas or the inputs used to produce them

Ideas / Stock of Knowledge

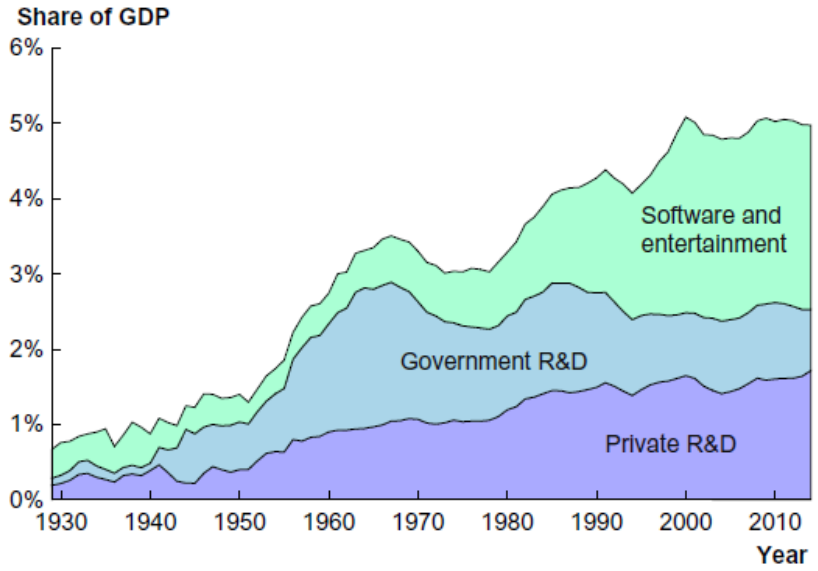


Fig. 9 Research and development spending, United States. Source: *National Income and Product Accounts, U.S. Bureau of Economic Analysis via FRED database. "Software and entertainment" combines both private and public spending. "Entertainment" includes movies, TV shows, books, and music.*

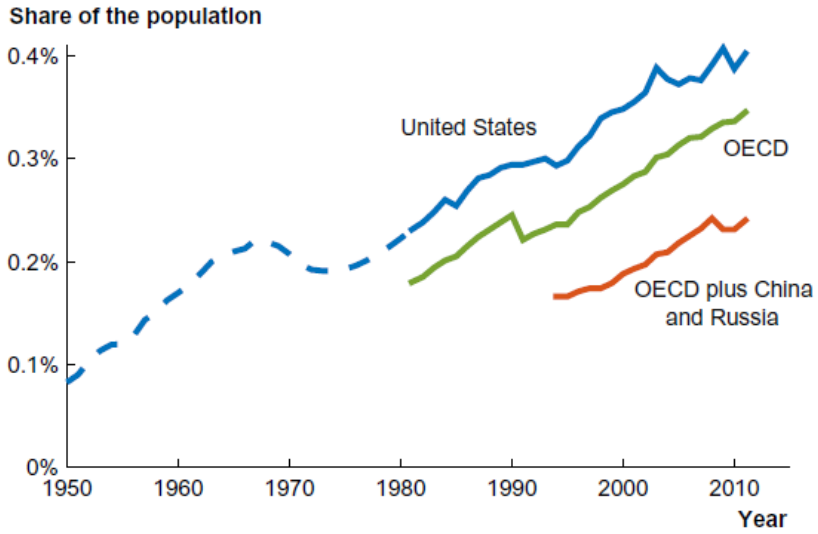


Fig. 10 Research employment share. Source: *Data for 1981–2001 are from OECD Main Science and Technology Indicators, http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB. Data prior to 1981 for the United States are spliced from Jones, C.I. 2002. Sources of U.S. economic growth in a world of ideas. Am. Econ. Rev. 92 (1), 220–239, which uses the NSF's definition of "scientists and engineers engaged in R&D."*

1.**total spending** on investment in intellectual property products has risen from less than 1% of GDP in 1929 to nearly 5% of GDP in recent years
2. **government spending** on research and development has been shrinking as a share of GDP since peaking in the 1960s with the space program

1.the fraction of the population engaged in R&D has been rising in recent decades
2. these data only capture a small part of what an economist would call research

Ideas / Stock of Knowledge

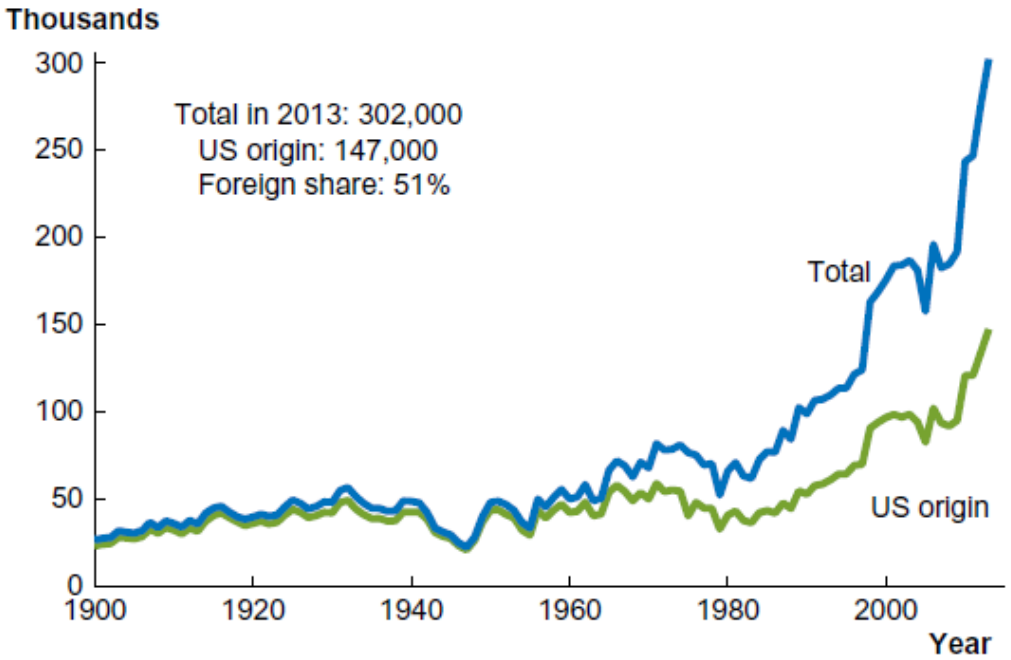


Fig. 11 Patents granted by the US Patent and Trademark Office. Source: *http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_counts.htm.*

1.At least since 1980 one sees a very dramatic rise in the number of patents granted in the United States, both in total and to US inventors

2.During the first 85 years of the 20th century, the number of patents granted to US residents appears to be stationary, in sharp contrast to the dramatic increase since 1985 or so

Griliches (1994) combined these two basic facts related to ideas (rapid growth in the inputs, stable production of patents) to generate a key implication: the productivity of research at producing patents fell sharply for most of the 20th century

Misallocation

- One of the great insights of the growth literature in the last 15 years is that **misallocation at the micro level can show up as a reduction in total factor productivity at a more aggregated level**

(see Banerjee and Duflo (2005), Chari et al. (2007), Restuccia and Rogerson (2008) and Hsieh and Klenow (2009))

- Misallocation is the best candidate answer to why are some countries so much richer than others

- Channel: there has been little work quantifying this channel,

Hsieh et al. (2013): quantifies the macroeconomic consequences of the remarkable convergence in the occupational distribution between 1960 and 2008 and finds that 15–20% of growth in aggregate output per worker is explained by the improved allocation of talent

Griliches (1992), Coe and Helpman (1995), Jones and Williams(1998), Klenow and Rodriguez-Clare (2005), and Bloom et al. (2013): to the extent that these spillovers are increasingly internalized or addressed by policy, changing misallocation of knowledge resources may be impacting economic growth

Hsieh and Moretti (2014): land use policies prevent the efficient spatial matching of people to land and to each other

Frontier Growth: Beyond GDP

Structural Change

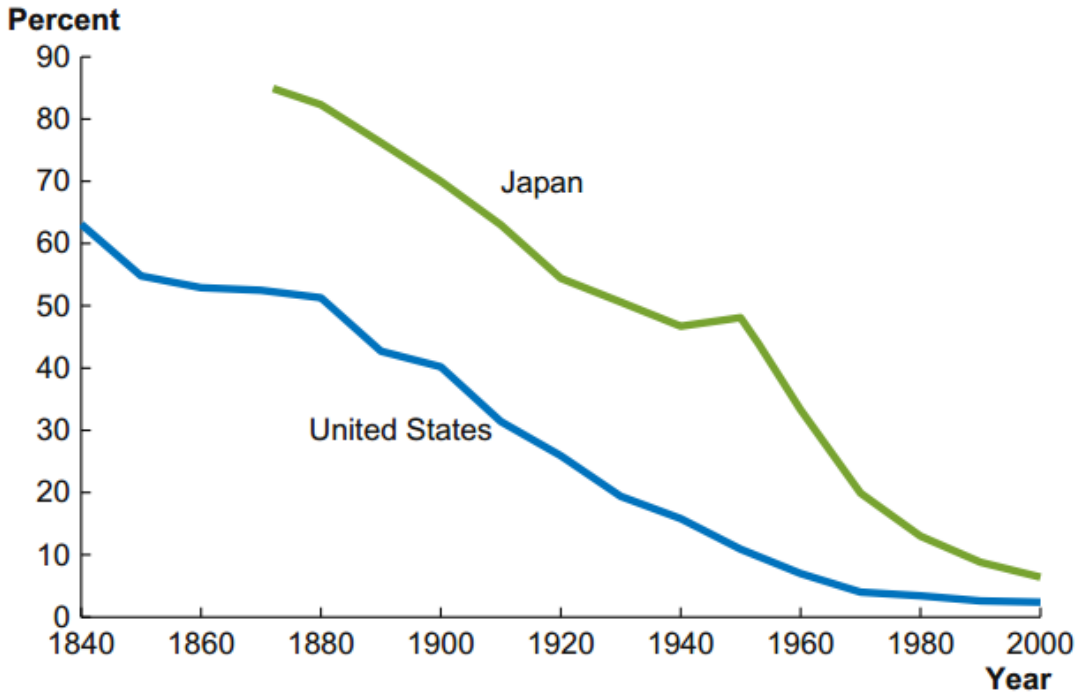


Fig. 12 Employment in agriculture as a share of total employment. Source: *Herrendorf, B., Rogerson, R., Valentinyi, A. 2014, Growth and structural transformation, In: Handbook of Economic Growth, vol. 2, Elsevier, pp. 855–941, http://ideas.repec.org/h/eee/grochp/2-855.html.*

Facts:

1. Agriculture → Manufacture → Services
2. Machines (capital) may substitute for labor.

The Rise of Health

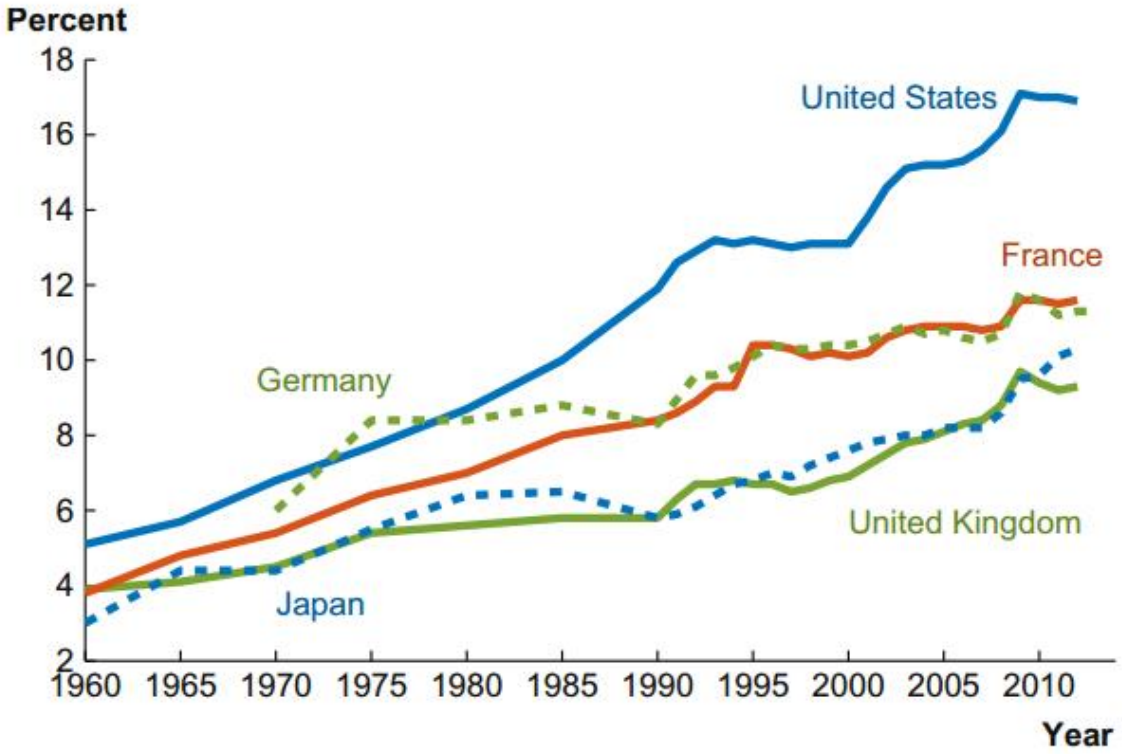


Fig. 13 Health spending as a share of GDP. Source: *OECD Health Statistics, 2014.*

Facts:
Health spending rises.
Explanation:
With standard preferences, the marginal utility of consumption declines rapidly.
Hence there is an income effect tilting spending toward life-saving categories.

The Rise of Health

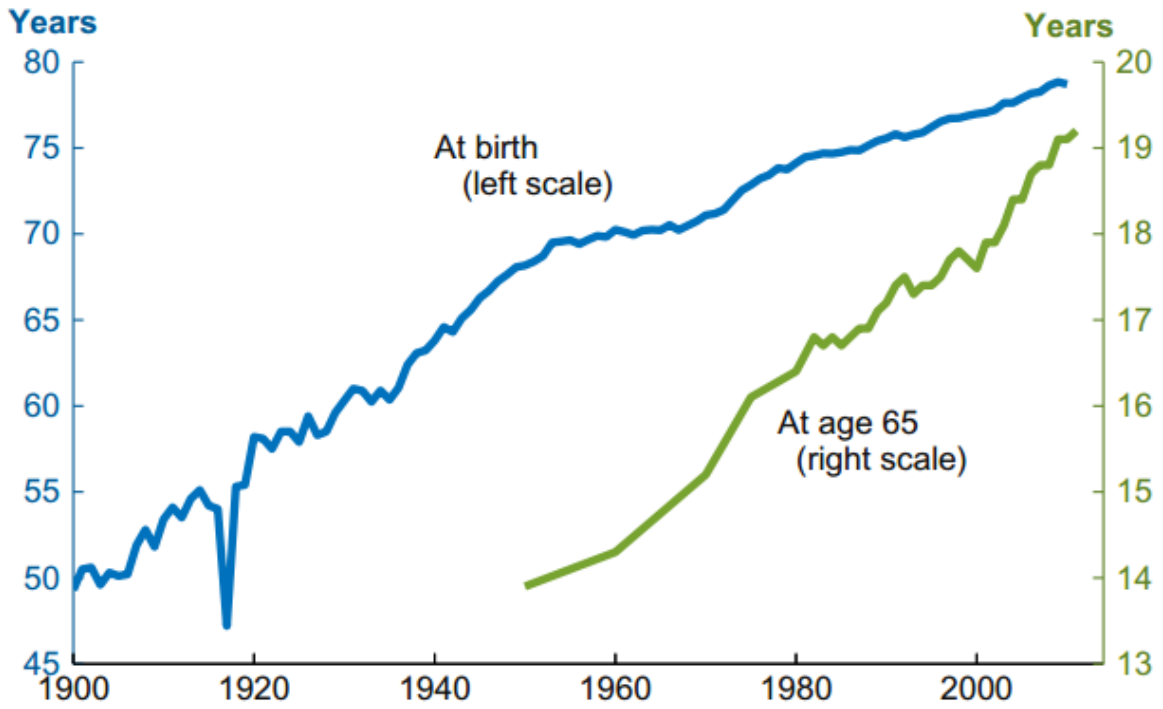


Fig. 14 Life expectancy at birth and at age 65, United States. Source: *Health, United States 2013 and https://www.clio-infra.eu*.

Facts:

1. Life expectancy at birth increased rapidly in the first half of the 20th century. Since 1950, the rate of improvement has been more modest.
2. The rise in life expectancy occurs at old ages.

Hours Worked and Leisure

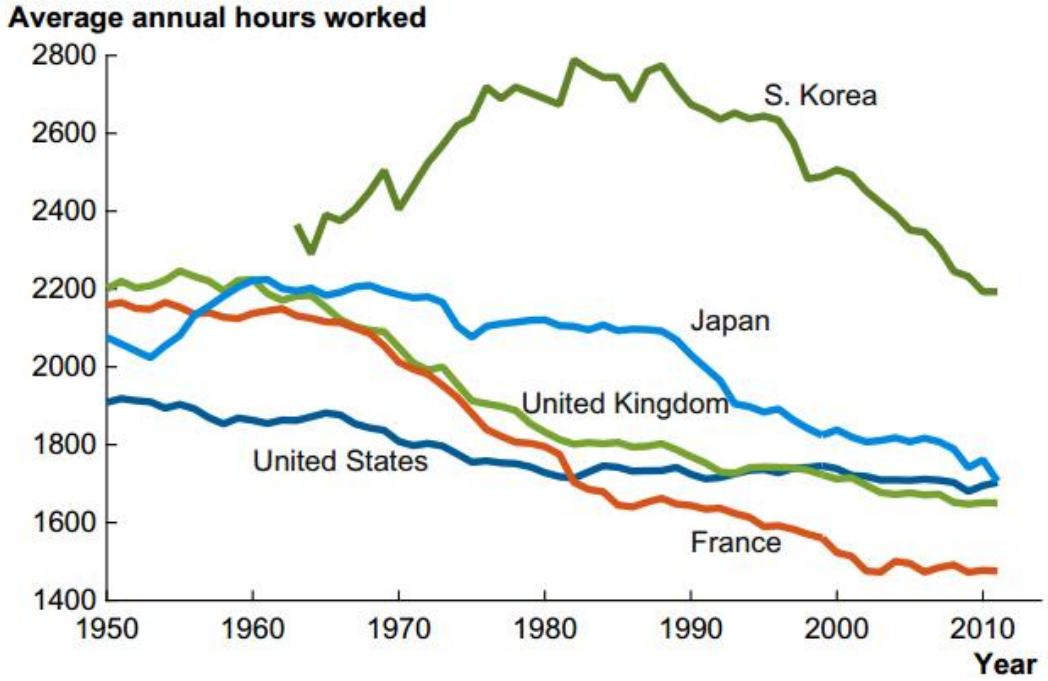


Fig. 15 Average annual hours worked, select countries. Source: *Average annual hours worked per person employed, from the Penn World Tables 8.0. See Feenstra, R.C., Inklaar, R., Timmer, M.P. 2015. The next generation of the Penn World Table. Am. Econ. Rev. 105 (10), 3150–3182. doi:10.1257/aer.20130954 and their excellent data appendix for details on the data.*

Facts:

Among advanced countries, annual hours worked has fallen significantly since 1950.

Hours Worked and Leisure

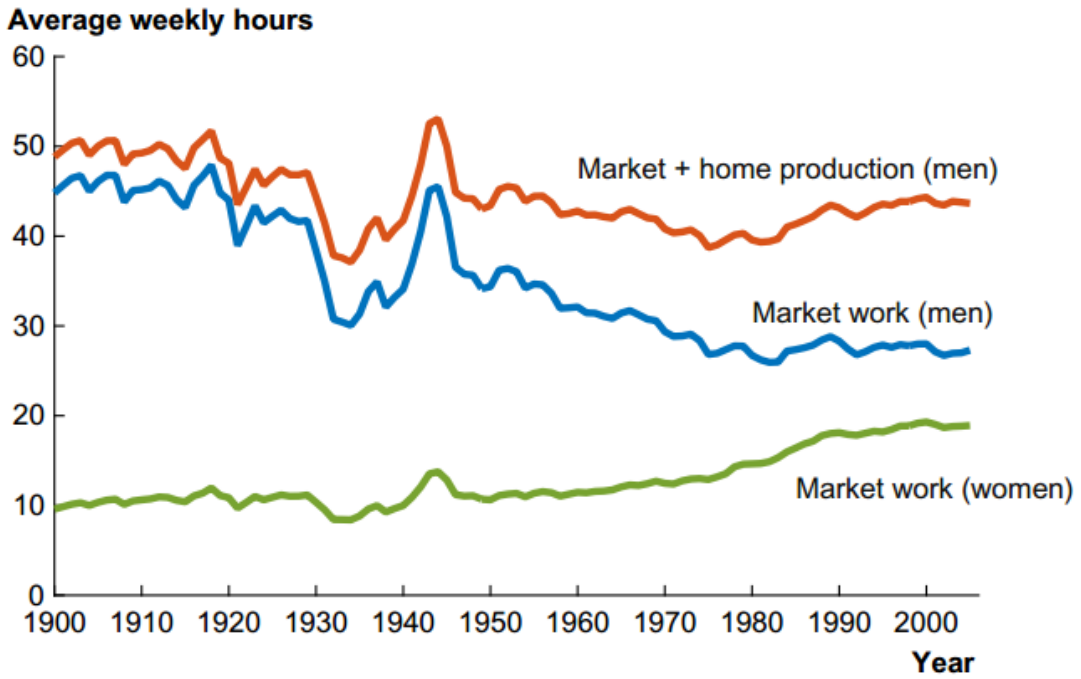


Fig. 16 Average weekly hours worked, United States. Source: *Average weekly hours per worker, from Ramey, V.A., Francis, N. 2009. A century of work and leisure. Am. Econ. J. Macroecon. 1 (2), 189–224. http://ideas.repec.org/a/aea/aejmac/v1y2009i2p189-224.html.*

Facts:

1. Average weekly hours of market work by men fell sharply between 1900 and 1980, before leveling off. Home production by men rose from just 4 h per week in 1900 to more than 16 h per week in 2005.
2. Market work by women has been on an upward trend.

Fertility

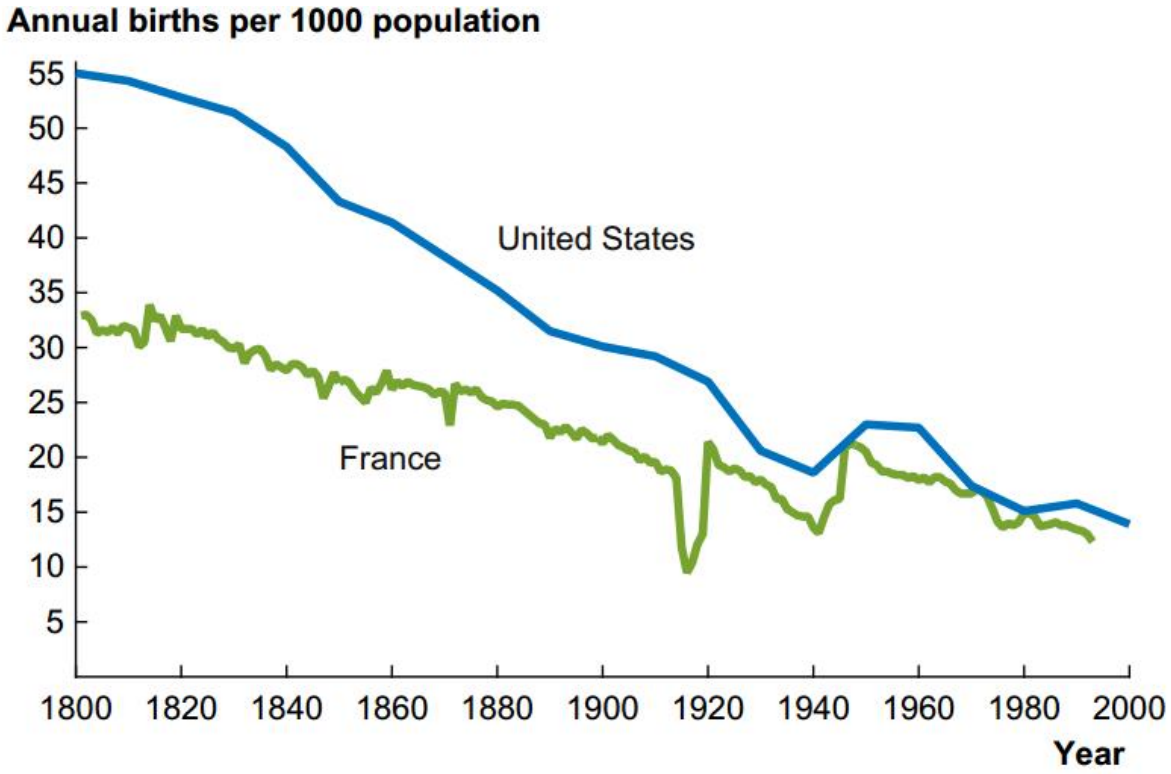


Fig. 17 Fertility in the United States and France. Source: *Data for the United States are from Haines, M. 2008, Fertility and mortality in the United States. In: Whaples, R., (Ed.), EH.Net Encyclopedia, http://eh.net/encyclopedia/fertility-andmortality-in-the-united-states/ and data for France are from Greenwood, J., Vandenbroucke, G. 2004. The baby boom and baby bust: O.E.C.D. fertility data. http://guillaumevdb.net/BabyBoom-data.pdf.*

Facts:
Fertility has met large decline since 1800.
Explanation:
Children are themselves time intensive, in which case conserving on children also conserves on time as people get richer.

Top Inequality

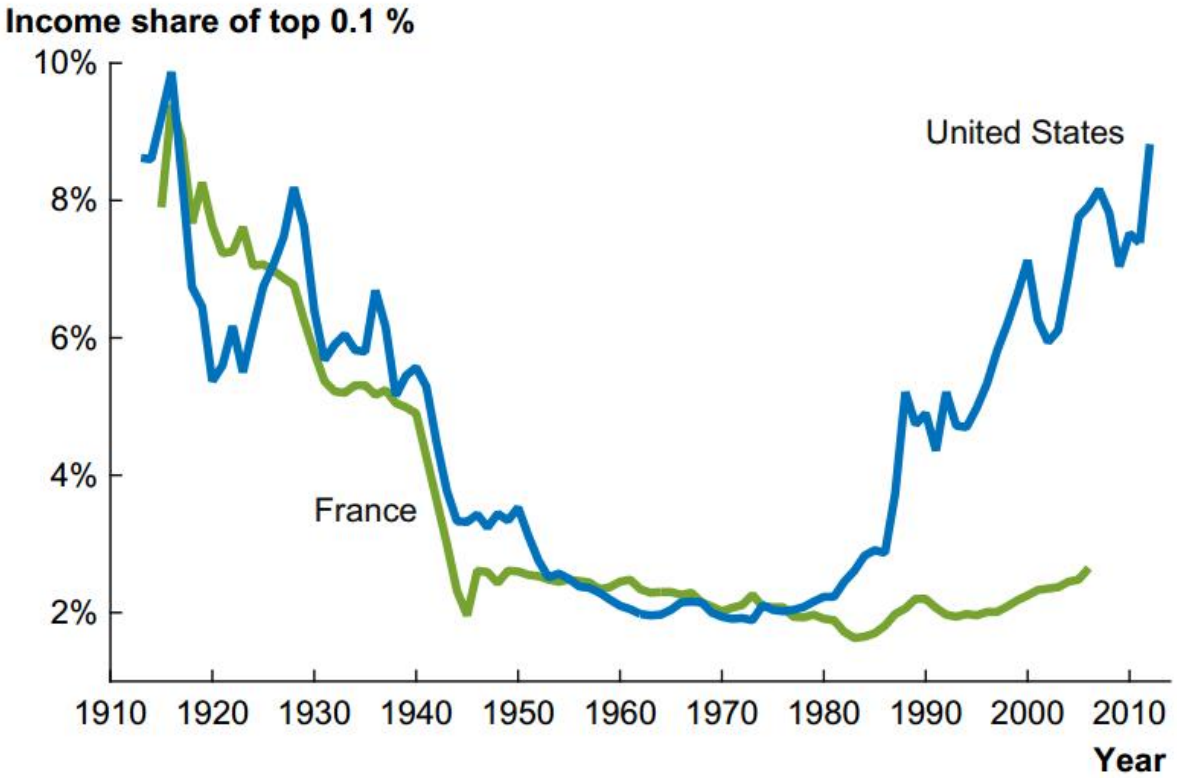


Fig. 18 Top income inequality in the United States and France. Source: *Alvaredo, F., Atkinson, A.B., Piketty, T., Saez, E. 2013. The World Top Incomes Database. Accessed on October 15, 2013, http://topincomes.g-mond.parisschoolofeconomics.eu/.*

Facts:

In both the United States and France, the share declined sharply until the 1950s to around 2%. It stayed at this low level until around 1980. But top income shares rise in the United States to essentially the same level as in 1920, while the share in France remains relatively low.

Top Inequality

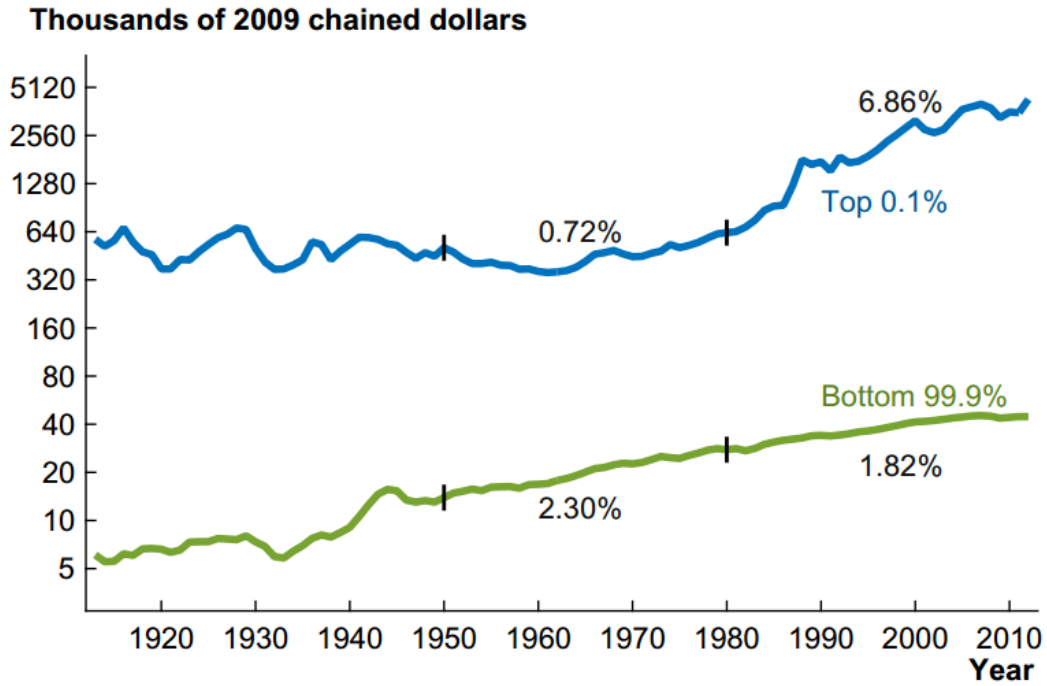


Fig. 19 GDP per person, top 0.1% and bottom 99.9%. *Note:* This figure displays an estimate of average GDP per person for the top 0.1% and the bottom 99.9%. Average annual growth rates for the periods 1950–1980 and 1980–2007 are also reported. Source: *Aggregate GDP per person data are from Fig. 1. The top income share used to divide the GDP is from the October 2013 version of the world top incomes database, from http://g-mond.parisschoolofeconomics.eu/topincomes/.*

Facts:

1. Until recently, there is surprisingly little growth in average GDP per person at the top. Instead, all the growth until around 1960 occurs in the bottom 99.9% .
2. This pattern changed in recent decades: after being virtually absent for 50 years, growth at the top accelerated sharply.

The Price of Natural Resources

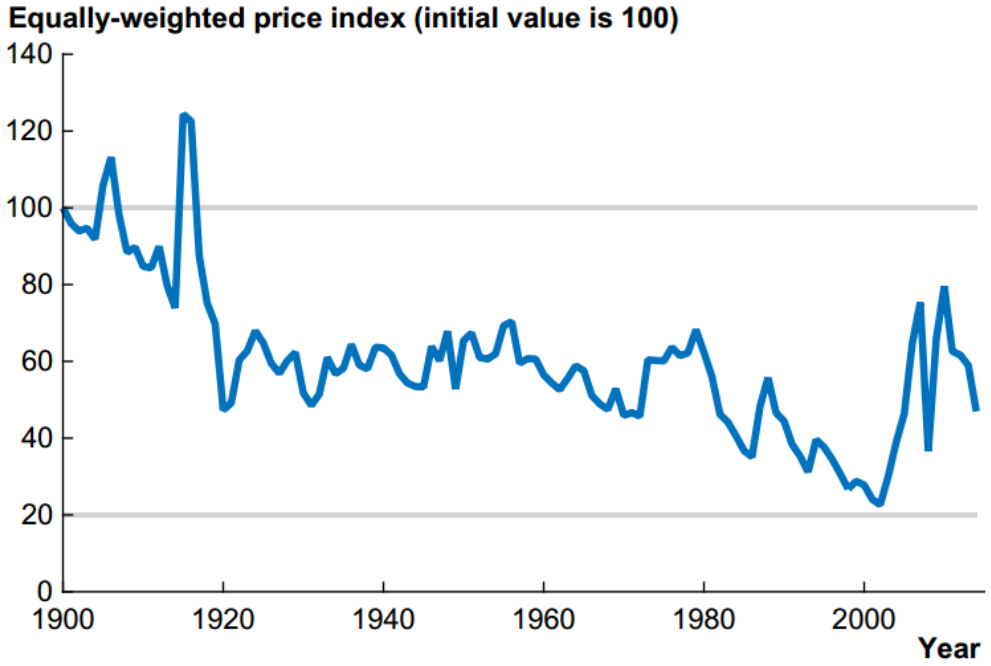


Fig. 20 The real price of industrial commodities. Source: *The price of an equally-weighted basket of aluminum, coal, copper, lead, iron ore, and zinc, deflated by the consumer price index. Commodity prices are from www.globalfinancialdata.com and the CPI is from www.measuringworth.com.*

Facts:

1. During the 20th century, world demand for these industrial commodities exploded.
2. The real price of these commodities declined over the 20th century.
3. The real price of these commodities has increased since 2000.

Explanations:

1. Some combination of increased discoveries and technological changes led the effective supply to grow even faster than the enormous rise in demand.
2. China and India grew rapidly over this period.

The Spread of Economic Growth

The Long Run

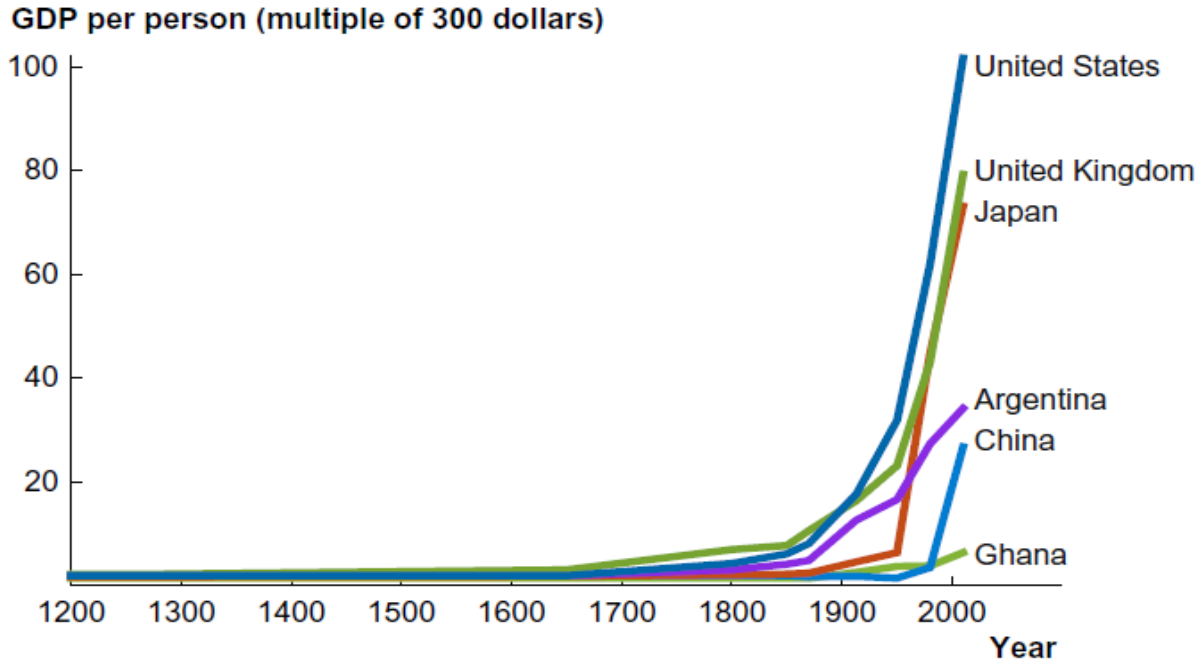


Fig. 21 The great divergence. *Note*: The graph shows GDP per person for various countries. The units are in multiples of 300 dollars and therefore correspond roughly to the ratio between a country's per capita income and the income in the poorest country in the world. Source: *Bolt, J., van Zanden, J.L. 2014. The Maddison Project: collaborative research on historical national accounts. Econ. Hist. Rev. 67 (3), 627–651.*

1.GDP per person differs modestly prior to the year 1600.
2.The spread of growth occurred at different points in time, resulting in what is commonly referred to as "The Great Divergence".

The Spread of Growth in Recent Decades

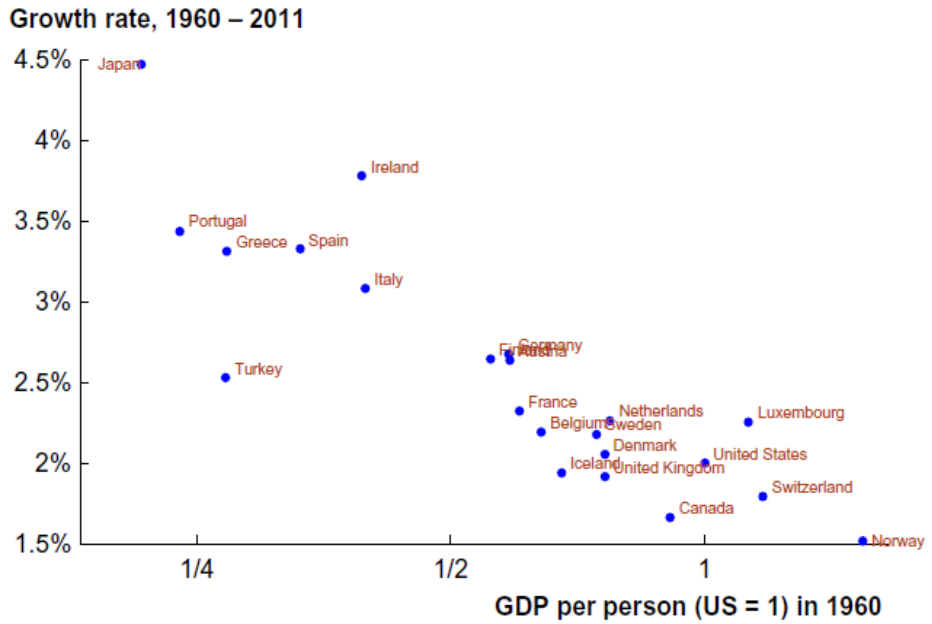


Fig. 25 Convergence in the OECD. Source: *The Penn World Tables 8.0. Countries in the OECD as of 1970 are shown.*

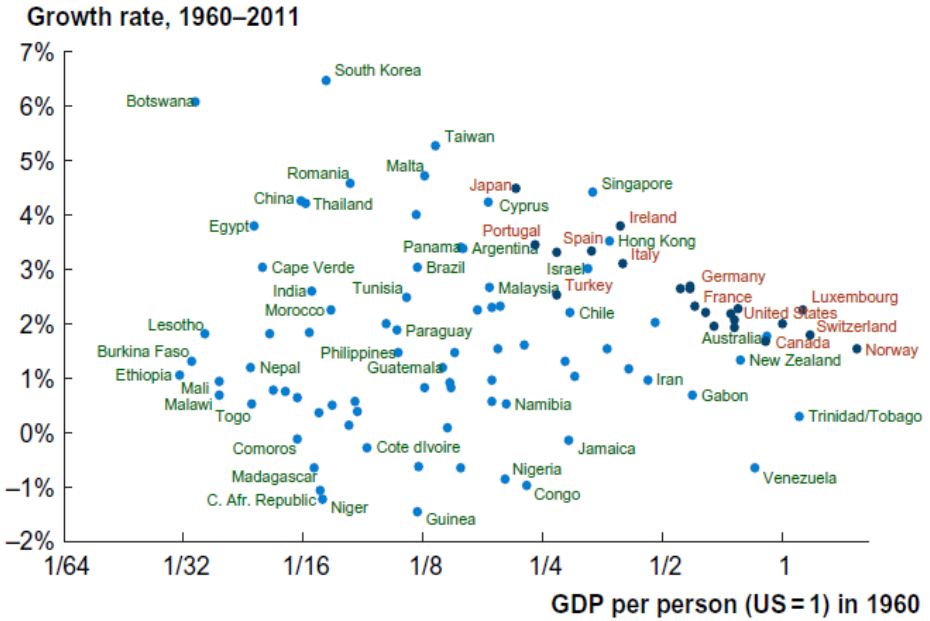


Fig. 26 The lack of convergence worldwide. Source: *The Penn World Tables 8.0.*

1. Among OECD countries, those that were relatively poor in 1960—like Japan, Portugal, and Greece—grew rapidly, while those that were relatively rich in 1960—like Switzerland, Norway, and the United States—grew more slowly.
2. The pattern is quite strong in the data; a simple regression line leads to an R-squared of 75%.
3. There is no tendence for poor countries around the world to grow either faster or slower than rich countries.

The Spread of Growth in Recent Decades

Table 4 The very long-run distribution

	Distribution			
"Bin"	1980	2010	Long run	Years to "shuffle"
Less than 5%	18	21	15	1190
Between 5% and 10%	19	16	8	1100
Between 10% and 20%	22	16	11	920
Between 20% and 40%	13	18	14	270
Between 40% and 80%	19	18	32	950
More than 80%	9	12	20	1000

Entries under "Distribution" reflect the percentage of countries with relative (to the United States) GDP per person in each bin. "Years to shuffle" indicates the number of years after which the best guess as to a country's location is given by the long-run distribution (ie, within a percentage point, bin by bin), provided that the country begins in a particular bin.

Source: Computed following Jones, C.I. 1997. On the evolution of the world income distribution. J. Econ. Perspect. 11, 19–36 using the Penn World Tables 8.0 for 134 countries.

1.Many countries are projected to move out of the lower and middle portions of the distribution and into the top.
2.Where they end up depends on the extent to which their institutions improve.

The Distribution of Income by Person, Not by Country

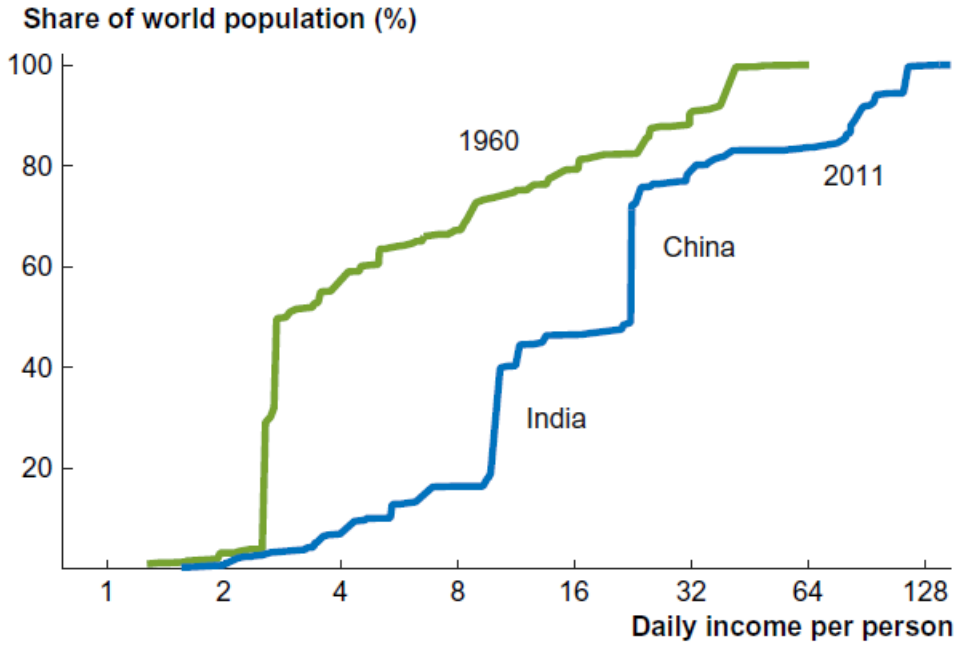


Fig. 28 The distribution of world income by population. Source: *The Penn World Tables 8.0, calculated across a stable sample of 100 countries.*

Assuming each person in a country gets that country's GDP per person and then compute the world income distribution by person.(Such a coarse estimation)

Beyond GDP

Table 5 Beyond GDP: Welfare across countries

	Consumption-equivalent welfare	Income	Log ratio	Life exp.	Decomposition			
					C/Y	Leisure	Cons. ineq.	Leis. ineq.
United States	100.0	100.0	0.000	0.000	0.000	0.000	0.000	0.000
United Kingdom	96.6	75.2	0.250	0.086	−0.143	0.073	0.136	0.097
France	91.8	67.2	0.312	0.155	−0.152	0.083	0.102	0.124
Italy	80.2	66.1	0.193	0.182	−0.228	0.078	0.086	0.075
Spain	73.3	61.1	0.182	0.133	−0.111	0.070	0.017	0.073
Mexico	21.9	28.6	−0.268	−0.156	−0.021	−0.010	−0.076	−0.005
Russia	20.7	37.0	−0.583	−0.501	−0.248	0.035	0.098	0.032
Brazil	11.1	17.2	−0.436	−0.242	0.004	0.005	−0.209	0.006
S. Africa	7.4	16.0	−0.771	−0.555	0.018	0.054	−0.283	−0.006
China	6.3	10.1	−0.468	−0.174	−0.311	−0.016	0.048	−0.014
Indonesia	5.0	7.8	−0.445	−0.340	−0.178	−0.001	0.114	−0.041
India	3.2	5.6	−0.559	−0.440	−0.158	−0.019	0.085	−0.028
Malawi	0.9	1.3	−0.310	−0.389	0.012	−0.020	0.058	0.028

Notes: The consumption-equivalent welfare numbers in the first column use a conventional utility function to "add up" the contributions from consumption, leisure, mortality, and inequality and express them in a consumption-equivalent manner. The income column reports GDP per person. The "decomposition" columns report an additive decomposition of the log difference between welfare and income.

Source: These numbers are taken from table 2 of Jones, C.I., Klenow, P.J. 2015. Beyond GDP: Welfare across countries and time. Stanford University, unpublished manuscript, and are based on data from household surveys in each country, from the World Bank (for mortality), and from the Penn World Tables 8.0 for a year close to 2005.

Facts:

1. Western European countries like the United Kingdom and France have much higher living standards than their GDPs indicate.
2. For poor countries, Life expectancy and leisure tend to be lower and inequality tends to be higher, all of which reduce welfare relative to GDP.

Development Accounting

A Cobb-Douglas production function:

$$Y_t = \underbrace{A_t M_T}_{\text{TFP}} K_t^{\alpha} H_t^{1-\alpha}$$

Y_t : final output
K_t : physical capital
H_t : human capital
A_t : the economy's stock of knowledge
M_T : anything else that influences total factor productivity (misallocation)

However, some of the accumulation of physical capital is caused by growth in total factor productivity, to credit such growth to total factor productivity, first divide both sides of the production function by Y_t^{α} and solve for Y_t to get

$$Y_t = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} H_t Z_t$$

where $\boldsymbol{Z_t} = (\boldsymbol{A_t M_T})^{\frac{1}{1-\alpha}}$ is total factor productivity measured in labor-augmenting units

Finally, dividing both sides by **the aggregate amount of time worked $\boldsymbol{L_t}$**, gives

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} \frac{H_t}{L_t} Z_t$$

Development Accounting

Table 6 Basic development accounting, 2010

	GDP per worker, y	Capital/GDP $(K/Y)^{\alpha/(1-\alpha)}$	Human capital, h	TFP	Share due to TFP
United States	1.000	1.000	1.000	1.000	–
Hong Kong	0.854	1.086	0.833	0.944	48.9%
Singapore	0.845	1.105	0.764	1.001	45.8%
France	0.790	1.184	0.840	0.795	55.6%
Germany	0.740	1.078	0.918	0.748	57.0%
United Kingdom	0.733	1.015	0.780	0.925	46.1%
Japan	0.683	1.218	0.903	0.620	63.9%
South Korea	0.598	1.146	0.925	0.564	65.3%
Argentina	0.376	1.109	0.779	0.435	66.5%
Mexico	0.338	0.931	0.760	0.477	59.7%
Botswana	0.236	1.034	0.786	0.291	73.7%
South Africa	0.225	0.877	0.731	0.351	64.6%
Brazil	0.183	1.084	0.676	0.250	74.5%
Thailand	0.154	1.125	0.667	0.206	78.5%
China	0.136	1.137	0.713	0.168	82.9%
Indonesia	0.096	1.014	0.575	0.165	77.9%
India	0.096	0.827	0.533	0.217	67.0%
Kenya	0.037	0.819	0.618	0.073	87.3%
Malawi	0.021	1.107	0.507	0.038	93.6%
Average	0.212	0.979	0.705	0.307	63.8%
1/Average	4.720	1.021	1.418	3.260	69.2%

The product of the three input columns equals GDP per worker. The penultimate row, "Average," shows the geometric average of each column across 128 countries. The "Share due to TFP" column is computed as described in the text. The 69.2% share in the last row is computed looking across the columns, ie, as approximately 3.5/(3.5 + 1.5).

Source: Computed using the Penn World Tables 8.0 for the year 2010 assuming a common value of $\alpha = 1/3$.

Development Accounting

Contribution of different factors

1. . The capital-output ratio is remarkably stable across countries. Differences in physical capital contribute almost nothing to differences in GDP per worker across countries.

2. the contribution from educational attainment is larger, but still modest.

3.differences in TFP are the largest contributor to income differences
an accounting sense.

Development Accounting

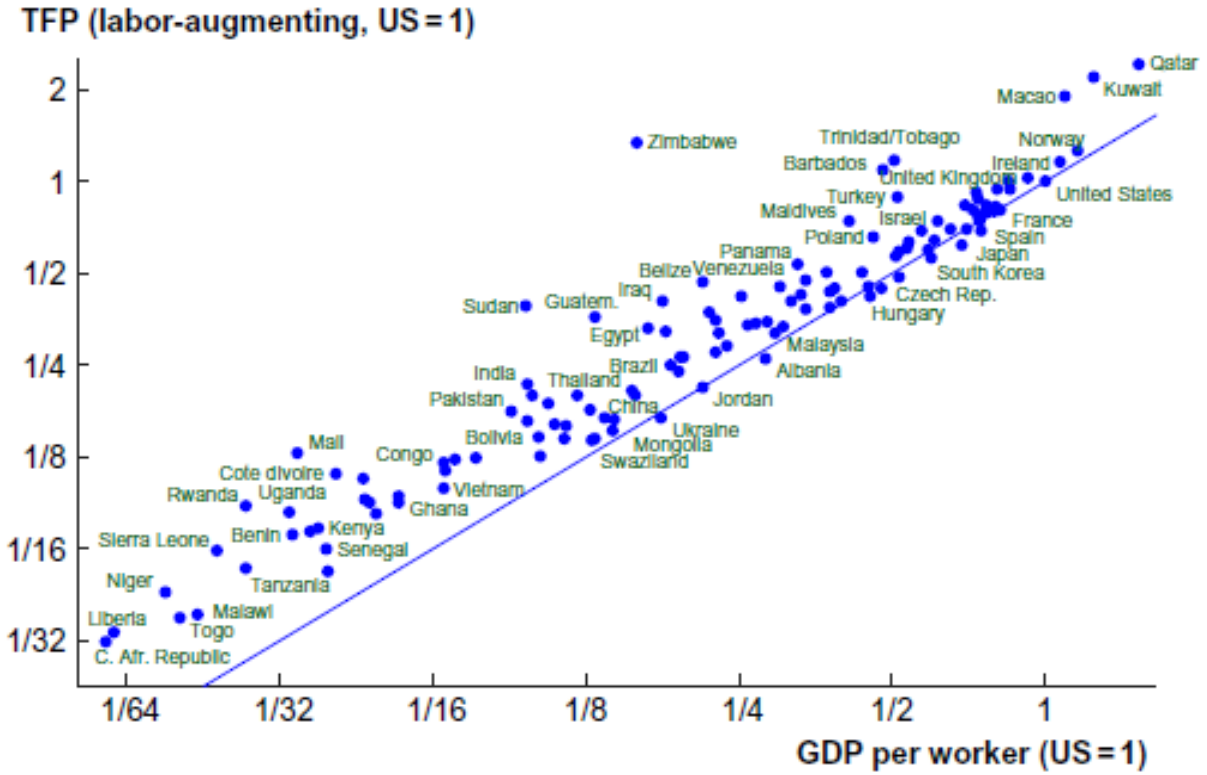


Fig. 29 Total factor productivity, 2010. Source: *Computed using the Penn World Tables 8.0 assuming a common value of* $\alpha = 1/3$.

Misallocation: A Theory of TFP

Misallocation: A Theory of TFP

A Simple Example:

Two Tasks X_1 and X_2:

$$Y = {X_1}^{\alpha} {X_2}^{1-\alpha}$$

One Input labor L:

$$X_1 = sL \; and \; X_2 = (1-s)L$$

Output:

$$Y = (sL)^{\alpha}[(1-s)L]^{1-\alpha}$$

$$Y = M(s)L, where \; M(s) \equiv s^{\alpha}(1-s)^{1-\alpha}$$

Maximization:

$$s^* = \alpha$$

Any departure of the allocation from s^* will reduce TFP.

Conclusion:

A given amount of input may produce less output. In other words, TFP is lower.

Institutions and the Role of Government

Two “Natural Experiments”: North and South Korea

Fig. 31 Korea at night. *Note*: North Korea is the dark area in the center of the figure, between China to the north and South Korea to the south. Pyongyang is the isolated cluster in the center of the picture. Source: *http://commons.wikimedia.org/wiki/File:North_and_South_Korea_at_night.jpg*.

Institutions and the Role of Government

Two "Natural Experiments": Reversal of fortune

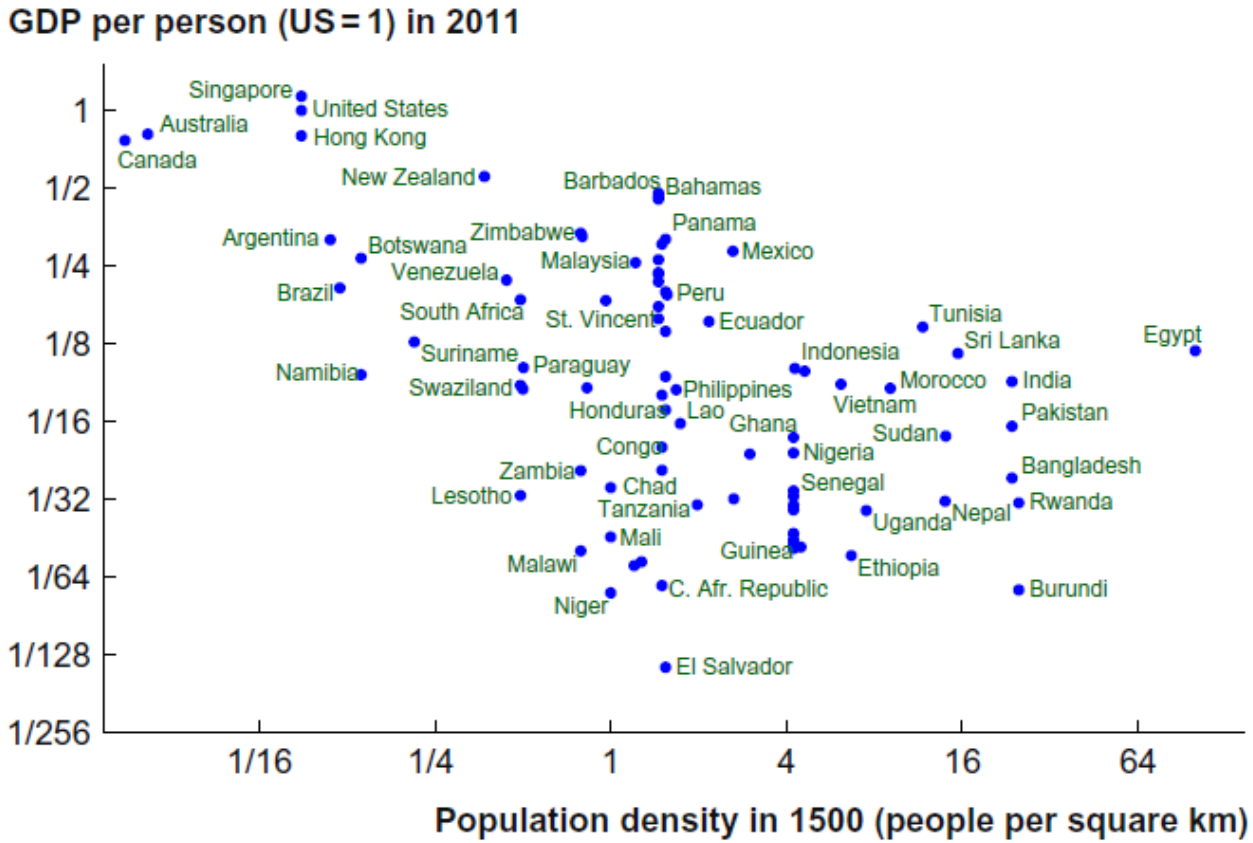


Fig. 32 The reversal of fortune. *Note:* Former European colonies that were proserous (at least in terms of population density) in 1500 are on average poorer today rather than richer. Source: *Population density is from Acemoglu, D., Johnson, S., Robinson, J.A. 2002. Reversal of fortune: geography and institutions in the making of the modern world income distribution. Q. J. Econ. 117 (4), 1231–1294 and GDP per person is from the Penn World Tables 8.0.*

Taxes and Economic Growth

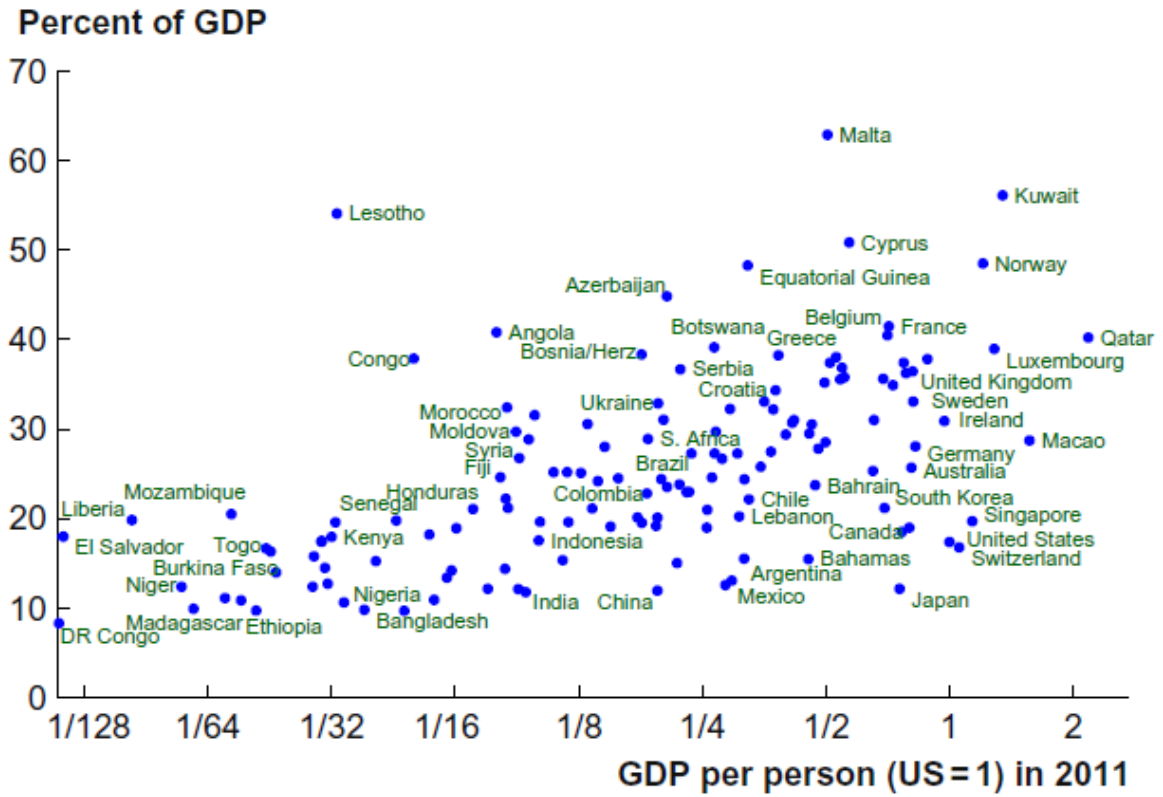


Fig. 34 Tax revenues as a share of GDP. *Note:* Tax revenue is averaged for the available years between 2000 and 2014, is for the central government only, and includes receipts for social insurance programs. Source: *This is an updated graph of a figure from Acemoglu, D. 2005. Politics and economics in weak and strong states. J. Monet. Econ. 52 (7), 1199–1226. http://ideas.repec.org/a/eee/moneco/v52y2005i7p1199-1226.html. The World Bank,* World Development Indicators. *GDP per person is from the Penn World Tables 8.0.*

TFPQ vs TFPR

Utility Function:

$$U = \int_0^1 (\alpha_i \ Y_i \ )^\rho di$$

α_i denotes taste parameters related to each variety

$0 < \rho = \frac{s-1}{s} < 1$, where s denotes elasticity of substitution

Inverse Demand Function:

$$p_i = \lambda^{-1} \rho \alpha_i{}^\rho Y_i{}^{\rho-1}$$

Production Function:

$$Y_i = A_i L_i$$

Profit:

$$\pi = p_i Y_i - w L_i$$

TFPQ vs TFPR

Maximization:

$$p_i = \frac{1}{\rho\lambda}\frac{w}{A_i}$$

$$Y_i p_i = \frac{wL_i}{\lambda\rho}$$

Data available:

$$Y_i \quad L_i \quad p_i \quad \rho \quad w$$

TFPQ vs TFPR

Revenue Productivity, $\mathbf{TFPR}_i$:

$$\frac{Y_i p_i}{L_i} = \frac{w}{\lambda \rho}$$

True Productivity, $\mathbf{TFPQ}_i$:

$$\frac{\alpha_i Y_i}{L_i} = \left(\frac{\lambda}{\rho}\right)^{1/\rho} \frac{(p_i \ Y_i \ )^{1/\rho}}{L_i} = \left(\frac{\lambda}{\rho}\right)^{1/\rho} \alpha_i A_i$$

Implication:

TFPR should be equated across heterogeneous firms within an industry.

TFPQ varies across firms.

The Hsieh-Klenow Facts

Key Assumption: TFPR should be equated across plants if resources are allocated optimally.

CD Production Function:

$$Y = AK^{\alpha_K} L^{\alpha_L}$$

Optimum with distortions:

$$\frac{rK}{pY} = \alpha_K \frac{1}{1+\tau_K}$$

$$\frac{wL}{pY} = \alpha_L \frac{1}{1+\tau_L}$$

Examples of distortions:

Credit market frictions, hiring and firing costs, quantity restrictions and so on.

The Hsieh-Klenow Facts

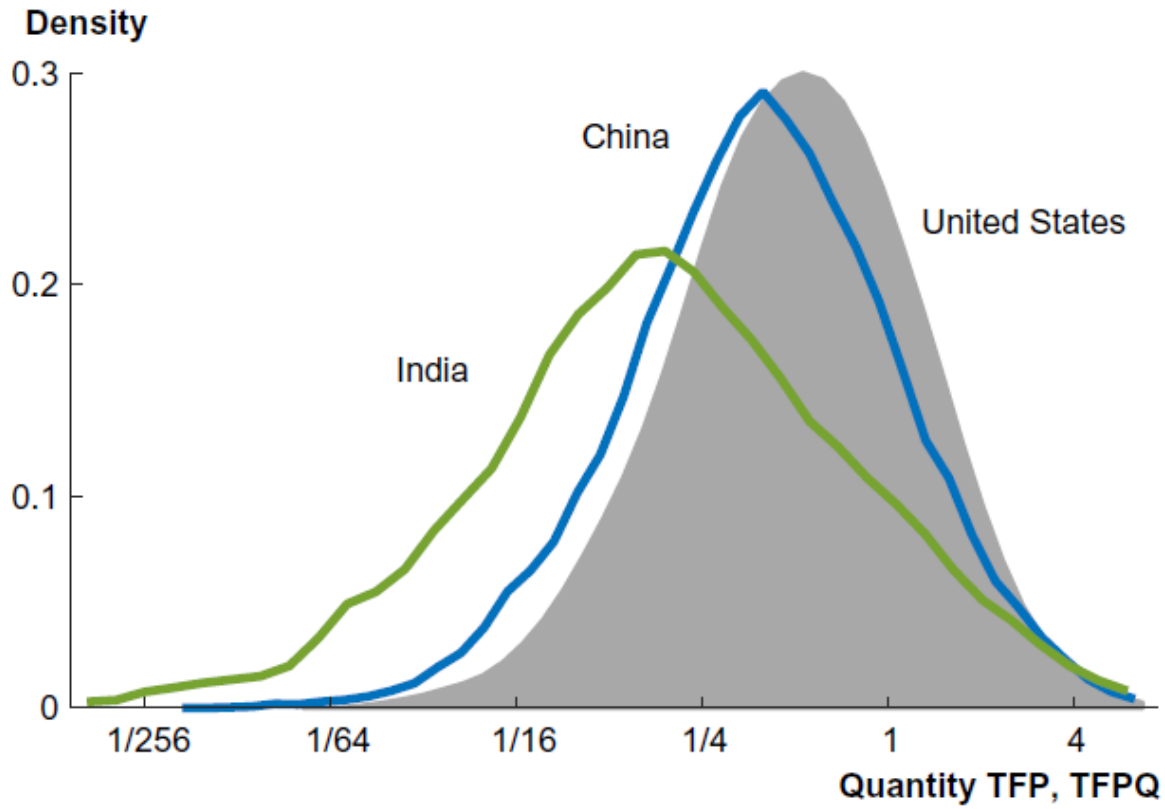


Fig. 35 The distribution of TFPQ in 4-digit manufacturing industries. *Note:* This is the average distribution of TFPQ within 4-digit manufacturing industries for the United States in 1997, China in 2005, and India in 1994, computed as described in the text. The means across countries are not meaningful. Source: *Hsieh, C.T., Klenow, P.J. 2009. Misallocation and manufacturing TFP in China and India. Q. J. Econ. 124 (4), 1403–1448; data provided by Chang Hsieh.*

The Hsieh-Klenow Facts

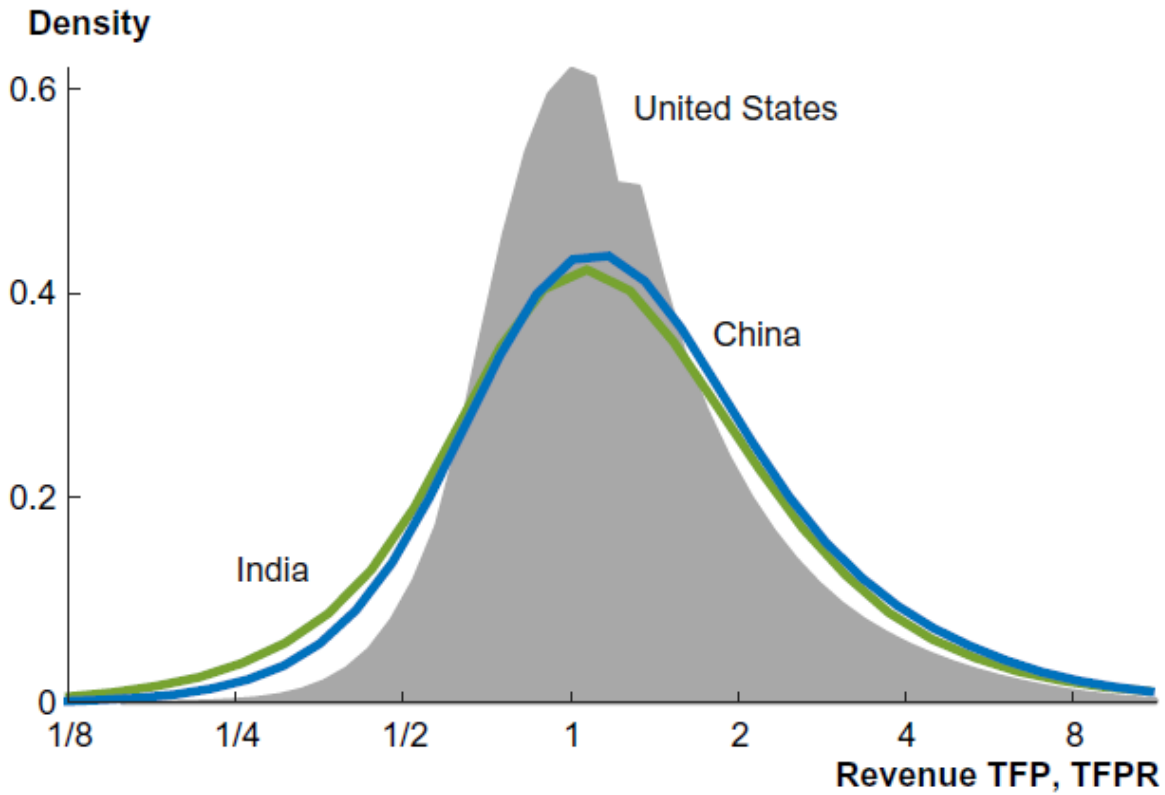


Fig. 36 The distribution of TFPR in 4-digit manufacturing industries. *Note:* This is the average distribution of TFPR within 4-digit manufacturing industries for the United States in 1997, China in 2005, and India in 1994, computed as described in the text. Source: *Hsieh, C.T., Klenow, P.J. 2009. Misallocation and manufacturing TFP in China and India. Q. J. Econ. 124 (4), 1403–1448; data provided by Chang Hsieh.*

The Hsieh-Klenow Facts

What could be causing this misallocation?
Hsieh and Klenow(2014)

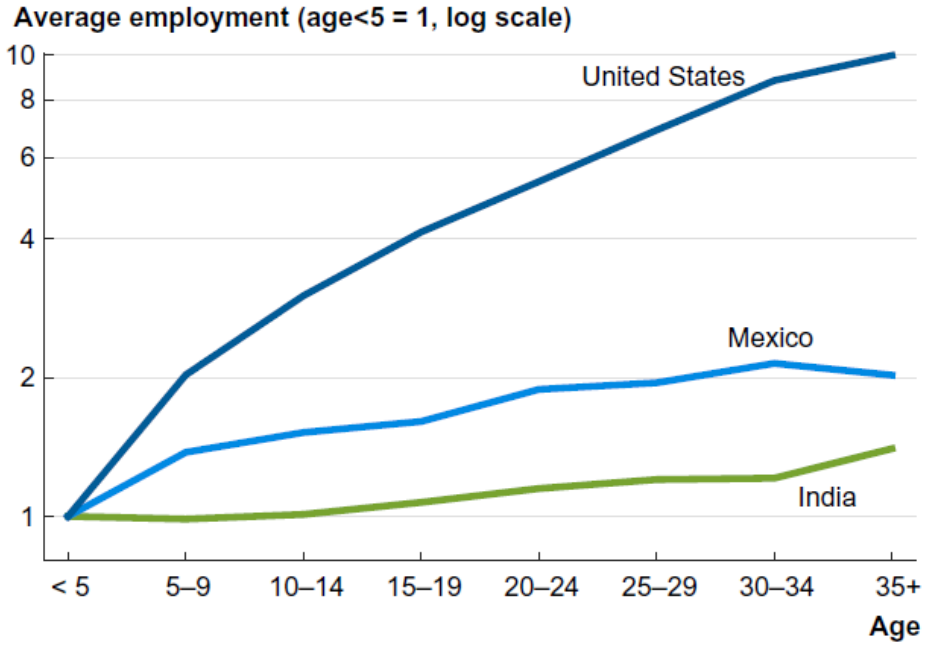


Fig. 37 Average employment over the life cycle. *Note:* The graph compares average employment per surviving plant in a later year to average employment per operating plant in an earlier year from the same cohort using census data for the manufacturing industry in the United States, Mexico, and India. Source: *Hsieh, C.T., Klenow, P.J. 2014. The life cycle of plants in India and Mexico. Q. J. Econ. 129 (3), 1035–1084; data provided by Chang Hsieh.*

The Hsieh-Klenow Facts

Other reasons:

Asker(2011): **Volatility and adjustment cost.**

Buera(2011a), Midrigan and Xu(2014), Moll(2014): **Credit market friction.**

Peters(2013): **Heterogeneous markups.**

Guner(2008), Gourio and Roys(2014), Garicano(2014): **effect of regulation tied to size of firms.**

Akcigit(2014a): **Incentive problems for managers limit the ability of potentially highly-productivity small firms to expand**

Hopenhayn(2014), Burea(2015)**: Overviews of the recent literature.**

THANKS