Principles of Economics

Macroeconomics

Long-Run Economic Growth II

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The Rule of 72

- A quantity growing at 1%/year doubles in 72 years...
- A quantity growing at 2%/year doubles in 36 years...
- A quantity growing at 3%/year doubles in 24 years...
- A quantity growing at 0.1%/year doubles in 720 years...
- A quantity growing at 0.01%/year doubles in 7200 years...

Guessing at Some Numbers

- 48000BC: Population: 100K. Living Standard: $1000/yr?
- 8000BC: Population: 5M. Living Standard: $1000/yr?
- -1BC: Population: 170M. Living Standard: $500/yr
- 1500: Population: 510M. Living Standard: $500/yr
- 1800: Population: 750M. Living Standard: $600/yr
- 1900: Population: 1.5B. Living Standard: $1200/yr
- 2014: Population: 7.4B. Living Standard: $7600/yr

Build a Framework for Thinking About Economic Growth

- Start by making a few very simple but very stylized assumptions:
    - A 1% increase in the *land and natural resources* **N** available for human beings to use would increase total production **Y** by 0.2%.
    - A 1% increase in the *produced capital stock* **K** available for human beings to use would increase total production **Y** by 0.3%.
    - A 1% increase in the *amount of labor* **L** available for society would increase total production **Y** by 0.5%.
    - A 1% increase in the *efficiency of labor* **E** due to better technology and better organization would increase total production **Y** by 0.5%.
- We summarize these assumptions in one equation:
    - $Y = (K)^{0.3}(N)^{0.2}(EL)^{0.5}$
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Build a Framework for Thinking About Economic Growth II

- We summarize these assumptions in an equation:
  - $Y = (K)^{0.3}(N)^{0.2}(EL)^{0.5}$
- Or:
  - $\ln(Y) = 0.3 \times \ln(K) + 0.2 \times \ln(N) + 0.5 \times (\ln(E) + \ln(L))$

We Can Then Ask: How Big Have the Improvements in Technology and Organization E Been?

Longest-Run Global Economic Growth (2014 $)

Date	Y (billions)	K	N	L (millions)	E (thousands)		Memo: K/Y
-48000	$0.1	$0.1	1	0.05			1
-8000	$5.0	$5.0	1	2.5			1
-1	$170.0	$425.0	1	85			2.5
1500	$255.0	$765.0	1	255			3
1800	$450.0	$1,800.0	1	375			4
1900	$1,800.0	$7,200.0	1	750			4
2014	$56,240.0	$224,960.0	1	3,700			4

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- $Y = (K)^{0.3}(N)^{0.2}(EL)^{0.5}$
- $E = Y^2/[(K)^{0.6}(N)^{0.4}(L)]$

Where Did We Start?

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Date	Y (billions)	K	N	L (millions)	E (thousands)		Memo: K/Y
-48000	$0.1	$0.1	1	0.05	0.1		1
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Pre-Neolithic Diffusion

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-48000	$0.1	$0.1	1	0.05	0.1		1
-8000	$5.0	$5.0	1	2.5	9.8		1
-1	$170.0	$425.0	1	85			2.5
1500	$255.0	$765.0	1	255			3
1800	$450.0	$1,800.0	1	375			4
1900	$1,800.0	$7,200.0	1	750			4
2014	$56,240.0	$224,960.0	1	3,700			4

- 100-fold improvement in 40,000 years

The Agrarian Age

Longest-Run Global Economic Growth (2014 $)

Date	Y (billions)	K	N	L (millions)	E (thousands)		Memo: K/Y
-48000	$0.1	$0.1	1	0.05	0.1		1
-8000	$5.0	$5.0	1	2.5	9.8		1
-1	$170.0	$425.0	1	85	510.1		2.5
1500	$255.0	$765.0	1	255	555.5		3
1800	$450.0	$1,800.0	1	375	1,103.6		4
1900	$1,800.0	$7,200.0	1	750			4
2014	$56,240.0	$224,960.0	1	3,700			4

- Another 100-fold improvement, this time in 10,000 years

The High Industrial Age

Longest-Run Global Economic Growth (2014 $)

Date	Y (billions)	K	N	L (millions)	E (thousands)		Memo: K/Y
-48000	$0.1	$0.1	1	0.05	0.1		1
-8000	$5.0	$5.0	1	2.5	9.8		1
-1	$170.0	$425.0	1	85	510.1		2.5
1500	$255.0	$765.0	1	255	555.5		3
1800	$450.0	$1,800.0	1	375	1,103.6		4
1900	$1,800.0	$7,200.0	1	750	8,237.9		4
2014	$56,240.0	$224,960.0	1	3,700	1,289,312.4		4

- Nearly 10-fold improvement 1800-1900
- A more than 100-fold improvement in little more than 100 years

What Happened?

- What happened post 8000 BC? We call it the Neolithic Revolution: settlement and literacy are worth a lot…

- What happened after 1500? Not the market economy—rather, limited government plus the Columbian exchange

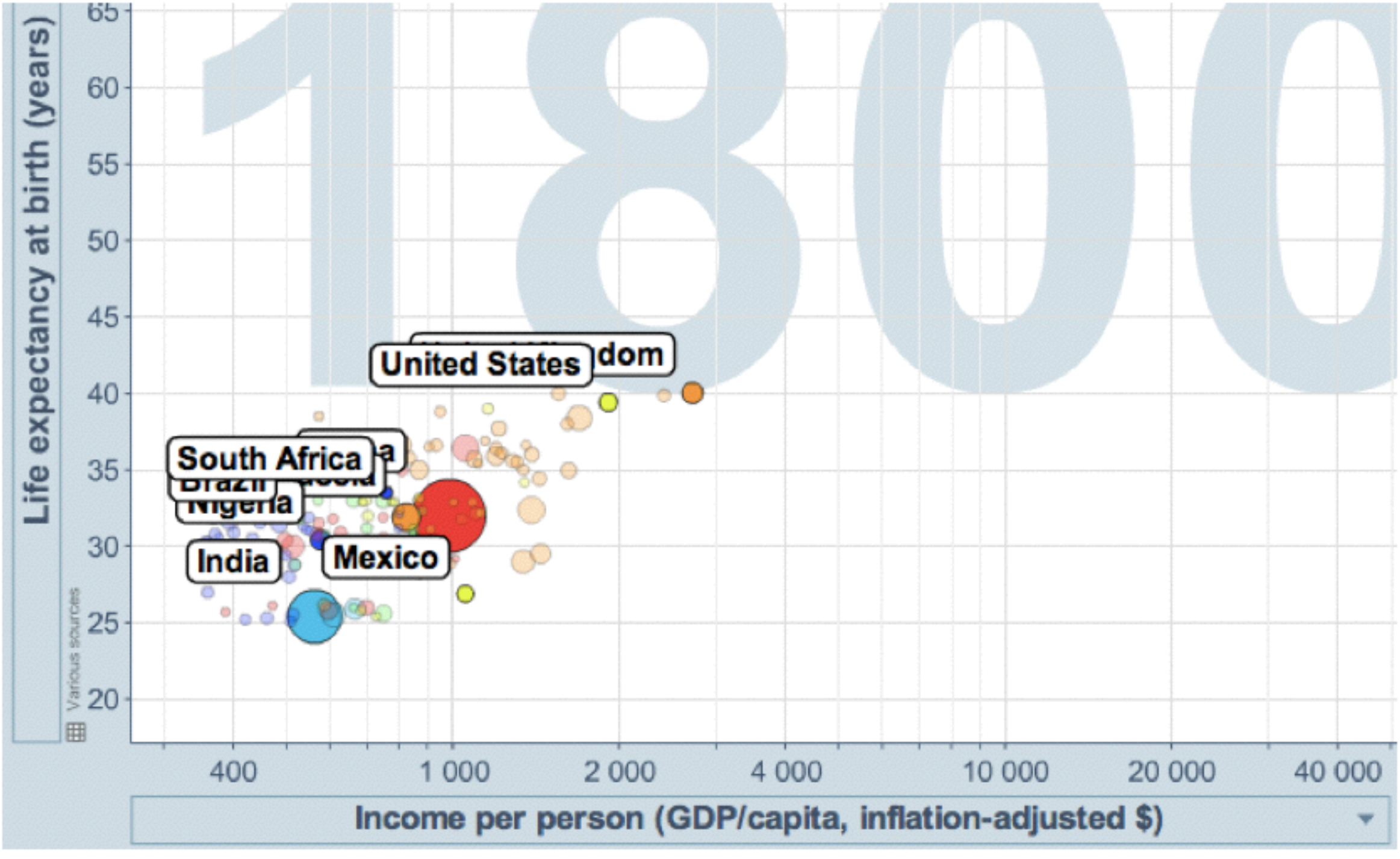
- What happened post-1800? We call it the Industrial Revolution

- Why didn't post-1800 happen earlier?

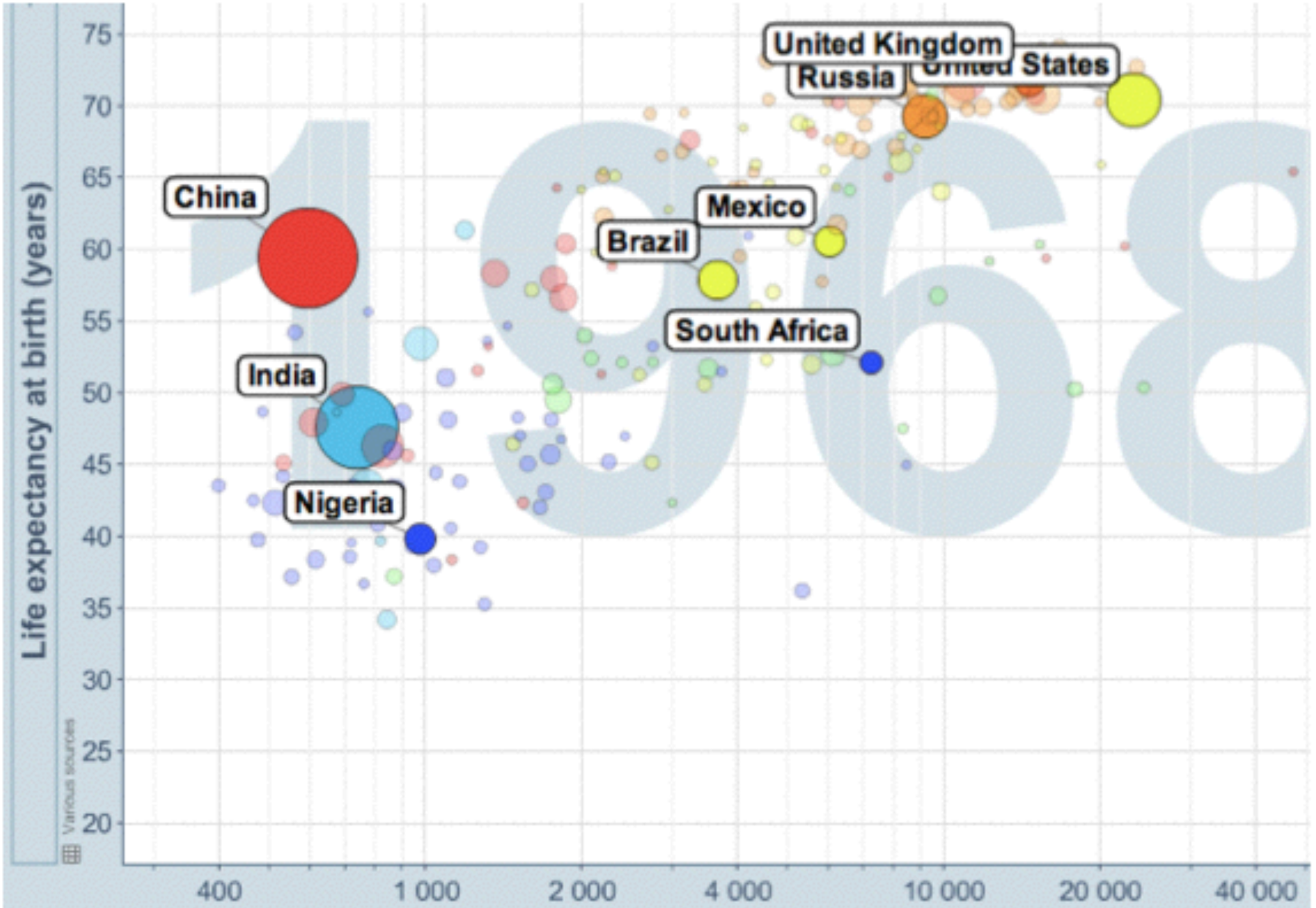
  - They were, axer all, about as smart as we are...

- We are going to note that these big historical questions exist…

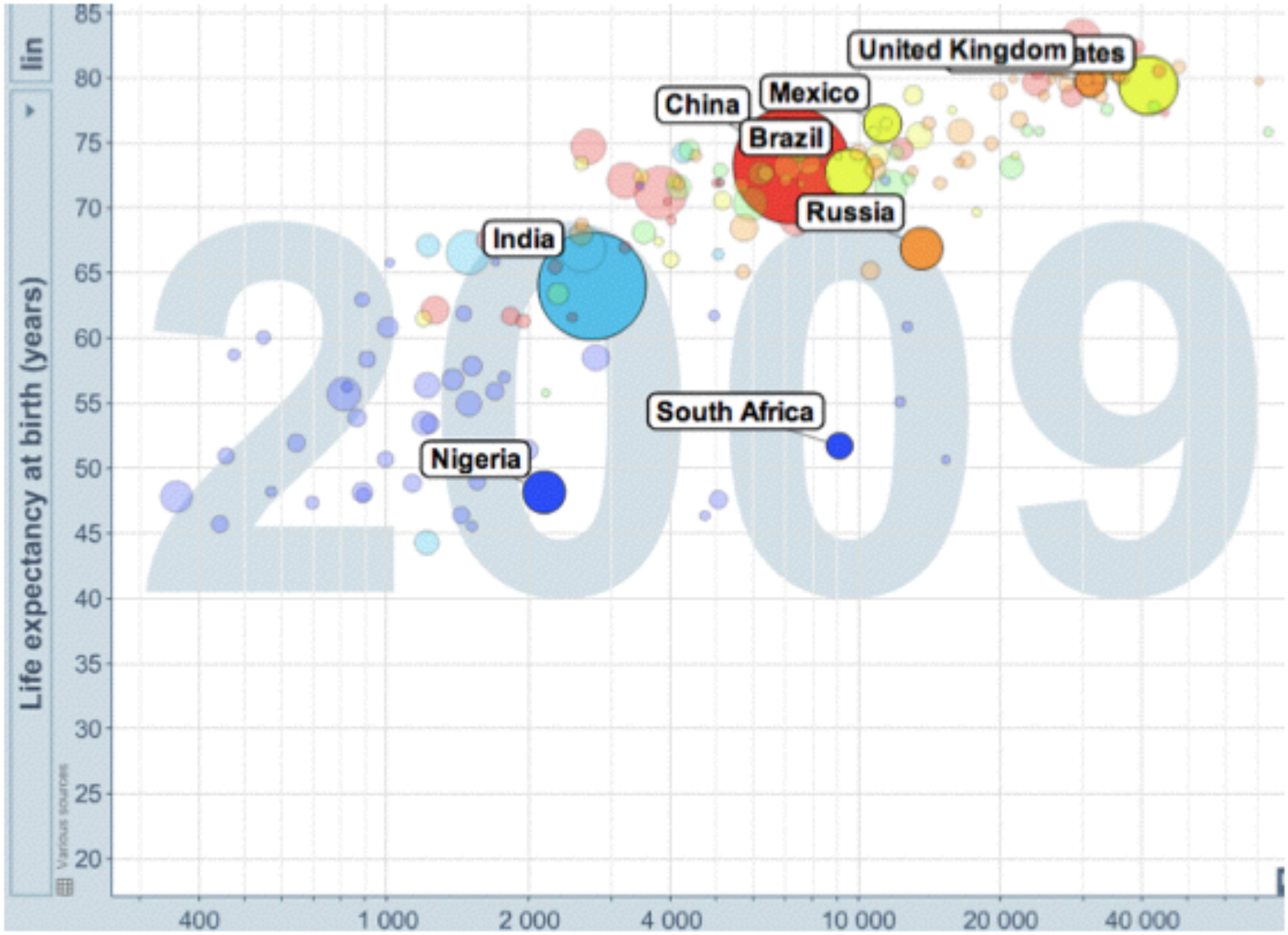
The World in 1800



The Great Divergence to 1968



Convergence Post 1968?



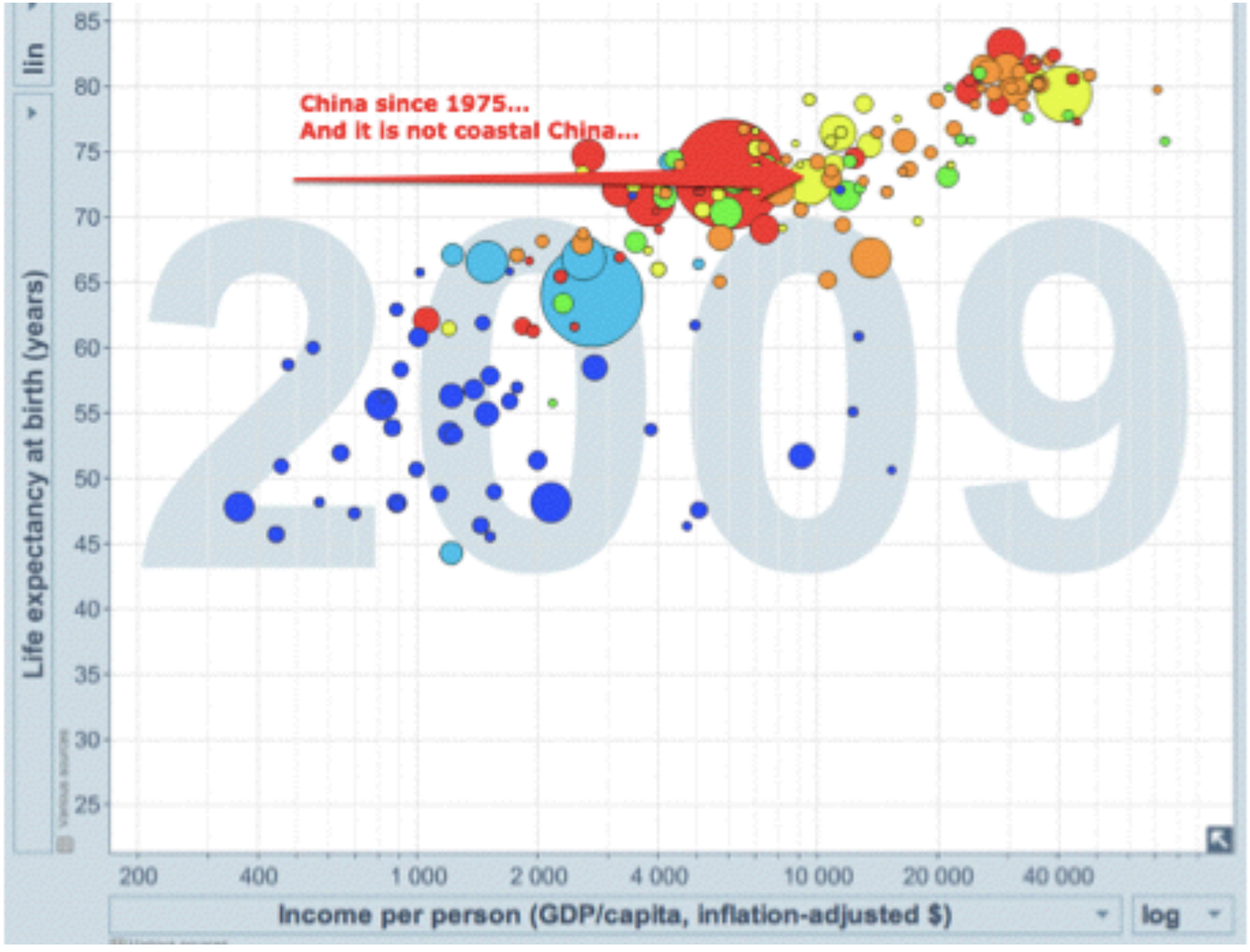
Why Divergence?

- The agrarian legacy
    - China's population has grown by a factor of 7 since 1800
    - Egypt's by a factor of 30
    - If most of your people are still unmechanized farmers, that is a huge set of headwinds
- The infrastructural task
    - Even if most of your people aren't unmechanized farmers and live in cities, a rapid population growth rate means a large investment burden
- Difficulties of technology transfer
- Difficulties of government
    - Communism
    - Corruption

Why Convergence?

- End of High Communism
- Expansion of world trade
- Technology transfer
- But if you look at it, the big difference between before 1968 and after 1968 is the different destinies of two countries
  - China
  - India

A Not-so-Long March



Counterfactuals

- Rule of Law:
  - Gives us capital/output ratio of 4 rather than 1 (or worse)--a doubling
  - Plus effects on incentives
  - Market organization: gives us a fivefold gain in wealth
  - The rest is innovation, and invention, and organization…
  - This is why Bob Solow won the Nobel Memorial Prize in Economic Sciences

Sources of the Solow Residual: "Technology"

- Here we have a big incentive problem…
  - Those who invent and innovate new technologies, new organizations, and new markets are enormous public benefactors
  - But they don't get the rewards of what they do
  - Patents and copyrights in the U.S. Constitution resolve the problem…
    - But at the cost of creating another...

“Unpriced” Commodities

- Ratio of consumer surplus to cost of production
  - 1:1 for “normal” commodities
  - 10:1 for “information goods and services”

How Happy Does This Make Us?

- Food, clothing, shelter, seeing some of your children survive, seeing none of your children die, status, feeling like you have accomplished something, cognitive puzzles, entertainment…

- How good are we at turning our wealth—our ability to command and transform nature and its resources—into utility?