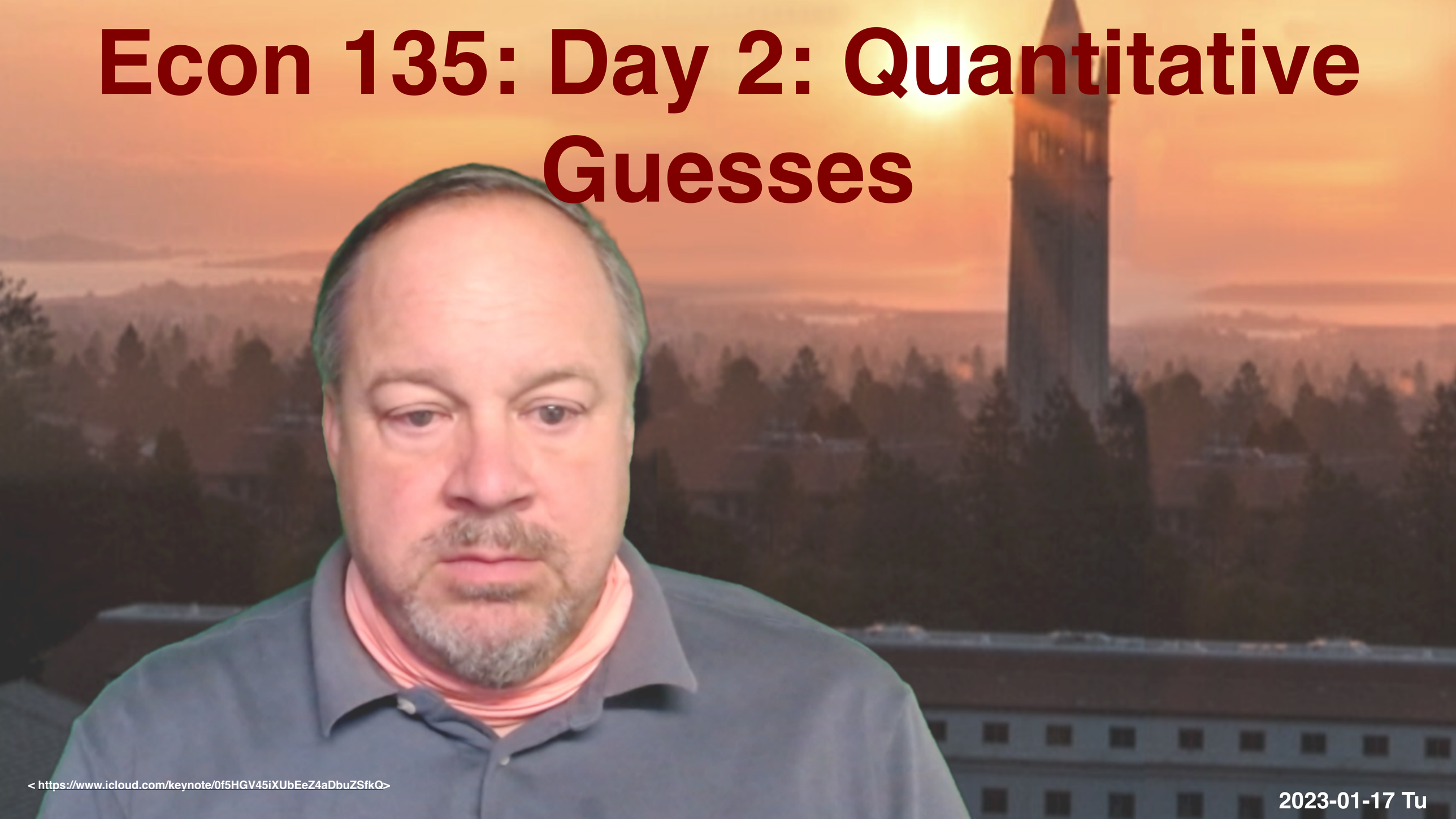
Econ 135: Day 2: Quantitative Guesses



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2023-01-17 Tu

Population

Date	Popula-tion P (millions)
-8000	2.04
-6000	5.09
-4000	10.5
-3000	15
-1500	37
-1000	50
-400	103
150	200
800	240
1000	296
1500	500
1770	750
1870	1299
1930	1909
1975	3678
2020	7566
2100	

- The labor force—the real, not the market-paid labor force—a roughly constant proportion of the population
- Hence no real distinction at this level of abstraction between L and P

Current Estimates

Date	Real Income/ Capita y	Popula- tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000		2.04			
-6000		5.09			
-4000		10.5			
-3000		15			
-1500		37			
-1000		50			
-400		103			
150		200			
800		240			
1000		296			
1500		500			
1770		750			
1870		1299			
1930		1909			
1975		3678			
2020	$12,000	7566			
2100					

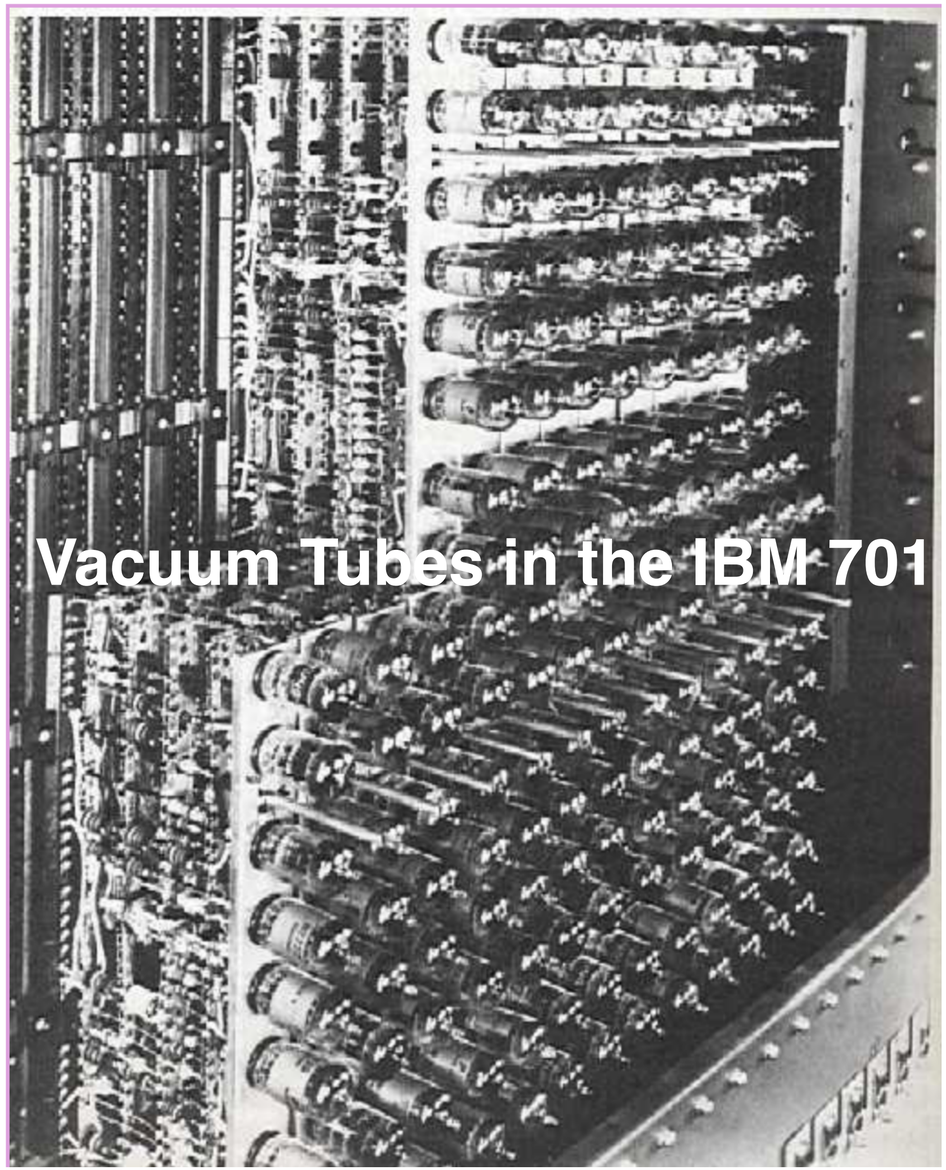
- Stunningly unequally distributed across countries…
- Substantially unequally distributed within societies…
- Is this the summary statistic we really want?

Projecting into the Past Using Estimated Growth Rates

Date	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000		2.04			
-6000		5.09			
-4000		10.5			
-3000		15			
-1500		37			
-1000		50			
-400		103			
150		200			
800		240			
1000		296			
1500		500			
1770		750			
1870	$1,300	1299			
1930	$3,000	1909			
1975	$6,000	3678			
2020	$12,000	7566			
2100		10000			

- How bad a thing is this to do?

From the Early 1960s: Each of These a Single Logic Gate


Vacuum Tubes in the IBM 701

A glass tube filled with a vacuum:

- A NAND gate: 1” in diameter x 4” long
- Today a NAND gate is 100 nm^3
- We could fit 5 x 10^{16} NAND gates inside one of these
- Bottom Line:
  - We produce commodities much more cheaply
  - But we also produce very different commodities
  - Commodities that could not have been produced at any price in 1960 are incredibly cheap today

Guessing at Income Levels

- Is every single one of us richer than Nathan Meyer Rothschild?
- NIPA is factor cost, but what we really want is consumer value, or rather user utility…

Clark: The English-Wage Hockey Stick

English construction workers

- Lots of monks in England hiring construction workers, and then writing everything down, and then saving it
- English construction workers on average earned the same real wages in 1000, in 1450, and in 1850
- In John Stuart Mill's old age—1870—they were only 20% above what they had been 400 years before.
- Yet today they stand sixteen times as high as in 1800—and maybe much more
- From Clark…

Projecting into the Past Using Estimated Growth Rates

Date	Real Income/ Capita y	Popula- tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000		2.04			
-6000	$900	5.09			
-4000	$900	10.5			
-3000	$900	15			
-1500	$900	37			
-1000	$900	50			
-400	$900	103			
150	$900	200			
800	$900	240			
1000	$900	296			
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1770	$1,100	750			
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- Generalizing from Clark
- Generalizing from heights (lower- and upper-class)
- Generalizing from population growth rates

Rick: Steckel: Heights…

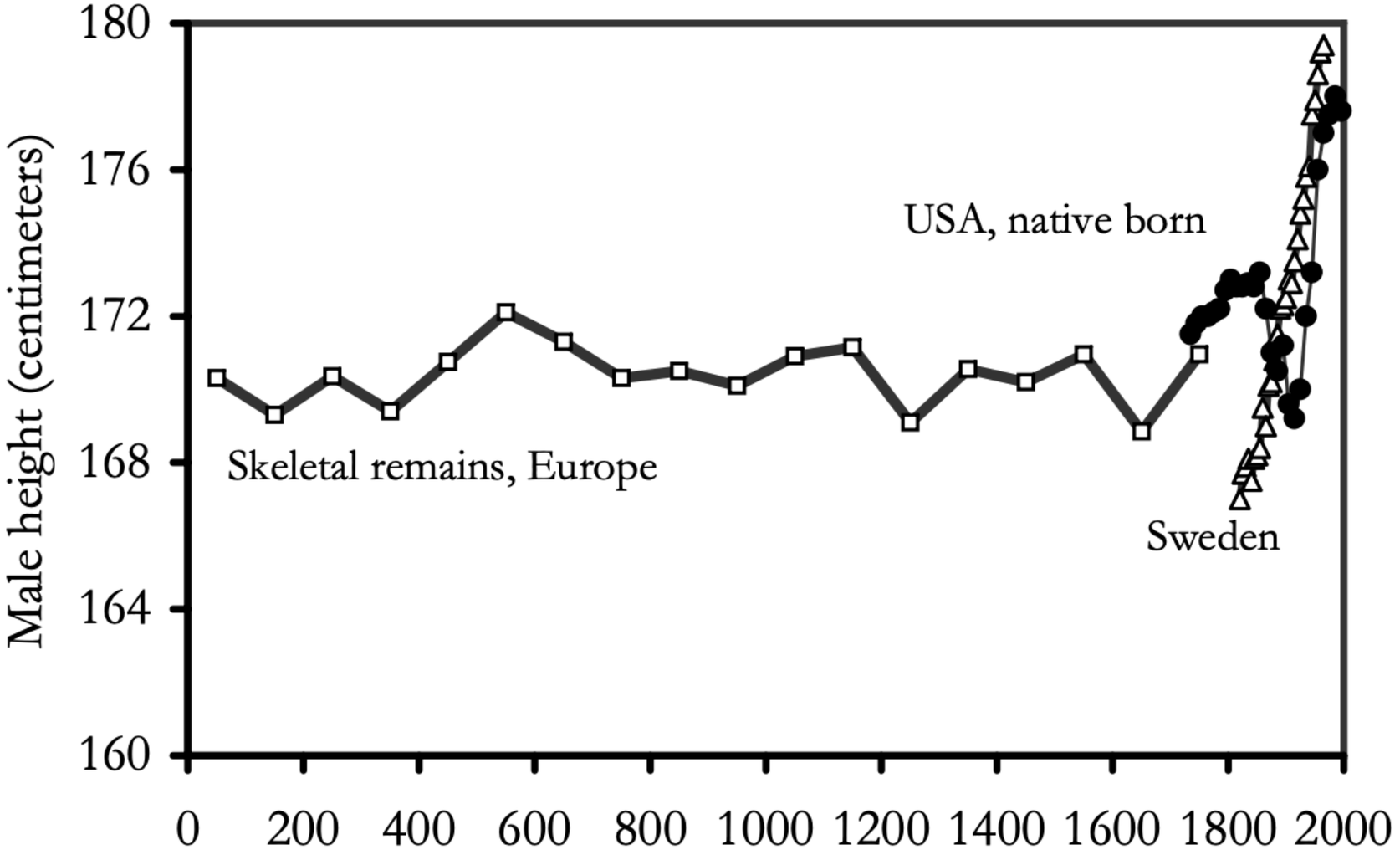
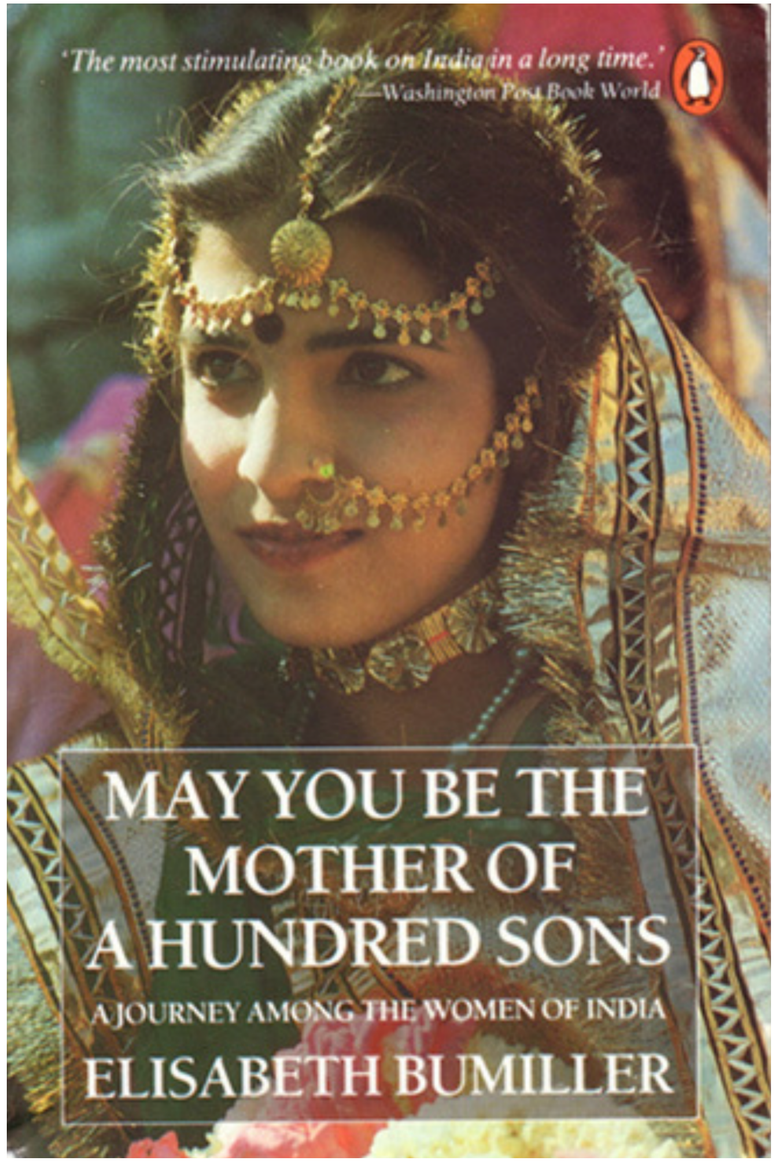


Figure 3.6 Male heights from skeletons in Europe, AD 1–2000. Data from Steckel, 2001, figures 3 and 4, and Koepke and Baten, 2005.

- What diet stunts your adult height by 8 cm?
- Upper classes 5 cm or so higher than lower classes…
- What would Alameda County child and protective services say about this?
- What constraints are parents under for this to happen?

Malthusian Demography



Social power depends on being the mother (or father, uncle) of sons:

- Technological progress is slow
- So population nearly stable
- Thus the average mother has only one son surviving to reproduce
- Some have two or three, and some have zero
- Hence very strong pressure to have as many as possible, in the hope that one will survive

- Slow population growth: average number of sons near 1
- Poisson distribution

- Two children survive to reproduce
- Three live to adulthood
- 4.5 survive to age 5
- 6.5 live births
- 9 pregnancies, with miscarriages and stillbirths

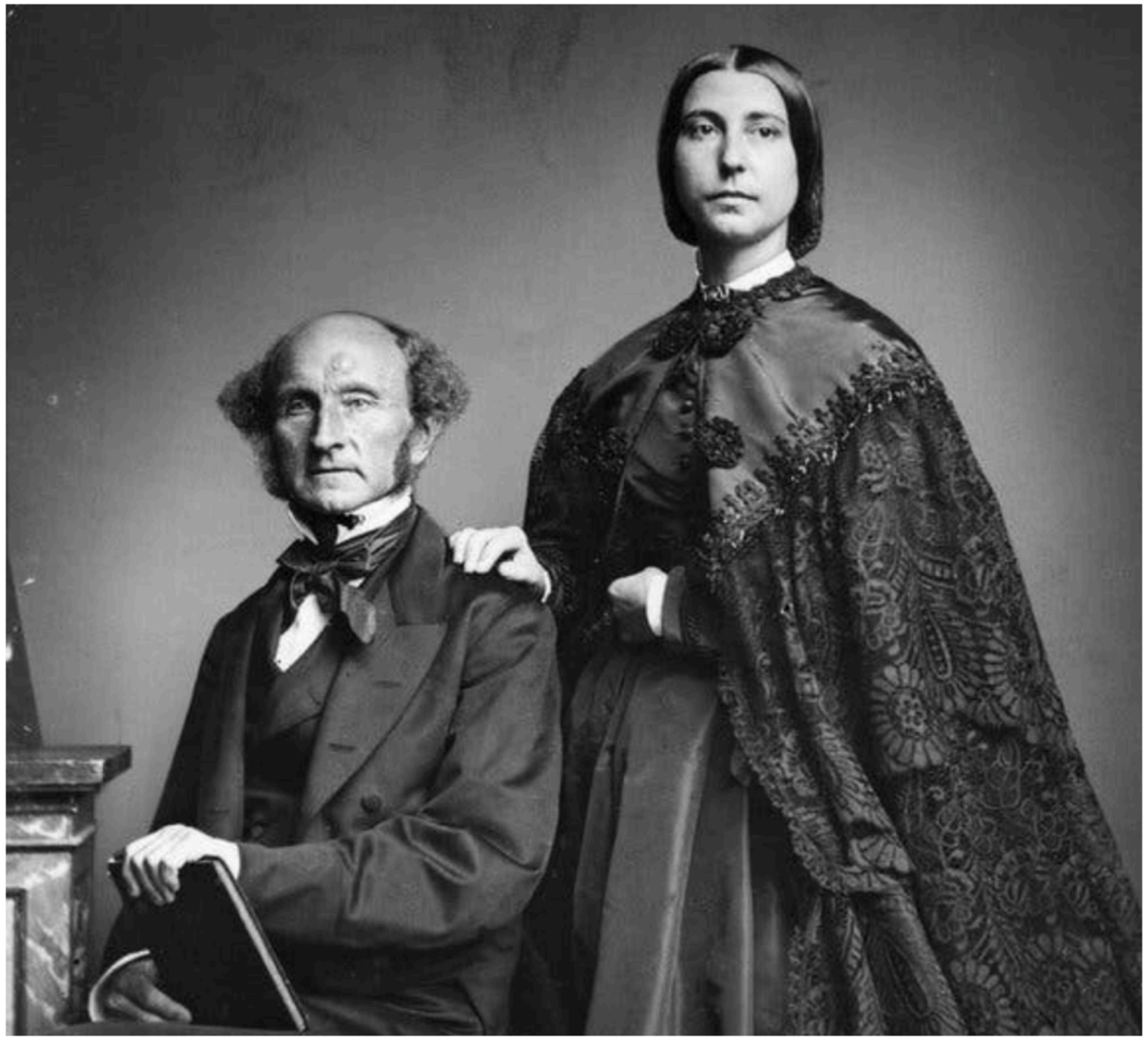
9 x 9 = 81/12 = more than 6 years pregnant

15 years breastfeeding

21 years eating for two

1 in 7 dead in childbed?

John Stuart Mill



British polymath:

- “It is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being.
- “They have enabled a greater population to live the same life of drudgery and imprisonment…”

Inequality & Distribution

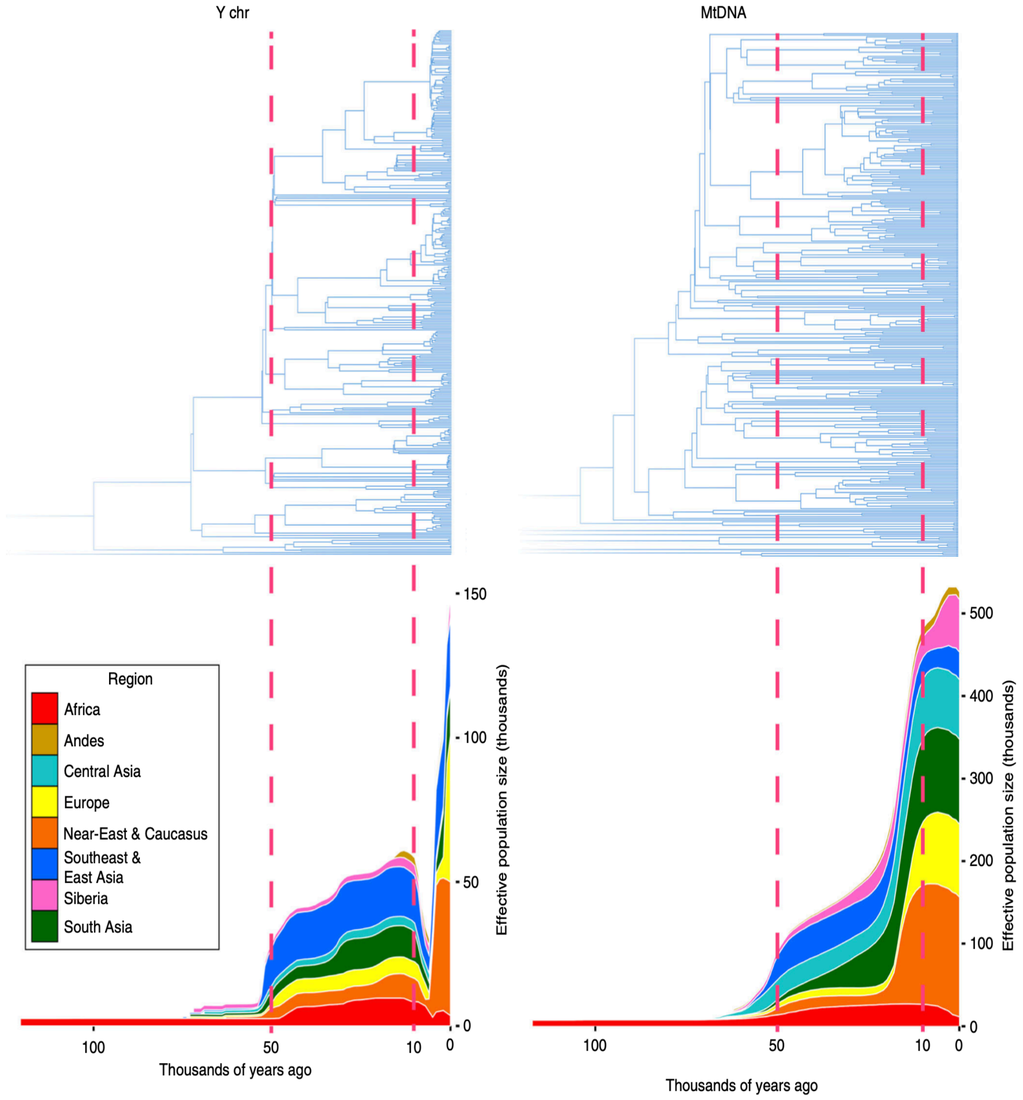


Fig. 1 Cumulative Bayesian skyline plots of Y-chromosome and mtDNA diversity by world regions. Reprinted from Karmin et al.[4] with permission from Monika Karmin and under a Creative Commons License (Attribution-NonCommercial 4.0 International)

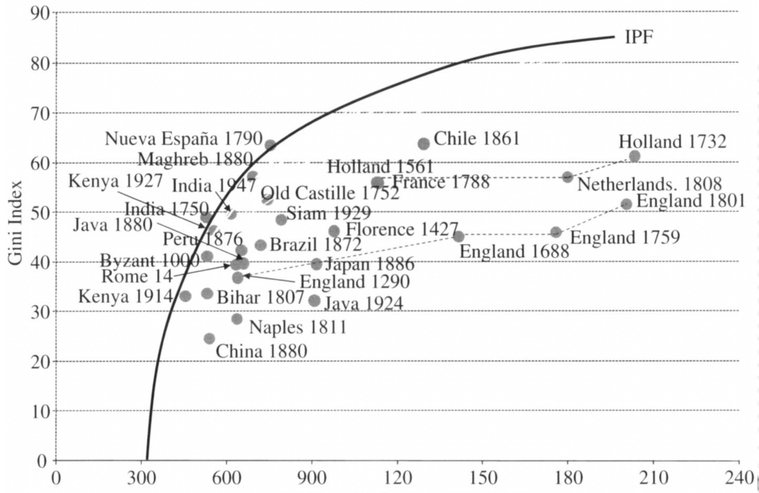
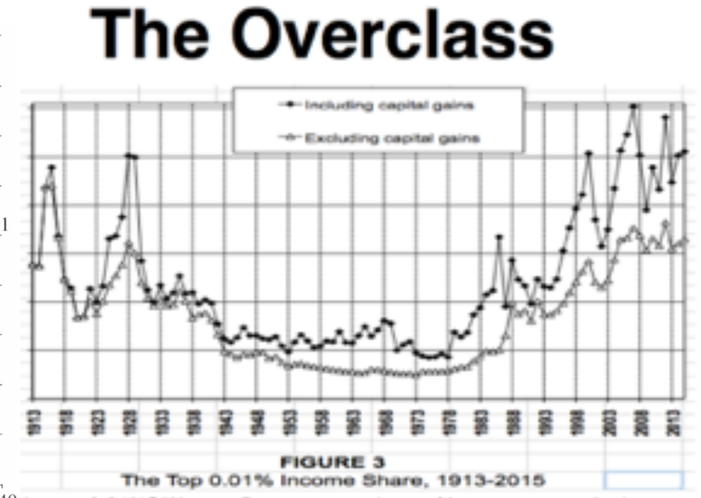
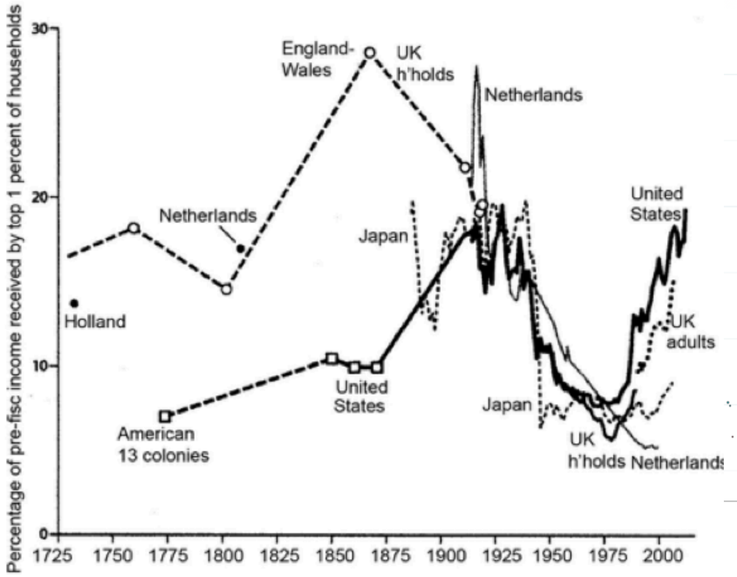
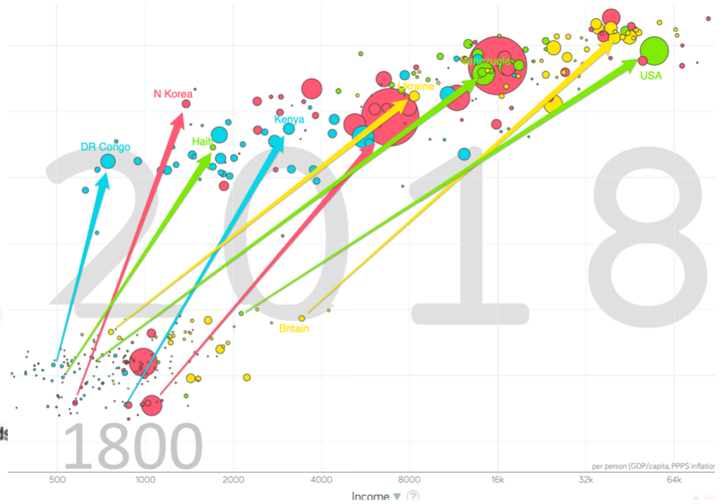


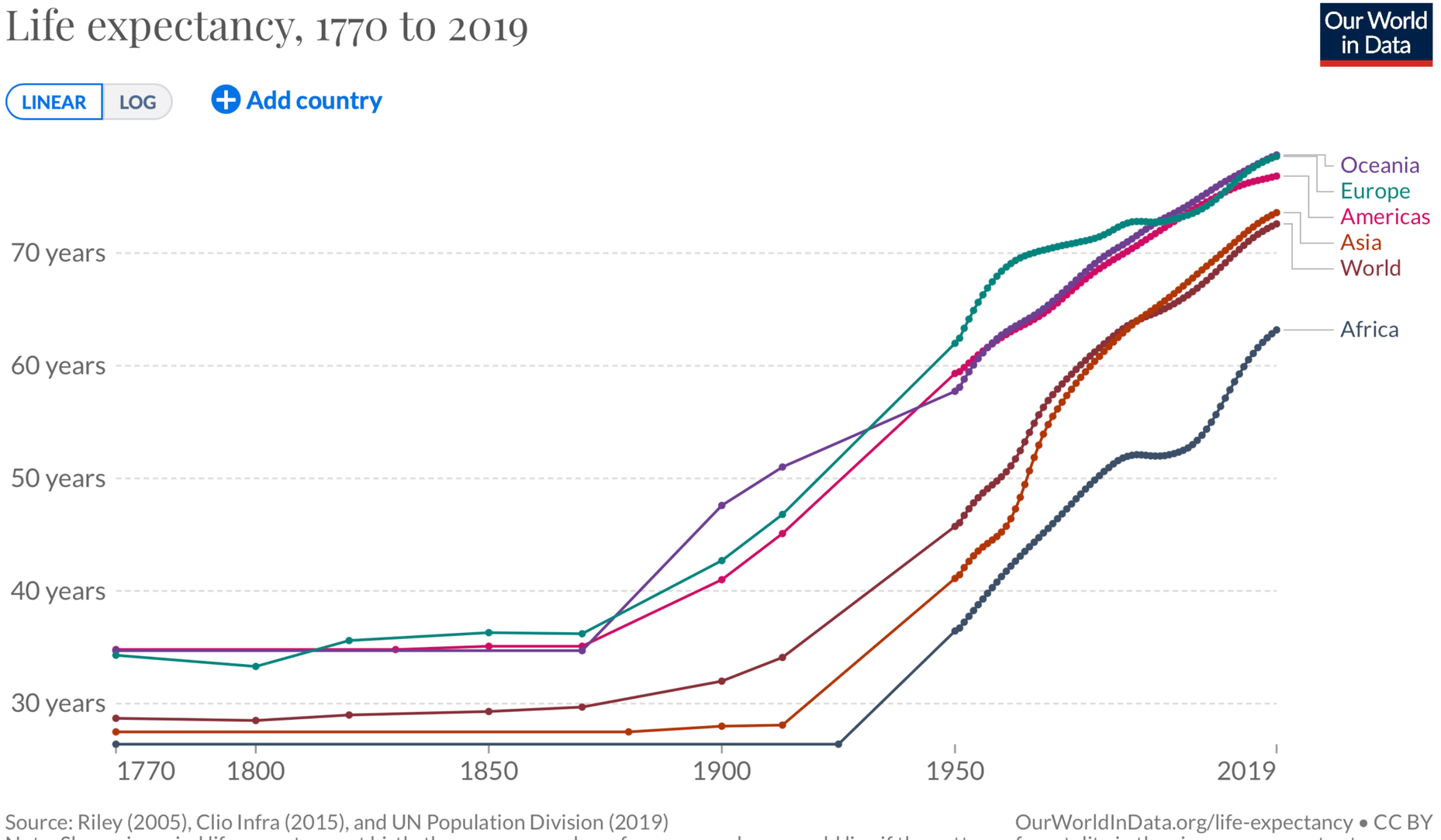
Figure 3 Income share received by the top 1%, four countries over







Artificial Means of Birth Control, Life Expectancy, & Female Literacy



- These things have great consequences for demography
- They trigger the "demographic transition"
- The fall in birth rates and the drive toward ZPG…

Diamond: Before the Neolithic Revolution

Date	Real Income/ Capita y	Popula- tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000	$1,200	2.04			
-6000	$900	5.09			
-4000	$900	10.5			
-3000	$900	15			
-1500	$900	37			
-1000	$900	50			
-400	$900	103			
150	$900	200			
800	$900	240			
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1500	$900	500			
1770	$1,100	750			
1870	$1,300	1299			
1930	$3,000	1909			
1975	$6,000	3678			
2020	$12,000	7566			
2100		10000			

- Guessing from skeletal heights alone
- A different Malthusian setpoint—life was more strenuous
- It's a jungle out there…
- Hence people as "unfit" as agrarian-age peasants would have been very likely to die…

And What Comes Next?

Date	Real Income/ Capita y	Popula- tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000	$1,200	2.04			
-6000	$900	5.09			
-4000	$900	10.5			
-3000	$900	15			
-1500	$900	37			
-1000	$900	50			
-400	$900	103			
150	$900	200			
800	$900	240			
1000	$900	296			
1500	$900	500			
1770	$1,100	750			
1870	$1,300	1299			
1930	$3,000	1909			
1975	$6,000	3678			
2020	$12,000	7566			
2100	$50,000	10000			

- Demographic transition
- Future here right now, but unequally distributed?
- How strongly is the engine of MEG still beating?

Total World Product

Date	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h
-8000	$1,200	2.04	$2.4		
-6000	$900	5.09	$4.6		
-4000	$900	10.5	$9		
-3000	$900	15	$14		
-1500	$900	37	$33		
-1000	$900	50	$45		
-400	$900	103	$93		
150	$900	200	$180		
800	$900	240	$216		
1000	$900	296	$266		
1500	$900	500	$450		
1770	$1,100	750	$825		
1870	$1,300	1299	$1,689		
1930	$3,000	1909	$5,727		
1975	$6,000	3678	$22,069		
2020	$12,000	7566	$90,794		
2100	$50,000	10000	$499,990		

- By 2100, 300x the real economy of 1870
- Have to go back to -6000 for an equivalent proportional leap
- We appear near the middle of a ***very, very*** special time
- The LORD willing and the creek don’t rise…

The Ideas Stock *H* & Its Growth Rate *h*

I define the worldwide value *H* of the stock of useful human ideas about manipulating nature and organizing humans invented, discovered, developed, deployed, and diffused—call it "technology", from τέχνη, *tekhne*, techniques or skills; and λόγος, *logos*, logic or rules—as:

$$H \propto y\sqrt{P} \text{ normalized to } H_{1870} = 1$$

Why $\sqrt{}$?

- Answers?

Total World Product

Date	Technological Ideas-Stock Growth Rate h	Technological Ideas Stock Level H (1870 = 1)	Average Annual Real Income per Capita y	Total Human Population L (millions)	Total Real World Income Y (billions)
-48000		0.0256	$1,200	1	$1.20
-8000		0.040	$1,200	2.5	$3.0
-6000		0.051	$900	7	$6.3
-3000		0.074	$900	15	$14
-1000		0.14	$900	50	$45
1		0.25	$900	170	$153
800		0.30	$900	240	$216
1500		0.43	$900	500	$450
1770		0.64	$1,100	750	$825
1870		1.0	$1,300	1300	$1,690
2010		19.6	$10,526	7600	$80,000
2100		118.4	$58,518	9000	$526,665

- Technology:
  - $H = y\sqrt{P}$
  - $H_{1870} = 1$
- Why the $\sqrt{}$?
- $H = yP \rightarrow$ labor doesn't matter
- $H = y \rightarrow$ resources per worker don't matter

Growth Rates *h*

Longest-Run Global Economic Growth

Date	Technological Ideas-Stock Growth Rate h	Technological Ideas Stock Level H (1870 = 1)	Average Annual Real Income per Capita y	Total Human Population L (millions)	Total Real World Income Y (billions)
-48000		0.0256	$1,200	1	$1.20
-8000	0.0011%	0.040	$1,200	2.5	$3.0
-6000	0.011%	0.051	$900	7	$6.3
-3000	0.013%	0.074	$900	15	$14
-1000	0.030%	0.14	$900	50	$45
1	0.061%	0.25	$900	170	$153
800	0.022%	0.30	$900	240	$216
1500	0.052%	0.43	$900	500	$450
1770	0.149%	0.64	$1,100	750	$825
1870	0.442%	1.0	$1,300	1300	$1,690
2010	2.125%	19.6	$10,526	7600	$80,000
2100	2.000%	118.4	$58,518	9000	$526,665

- Technology:
  - $H = y\sqrt{P}$
  - $H_{1870} = 1$
- Why the $\sqrt{}$?
- What alternatives?

Dangers of Excessive Quantification

John Maynard Keynes warned us against carrying this too far:

Approximate statistical comparisons depending on some broad element of judgment rather than of strict calculation… may possess significance and validity within certain limits. But the proper place for such things... lies within the field of historical and statistical description, and their purpose should be to satisfy historical or social curiosity... of a similar character to the statement that Queen Victoria was a better queen but not a happier woman than Queen Elizabeth—a proposition not without meaning and not without interest, but unsuitable as material for the differential calculus. Our precision will be a mock precision if we try to use such partly vague and non-quantitative concepts as the basis of a quantitative analysis...

Major Features

Date	Real Income/ Capita y	Popula- tion P (millions)	Total Income Y (billions)
-8000	$1,200	2.04	$2.4
-6000	$900	5.09	$4.6
-4000	$900	10.5	$9
-3000	$900	15	$14
-1500	$900	37	$33
-1000	$900	50	$45
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2100	$50,000	10000	$499,990

1. **The Neolithic Revolution** from -8000 to -6000
2. **The glacial pace of technological progress in the past**—1870 to 2010 we saw, in an average year, 200 times the *h* of the early Agrarian Age. (And, of course, growth from a much, much higher pace.)
3. Nevertheless, the **large cumulative magnitude of technological progress**.
4. **The acceleration of growth in the early Agrarian Age** -6000 to the year 1
5. **The Late-Antiquity Pause** from 1 (actually 150) to 800
6. **The Mediæval Recovery**
7. **The Imperial-Commercial Age** step-up in growth over 1500 to 1770.
8. **The British Industrial Revolution Age** from 1770 to 1870.
9. **Modern Economic Growth** from 1870 to 2010.
10. **The Population Explosion and Demographic Transition** from 1770 to 2100.
11. **Whatever is going on now**—if global warming and other problems do not interrupt Modern Economic Growth, what do we have to look forward to for the world of 2100?
12. **Is this a misguided intellectual enterprise**—focusing on H, and taking it to be something real and important rather than a distracting mental-fictional cloud-castle that does more to confuse than to enlighten us?

Aristotle: THE Philosopher

For, literally, millennia…

- "the master of those who know", as Dante called him…
- Interested in *everything*—except economic growth
- Scroll I of his *Politics*
  - "household management" = oiko-nomos = economics
  - In order: bossing slaves, raising children, directing your wife, knowing market conditions

And This Is the Lot of Humanity

Unless…

A household… [needs] property as instruments for living. And... a slave is living property.… If every tool could accomplish its own work, obeying or anticipating the will of others, like the statues of Daidalos, or the tripods of Hephaistos, which, says the poet Homer, “of their own accord entered the assembly of the Gods;” if, in like manner, the shuttle would weave and the plectrum touch the lyre without a hand to guide them, chief workmen would not want servants, nor masters slaves…

The Tripods [Self-Propelled Catering Carts] of Hephaistos…

Homer: “Thetis of the Silver Feet…”

Akhilleus Needs Weapons! And Mom Steps in:

Thetis of the silver feet came to the house of Hephaistos,
imperishable, starry, and shining among the immortals,
built in bronze for himself by the god of the dragging footsteps.

She found him sweating as he turned here and there to his bellows
busily, since he was working on twenty tripods
which were to stand against the wall of his strong-founded dwelling.
And he had set golden wheels underneath the base of each one
so that of their own motion they could wheel into the immortal
gathering, and return to his house: a wonder to look at.
These were so far finished, but the elaborate ear handles
were not yet on. He was forging these, and beating the chains out.

As he was at work on this in his craftsmanship and his cunning
meanwhile the goddess Thetis the silver-footed drew near him…

Guesses at Global Longest-Run Global Economic Growth

Date	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h			Population Growth n	Efficiency-Growth g
-8000	$1,200	2.04	$2.4	0.037	0.003%		Neolithic revolution	0.006%	0.000%
-6000	$900	5.09	$4.6	0.043	0.009%		**"Tribal" mode of production**	0.046%	-0.014%
-4000	$900	10.5	$9	0.062	0.018%		Final start of "urbanization"?	0.036%	0.000%
-3000	$900	15	$14	0.075	0.018%		Start of Bronze-Literacy age	0.037%	0.000%
-1500	$900	37	$33	0.117	0.030%		**Bronze-Literacy mode of pro**	0.060%	0.000%
-1000	$900	50	$45	0.136	0.030%		Start of Iron age	0.060%	0.000%
-400	$900	103	$93	0.195	0.060%		"Ancient" mode of domination	0.120%	0.000%
150	$900	200	$180	0.272	0.060%		High Antiquity	0.121%	0.000%
800	$900	240	$216	0.297	0.014%		Late-Antiquity Pause	0.028%	0.000%
1000	$900	296	$266	0.330	0.052%		**Feudal mode of production**	0.105%	0.000%
1500	$900	500	$450	0.429	0.052%		Commercial-Gunpowder-Empi	0.105%	0.000%
1770	$1,100	750	$825	0.643	0.149%		Imperial-Commercial Revolutio	0.150%	0.074%
1870	$1,300	1299	$1,689	1.000	0.442%		**Steampower mode of produc**	0.550%	0.167%
1930	$3,000	1909	$5,727	3.000	1.714%		**Second-Industrial-Revolutior**	0.641%	1.394%
1975	$6,000	3678	$22,069	9.000	2.269%		**Mass-Production mode of pr**	1.457%	1.540%
2020	$12,000	7566	$90,794	27.000	2.342%		**Global-Value-Chain mode of**	1.603%	1.540%
2100	$50,000	10000	$499,990	129.333	1.958%	?	Into the Future?	0.349%	1.784%

Glacial-Frozen Technology Before 1500

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Near-Stasis with “Efflorescences”

Near-Stasis with “Efflorescences”

The Ice Breaks After 1500

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150	$900	200	$180	0.272	0.060%		High Antiquity	0.121%	0.000%
800	$900	240	$216	0.297	0.014%		Late-Antiquity Pause	0.028%	0.000%
1000	$900	296	$266	0.330	0.052%		**Feudal mode of production**	0.105%	0.000%
1500	$900	500	$450	0.429	0.052%		Commercial-Gunpowder-Empi	0.105%	0.000%
[illegible]	$1,100	750	$825	0.643	0.149%		Imperial-Commercial Revolutio	0.150%	0.074%
1870	$1,300	1299	$1,689	1.000	0.442%		**Steampower mode of produc**	0.550%	0.107%
1930	$3,000	1909	$5,727	3.000	1.714%		**Second-Industrial-Revolutior**	0.641%	1.394%
1975	$6,000	3678	$22,069	9.000	2.269%		**Mass-Production mode of pr**	1.457%	1.540%
2020	$12,000	7566	$90,794	27.000	2.342%		**Global-Value-Chain mode of**	1.603%	1.540%
2100	$50,000	10000	$499,990	129.333	1.958%	?	Into the Future?	0.349%	1.784%

Explosion After 1870

Guesses at Global Longest-Run Global Economic Growth

Date	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h			Population Growth n	Efficiency-Growth g
-8000	$1,200	2.04	$2.4	0.037	0.003%		Neolithic revolution	0.006%	0.000%
-6000	$900	5.09	$4.6	0.043	0.009%		**"Tribal" mode of production**	0.046%	-0.014%
-4000	$900	10.5	$9	0.062	0.018%		Final start of "urbanization"?	0.036%	0.000%
-3000	$900	15	$14	0.075	0.018%		Start of Bronze-Literacy age	0.037%	0.000%
-1500	$900	37	$33	0.117	0.030%		**Bronze-Literacy mode of pro**	0.060%	0.000%
-1000	$900	50	$45	0.136	0.030%		Start of Iron age	0.060%	0.000%
-400	$900	103	$93	0.195	0.060%		"Ancient" mode of domination	0.120%	0.000%
150	$900	200	$180	0.272	0.060%		High Antiquity	0.121%	0.000%
800	$900	240	$216	0.297	0.014%		Late-Antiquity Pause	0.028%	0.000%
1000	$900	296	$266	0.330	0.052%		**Feudal mode of production**	0.105%	0.000%
1500	$900	500	$450	0.429	0.052%		Commercial-Gunpowder-Empi	0.105%	0.000%
1770	$1,100	750	$825	0.643	0.149%		Imperial-Commercial Revolutio	0.150%	0.074%
1870	$1,300	1299	$1,689	1.000	0.442%		**Steampower mode of produc**	0.550%	0.167%
1930	[illegible]	1909	$5,727	3.000	1.714%		**Second-Industrial-Revolutio**	[illegible]	1.394%
1975	$6,000	3678	$22,069	9.000	2.269%		**Mass-Production mode of pr**	1.457%	1.540%
2020	$12,000	7566	$90,794	27.000	2.342%		**Global-Value-Chain mode of**	1.603%	1.540%
2100	[illegible]	10000	$499,990	129.333	1.958%	?	Into the Future?	[illegible]	1.784%

And If We Go Further?

Guesses at Global Longest-Run Global Economic Growth

Date	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)	Ideas Stock Level H	Ideas Growth Rate h			Population Growth n	Efficiency-Growth g
-8000	$1,200	2.04	$2.4	0.037	0.003%		Neolithic revolution	0.006%	0.000%
-6000	$900	5.09	$4.6	0.043	0.009%		**"Tribal" mode of production**	0.046%	-0.014%
-4000	$900	10.5	$9	0.062	0.018%		Final start of "urbanization"?	0.036%	0.000%
-3000	$900	15	$14	0.075	0.018%		Start of Bronze-Literacy age	0.037%	0.000%
-1500	$900	37	$33	0.117	0.030%		**Bronze-Literacy mode of pro**	0.060%	0.000%
-1000	$900	50	$45	0.136	0.030%		Start of Iron age	0.060%	0.000%
-400	$900	103	$93	0.195	0.060%		"Ancient" mode of domination	0.120%	0.000%
150	$900	200	$180	0.272	0.060%		High Antiquity	0.121%	0.000%
800	$900	240	$216	0.297	0.014%		Late-Antiquity Pause	0.028%	0.000%
1000	$900	296	$266	0.330	0.052%		**Feudal mode of production**	0.105%	0.000%
1500	$900	500	$450	0.429	0.052%		Commercial-Gunpowder-Empi	0.105%	0.000%
1770	$1,100	750	$825	0.643	0.149%		Imperial-Commercial Revolutio	0.150%	0.074%
1870	$1,300	1299	$1,689	1.000	0.442%		**Steampower mode of produc**	0.550%	0.167%
1930	$3,000	1909	$5,727	3.000	1.714%		**Second-Industrial-Revolutior**	0.641%	1.394%
1975	$6,000	3678	$22,069	9.000	2.269%		**Mass-Production mode of pr**	1.457%	1.540%
2020	$12,000	7566	$90,794	27.000	2.342%		**Global-Value-Chain mode of**	1.603%	1.540%
2100	$50,000	10000	$499,990	129.333	1.958%	?	Into the Future?	0.349%	1.784%
2200	$447,821	10000	$4,478,208	955.651	2.000%	?		0.000%	2.192%
2500	$180,663,805	10000	$1,806,638,050	385537.29	2.000%	?		0.000%	2.000%

- We all know what exponential growth looks like…
- What does a "singularity" look like?
- Where does exponential growth logistic?
- And what about the "Great Filter"?

Last: Bob Rubin's Question

?

Something I have always found very useful:

- Ever since I first heard it back in 1993:
- What, at the end of the semester, will we wish we had done today?