Econ 135: Day 6: Slow Pre-Modern Technologica Growth

2023-02-06 Tu

In Everything Except Economic Growth, They Were Like Us

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1770	0.146%	0.694	$1,100	875	$963
1870	0.365%	1.000	$1,300	1300	$1,690
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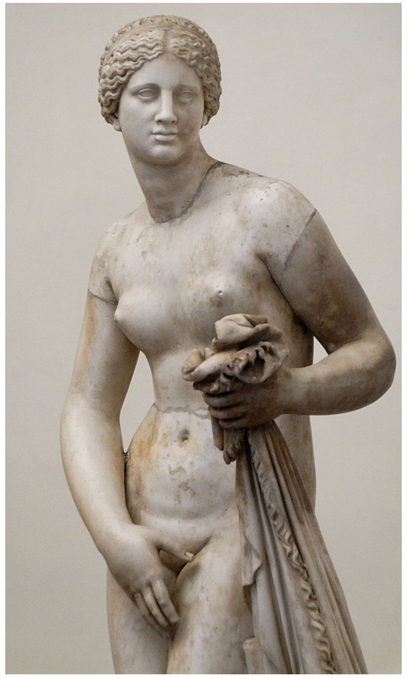
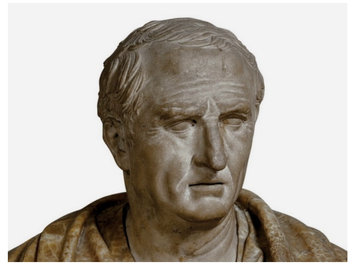
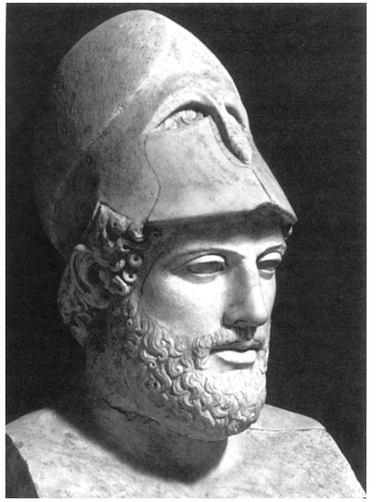
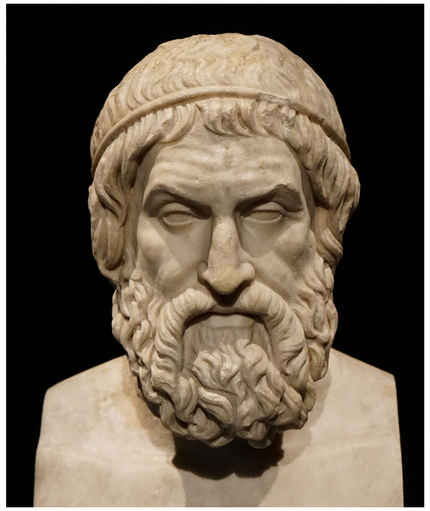
2200	2.000%	941.227	$369.453	10000	$3.694.528









They Even Appear “Like Us” in Technological Accomplishments: The Anti-Kythera Mechanism

What is this?

- Built between -150 and -70. Rhodes 13” x 7” x 4“ wooden box. Gears—largest 5” in diameter
- Wikipedia: “37 gear wheels enabling it to follow the movements of the Moon and the Sun through the zodiac, to predict eclipses and even to model the irregular orbit of the Moon, where the Moon's velocity is higher in its perigee than in its apogee. This motion was studied in the 2nd century BC by astronomer Hipparchus of Rhodes, and it is speculated that he may have been consulted in the machine's construction. The knowledge of this technology was lost at some point in antiquity. Similar technological works later appeared in the medieval Byzantine and Islamic worlds, but works with similar complexity did not appear again until the development of mechanical astronomical clocks in Europe in the fourteenth century…”

What is this?

- Brian Resnick:
  - “A main gear would move to represent the calendar year, and would, in turn, move many separate smaller gears to represent the motions of the planets, sun, and moon. So you could set the main gear to the calendar date and get approximations for where those celestial objects would be in the sky on that date….
  - You, as a user, could input a few simple variables and it would yield a flurry of complicated mathematical calculations.… All the user had to do was enter the main date on one gear, and through a series of subsequent gear turns, the mechanism could calculate things like the angle of the sun crossing the sky. (For some reference, mechanical calculators—which used gear ratios to add and subtract—didn’t arrive in Europe until the 1600s)…”
- The Antikythera Mechanism (7:50) <https://www.youtube.com/watch?v=UpLcnAIpVRA>
- The Antikythera Mechanism (1:48:50) <https://www.youtube.com/watch?v=xWVA6TeUKYU>

The Malthusian Trap: The Circle of Causation

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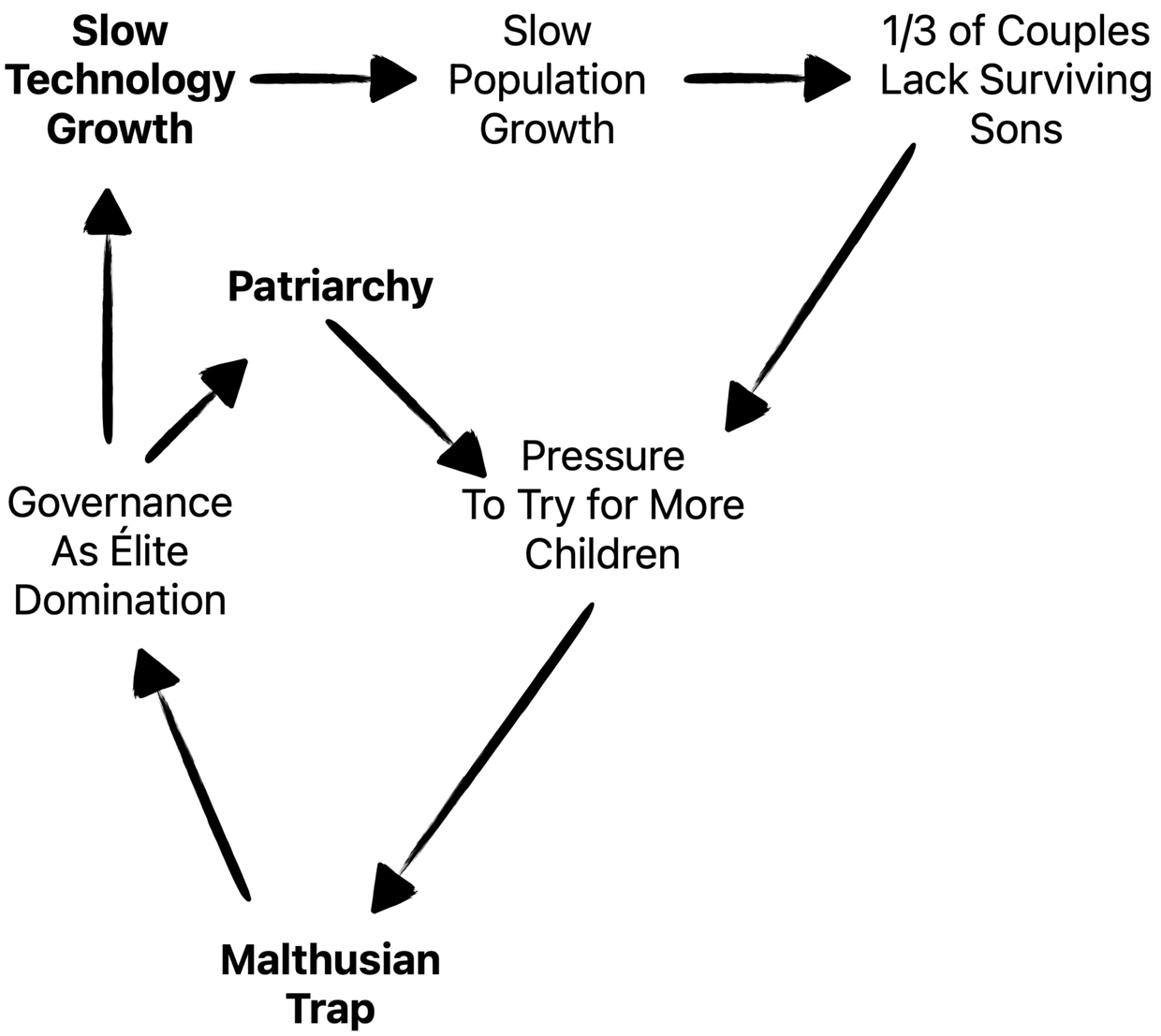
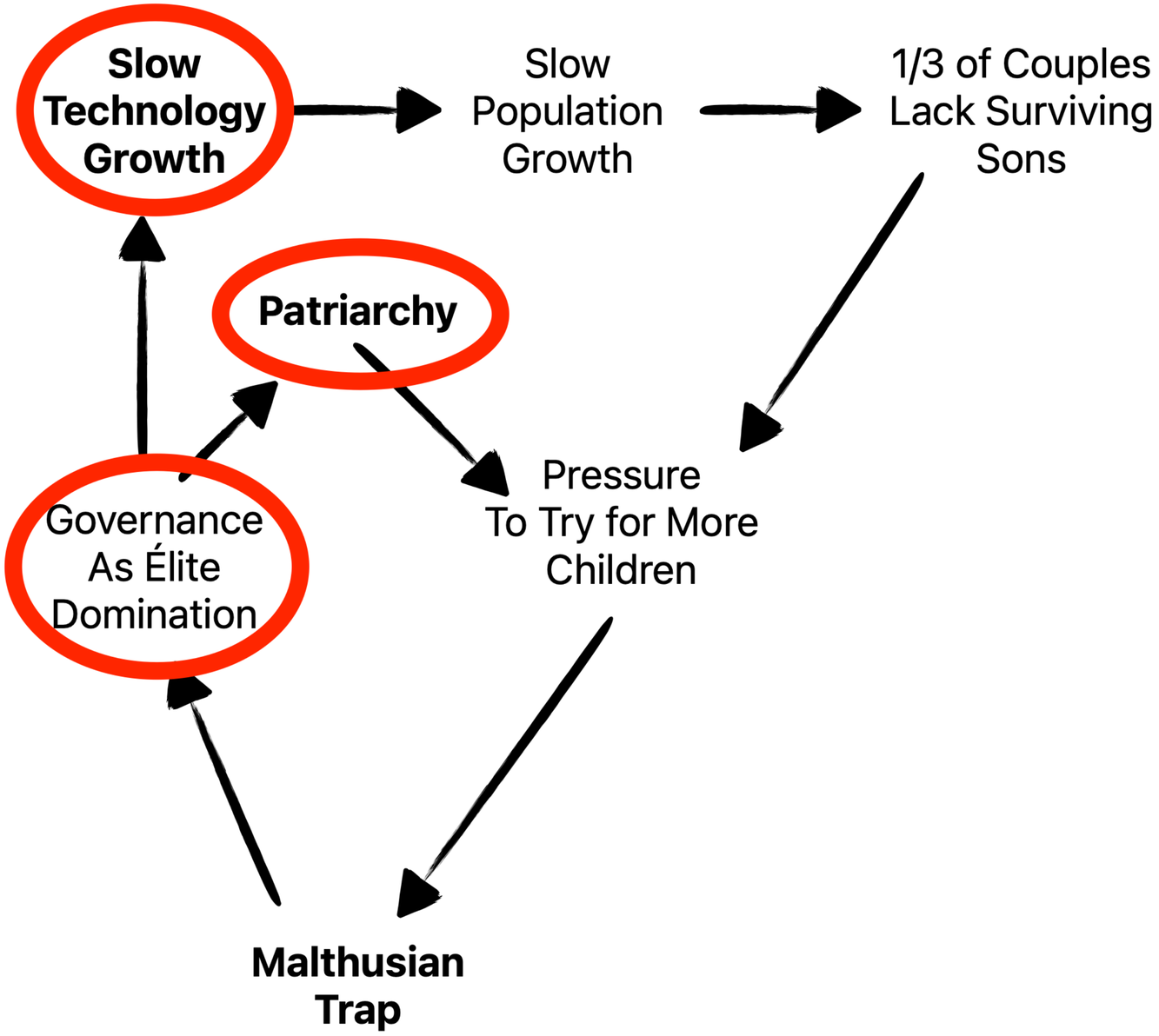


Points of Vulnerability?



How to Break the Malthusian Trap?

- Could governance be something other than elite domination?
  - Then those who directed society's energies could focus on something else than takiing and holding ***enough*** for themselves
- Could patriarchy lose its hold?
  - A clan-based daughter-friendly society would be one in which the pressure to try to secure a surviving sone would be greatly diminished
- Could technological growth be rapid?
  - Then the historical path to wealth and then the demographic transition could be opened up

Today We Focus on Slow Technological Growth

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What Are the Major Theories?

- Two-heads are better than one
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Jared Diamond, Paul Romer, Michael Kremer…

- Most commodities are *rival*—if I am using this computer, you can't be (at least not right now)
- Ideas are *non-rival*—write once, run everywhere
- Suppose that knowledge is cumulative—that each proportional gain in technological competence requires the same amount of thinking effort
- More brains to think means technological progress is faster
- How well does this do as a theory?

But It Falls Apart After 150…

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The Late-Antiquity Pause

- What is going on here?
- And what is the pace when we resume, after 800 or so?

Technologies of Communication and Discovery

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There Are Many…

- Brains
- More brains—two-heads-are-better-than-one
- “Cultural learning”
- Tools as reminders
- Language
- Settlement—inscribing knowledge and reminders on the landscape
- Animal domestication
- Property
- Gift exchange
- Multi-level hierarchy
- Accounting
- Writing
- Mathematics
- Metalworking
- Long-distance trade
- Empirical inquiry
- Ideas true about the world as opposed to ideas useful for solidarity or useful for exploitation
- Bureaucracy
- Law as force-multiplier for imperium
- Bellows
- Money
- Tinkering culture

These Make Things Much Worse…

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Growth Should Have Been Faster than Population!

- Picking the low-hanging fruit?
- Stepping-on-toes?

What Can the Late-Antiquity Pause Tell Us?

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In Combination with Human Achievements

- In art, architecture, politics, imperial organization, and so on
- Why are societies such delicate innovation machines?

More Technologies of Communication and Discovery

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There Are Many…

- Law as limit to imperium
- Professional judges
- Market-economy relations of production
- Gunpowder as a force-leveller
- Printing
- Globalization
- Peaceful competition as a major spur to innovation
- Limited yet powerful government—able to maintain its property-rights order against roving bandits, local notable, and its own functionaries
- Higher math
- Experimental method
- Science—”nothing via authorities”
- Steam engines
- Machine tools
- Industrial-research laboratories
- Modern corporations
- Really cheap globalization

Moses Finley's Theory

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- **Moses Finley**: *Technical Innovation and Economic Progress in the Ancient World* <https://delong.typepad.com/finley-technical.pdf>
  - "There was… technical…progress…. The range and quality of products were enhanced and standards of life rose, at least for the rich… A larger share of the total income was available for non-productive expenditure…
  - Intellectually (or scientifically) speaking, there was a basis for more technical advance-in production-than was actually made. Why did productivity then not advance markedly, if the interest, the knowledge, and the necessary intellectual energy would seem to have been present? The question cannot be dismissed simply by pointing to alternative values…

Finley on the Gap Between Other Civilizational "Accomplishments" and Technology-Driven Growth

- Finley:

  - It is a commonplace that the Greeks and Romans together added little to the world's store of technical knowledge and equipment. The Neolithic and Bronze Ages between them invented or discovered, and then developed, the essential processes of agriculture, metallurgy, pottery, and textile-making. With these the Greeks and Romans built a high civilization, full of power and intellect and beauty, but they transmitted to their successors few new inventions. The gear and the screw, the rotary mill and the water-mill, the direct screw-press, glass-blowing and concrete, hollow bronze-casting, the dioptra for surveying, the torsion catapult, the water-clock and water organ, automata (mechanical toys) driven by water and wind and steam-this short list is fairly exhaustive, and it adds up to not very much for a great civilization over fifteen hundred years…

  - The ancient world was very unambiguous about wealth. Wealth was a good thing, a necessary condition for the good life, and that was all there was to it. There was no nonsense about wealth as a trust, no subconscious guilt feelings, no death-bed restitutions of usury…

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Slavery & Exploitation Primary

- Finley:
  - The pejorative judgments of ancient writers about labour, and specifically about the labour of the artisan, and of anyone who works for another, are too continuous, numerous, and unanimous, too wrapped up in discussions of every aspect of ancient life, to be dismissed as empty rhetoric.... Tocqueville['s]... notebooks... are filled with the theme that 'slavery is even more prejudicial to the masters than to the slaves', because, as a leading Louisville merchant said to him, 'it deprives us of the energy and spirit of enterprise that characterizes the States that have no slaves'. Greek and Roman slavery functioned in a different context, to be sure, both internally and externally, and comparisons must be made with caution and reserve. But this particular one seems to me to be valid and necessary...
  - From the second century on, the emperors were faced with continuing difficulties and crises in supplies and revenues. They had good reason to think of more production. That, instead, they thought of more regimentation, of a bigger bite out of the old pie, seems to me explicable largely in terms of attitudes, of thought-processes...
  - Archimedes's practical inventions, I hasten to add, were military and were made only under the extraordinary and irresistible stimulus of the siege of his native Syracuse by the Romans…. Why did neither the Ptolemies nor the Sicilian tyrants nor the Roman emperors systematically (or even spasmodically) turn their engineers to the search for higher productivity, at least in those sectors of the economy which produced the royal revenues? Whatever the answer, it was not lack of capital (or lack of authority). Funds, manpower and technical skills were made available (and wasted) in vast and ever increasing amounts for roads, public buildings, water supply, drainage and other amenities, but not for production. Of course, the effort to increase productivity might have proved unsuccessful - but it was never even attempted…

Focusing on Increasing Production (as Opposed to Exploitation “Crude”

- Finley:
  - At the end of the first section of the Politics (I 258b 33ff.), [Aristotle] wrote as follows (in Barker's translation):
    - “A general account has now been given of the various forms of acquisition: to consider them minutely, and in detail, might be useful for practical purposes; but to dwell long upon them would be in poor taste…”.
  - Aristotle was the greatest polymath of antiquity, a tireless researcher, and the founder of any number of new disciplines in science and philosophy. His curiosity was unbounded, but 'good taste', a moral category, interposed to put beyond the pale knowledge in its practical applications except when the application was ethical or political….
  - Impossible as it is to lump the whole of ancient society into one generalization, it would not be far wrong to say that from the Homeric world to Justinian great wealth was landed wealth, that new wealth came from war and politics (including such by-products as tax-farming), not from enterprise, and that whatever was available for investment found its way into the land as quickly as it could….
  - The magnates drew large rents and profits from their estates… [and often] left the management and operation of their estates either to tenants or to slaves and slave bailiffs. In either case their psychology was that of the rentier, and hence neither their material circumstances nor their attitudes were favourable to innovation. They were not so stupid or so hide-bound that they could not abandon grain production for olive and vine cultivation or pasture when circumstances pressed them, or that they could not (sometimes) tell a better landed investment from a poorer one. But essentially their energies went into spending their wealth, not making it, and they spent it on politics and the good life...

Modes of Domination & Consumption, Not of Production

- On the larger issue David Hume saw the picture exactly, when he wrote:
  - “I do not remember a passage in any ancient author, where the growth of a city is ascribed to the establishment of a manufacture. The commerce, which is said to flourish, is chiefly the exchange of those commodities, for which different soils and climates were suited…”.
- Servile and other forms of dependent labour were very profitable. Such changes as occurred in the Roman Empire in the position of the wealthy were political, not economic, and therefore they had no significant incentive to alter the productive arrangements.
- In the end, it was the military and political breakdown of the Empire which drove the western aristocracy back onto their estates and to the beginnings of a manorial system…

Might Finley Be Wrong? Seneca vs. Posidonius on Whether Technology Is Philosophy

Lucius Annaeus Seneca Minor (64): *Moral Letters to Lucilius 90: On the Part Played by Philosophy in the Progress of Man*: 'That philosophy discovered the arts of which life makes use in its daily round I refuse to admit…. I, for my part, do not hold that philosophy devised these shrewdly-contrived dwellings of ours which rise story upon story, where city crowds against city, any more than that she invented the fish-preserves, which are enclosed for the purpose of saving men's gluttony from having to run the risk of storms….

Was it philosophy that taught the use of keys and bolts? Nay, what was that except giving a hint to avarice?… All this sort of thing was born when luxury was being born…

On another point also I differ from Posidonius, when he holds that mechanical tools were the invention of wise men…. Nay, the sort of men who discover such things are the sort of men who are busied with them…. The hammer [and] the tongs… were both invented by some man whose mind was nimble and keen, but not great or exalted; and the same holds true of any other discovery which can only be made by means of a bent body and of a mind whose gaze is upon the ground….

Which man, pray, do you deem the wiser—the one who invents a process for spraying saffron perfumes to a tremendous height from hidden pipes, who fills or empties canals by a sudden rush of waters, who so cleverly constructs a dining-room with a ceiling of movable panels that it presents one pattern after another, the roof changing as often as the courses,—or the one who proves to others, as well as to himself, that nature has laid upon us no stern and difficult law when she tells us that we can live without the marble-cutter and the engineer, that we can clothe ourselves without traffic in silk fabrics, that we can have everything that is indispensable to our use, provided only that we are content with what the earth has placed on its surface? If mankind were willing to listen to this sage, they would know that the cook is as superfluous to them as the soldier….

Posidonius then passes on to the farmer…. This trade also, he declares, is the creation of the wise,—just as if cultivators of the soil were not even at the present day discovering countless new methods of increasing the soil's fertility!… He even degrades the wise man by sending him to the mill…. Posidonius came very near declaring that even the cobbler's trade was the discovery of the wise man….

Not so; these early inventions were thought out by no other class of men than those who have them in charge to-day. We know that certain devices have come to light only within our own memory… windows which admit the clear light through transparent tiles,.. baths with pipes let into their walls for the purpose of diffusing the heat… marble… rounded and polished masses of stone…. Or our signs for whole words, which enable us to take down a speech, however rapidly uttered, matching speed of tongue by speed of hand?

All this sort of thing has been devised by the lowest grade of slaves…

Other Theories

What are the possibilities here?:

- No puzzle—given how few heads they had, and given the absence of printing and the difficulty of controlled experiments, it is a miracle that they managed to advance technology as far as they did as fast as they did…
- No: there was something wrong. They had the wrong kind of society…
- No: something went wrong: civilization seems to be progressing up to the year 1… 0.013%/yr… 0.030%/yr… 0.061%/yr… & then it stalls out: instead of doubling to a Commercial Revolution rate of growth after the year 1, the rate of ideas growth more than halves…

Temin:

- "The high ratio of wages to energy costs was… absent in eighteenth-century continental Europe… [and] in the Roman Empire…. There was no possibility of escaping from the Malthusian constraints with the price ratios that existed then. However prosperous Rome may have been, it was not on the verge of having an Industrial Revolution. There was no analog of the British coal industry in antiquity…
- "The decline of the Roman Empire led to a decline of both land taxes and land ownership. The growing chaos Wickham described precluded both activities. A better frame would have been to say that the society changed from one based on taxes to one based on personal service. What does it mean to own land if taxes on the land no longer sustain a government? Feudalism was the way out of this chaos. It is best seen as a way to organize defense in a violent world. There was not enough security for a central government to collect taxes and field a military force, and all action had to be local…"

Ober:

- "There is a body of classical literature that exemplifies the scorn for money-making that was emphasized by the Finley school… an essentially timeless and changeless ancient economy predicated on violent extraction and gift exchange…"
- "For Finley and his school, social status remained foundational; any activity that was not grounded in status, and in the power relations thought to inhere in status relations, was, consequently, unmoored and ephemeral…. Economic activity aimed at increasing productivity, innovations aimed at increasing efficiency, and increased consumption… were, thereby, rendered more or less invisible…. The result was, so I suppose, both a misunderstanding of the relevant texts and a misrepresentation of the underlying social reality…"
- "Plato, Xenophon, and Aristotle… figure prominently…. While scorn for trade and commerce can indeed be found outside the philosophical corpus, absent the Socratic[s]… what 'Greek literature' has to say about economic activity… [is] different…"

Temin

Era	Population	Technology Growth	Growth per Billion
Late Agrarian	0.25	0.05%	0.20%
Imperial-Commerical	0.6	0.15%	0.25%
British Industrial	0.9	0.44%	0.49%
Modern Economic Growth	3.5	2.1%	0.60%

- The decline of the Roman Empire led to a decline of both land taxes and land ownership. The growing chaos Wickham described precluded both activities. A better frame would have been to say that the society changed from one based on taxes to one based on personal service. What does it mean to own land if taxes on the land no longer sustain a government? Feudalism was the way out of this chaos. It is best seen as a way to organize defense in a violent world. There was not enough security for a central government to collect taxes and field a military force, and all action had to be local…

Josiah Ober

- “There is a body of classical literature that exemplifies the scorn for money-making that was emphasized by the Finley school… an essentially timeless and changeless ancient economy predicated on violent extraction and gift exchange…”
- “For Finley and his school, social status remained foundational; any activity that was not grounded in status, and in the power relations thought to inhere in status relations, was, consequently, unmoored and ephemeral…. Economic activity aimed at increasing productivity, innovations aimed at increasing efficiency, and increased consumption… were, thereby, rendered more or less invisible…. The result was, so I suppose, both a misunderstanding of the relevant texts and a misrepresentation of the underlying social reality…”
- “Plato, Xenophon, and Aristotle… figure prominently…. While scorn for trade and commerce can indeed be found outside the philosophical corpus, absent the Socratic[s]… what ‘Greek literature’ has to say about economic activity… [is] different…”

I Cannot Really Referee This Fight—Either Fight…

Readings:

- **Willem M. Jongman** (2007): *Gibbon was Right: The Decline and Fall of the Roman Economy* <https://delong.typepad.com/jongman-gibbon-was-right.pdf>
- **Moses Finley**: *Technical Innovation and Economic Progress in the Ancient World* <https://delong.typepad.com/finley-technical.pdf>
- **Peter Temin**: *The Roman Market Economy,* Roman Growth <https://delong.typepad.com/files/temin-roman-growth.pdf>
- **Josh Ober** (2019): *Agamemnon's Cluelessness*, selections <https://delong.typepad.com/files/ober-agamemnon-selections.pdf>

Date	Ideas Growth Rate h	Ideas Stock Level H	Real Income/ Capita y	Popula-tion P (millions)	Total Income Y (billions)
-73000				0.01	
-68000		0.0082	$1,200	0.1	$0.12
-48000	0.002%	0.011	$1,200	0.2	$0.24
-30000	0.003%	0.018	$1,200	0.5	$1
-8000	0.005%	0.057	$1,200	5	$6
-6000	0.003%	0.061	$900	10	$9
-4000	0.007%	0.070	$900	13.23	$12
-3000	0.007%	0.074	$900	15	$14
-1500	0.030%	0.117	$900	37	$33
-1000	0.030%	0.136	$900	50	$45
-400	0.060%	0.195	$900	103	$93
150	0.060%	0.272	$900	200	$180
800	0.007%	0.285	$900	220	$198
1000	0.078%	0.333	$900	300	$270
1500	0.062%	0.467	$1,000	480	$480
1770	0.146%	0.694	$1,100	875	$963
1870	0.365%	1.000	$1,300	1300	$1,690
1930	1.793%	3.000	$3,000	2100	$6,300
1975	2.256%	9.000	$6,000	4000	$24,000
2020	2.282%	27.000	$12,000	7800	$93,600
2077	1.939%	81.000	$33,173	9311	$308,857
2100	1.939%	127.381	$50,000	10000	$500,000
2200	2.000%	941.227	$369.453	10000	$3.694.528