Notes on the collapse of complex societies

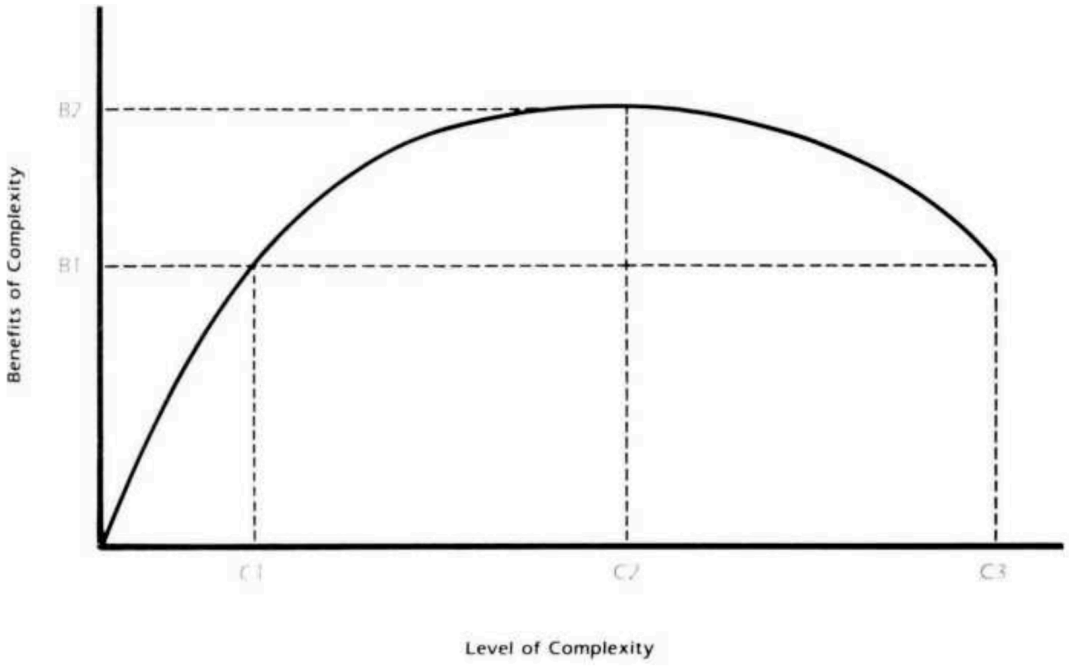


Fig. 19. The marginal product of increasing complexity.

This chart sums up the thesis of the book, but it's mislabeled. It's the benefits of complexity vs level of complexity, not the marginal product of increasing complexity. The marginal product of complexity would be the derivative of this function, which would look like a monotonically decreasing function that at some point goes from positive to negative.

The core thesis of the book is that:

1. There are returns to increasing the complexity of a society. "Complexity" is a Nebulous term here as it is elsewhere; some things that increase complexity include more layers of hierarchy, more specialization of people's roles, more different kinds of physical artifacts (eg. specialization of tools).[1]
2. Societies deal with external stresses by increasing complexity. There are consistently external stresses creating pressures for societies to move to the right. The larger the shock/stress, the more "benefit" you need to create to offset it.
3. The benefits of complexity vs. a society's level of complexity is concave — that is, it looks like an upside-down U. That means that when you first start increasing the complexity of a society, the marginal return to more complexity is positive. As you increase complexity, the

[1] I found the number of different types of artifacts as a proxy for complexity particularly thought provoking. Today, we interact with thousands? Millions? Of different kinds of physical things. A thousand years ago, people might have only interacted with order hundreds or less.

amount of benefit you get for the same amount of additional complexity decreases. At some point, additional complexity actually has *negative* effects.
4. Societies stagnate when additional complexity brings small or negative benefits.
5. Because societies are consistently under stress, they can't just stay in equilibrium at the point where increasing complexity provides no additional benefits. This leads to one of two situations:
    1. The society faces a slow collapse because of the build up of stresses. People on the periphery slowly peel off because it actually benefits them to have less complexity.
    2. The society encounters a shock (draught, invasion, etc) that it cannot deal with because it cannot derive enough benefit by increasing complexity to deal with the shock.
6. New 'energy subsidies' can change the shape of the benefit-complexity curve and make it so that there is more benefit you can get while increasing complexity. These 'energy subsidies' are poorly defined, but via examples take the form of gold looted for the Roman Empire or new sources of energy in modernity.

Maybe an even shorter summary is "diminishing marginal returns dominate everything around us." A large amount of the book is devoted to debunking other theories of societal collapse and going into case studies that support the marginal returns to complexity theory. These are fascinating — few sources draw parallels between the rise and fall of societies in North America and the Romans — but mainly served the purpose of convincing me that Tainter's theory has legs.

There's an undertheorized/implicit core to the theory around the relationship between energy (in the physics sense), resources, and moving along the complexity-benefit curve. Tainter notes the phenomenon that at high levels of complexity societies find themselves increasing taxes with diminishing benefits, incurring the ire of the population. Tying this phenomenon back to the curve means (potentially) that the wealth from taxes are (ultimately) going towards buying more energy which is required to support higher levels of complexity.

You need more energy to support higher levels of complexity because higher levels of complexity involve more people and resources going towards things that don't directly address threats and increase quality of life: specialists, coordination, managers, information exchange, etc. Tainter alludes to this, but I'm not sure he says this directly. Making it explicit is important for a reason I'll get to in a bit.

There are many obvious parallels that jump out between the doomed past societies and our own: crumbling infrastructure, frustration from increasing taxes with little visible benefit, increasing numbers of specialists, the equivalence between the Romans getting a huge load of gold from conquering the east and the modern use of fossil fuels, etc. Drawing these parallels is not new, nor does Tainter ignore either the parallels or the reasons that people have given for why the parallels no longer hold.

The relatively modern phenomenon of R&D is a big reason why people think that the "societal physics" that caused collapse in the past no longer hold. However, Tainter points out that R&D has had diminishing marginal returns since before WWII, suggesting that it is subject to the same

declining marginal returns to complexity as the rest of society. (Yes, this ties into Bloom et. Al./ are ideas getting hard to find etc.)

I think all of this all bottoms out in some ideas that are both mundane and profound (and could *maybe* be more concisely expressed in equations): increasing the amount of good stuff we have and dealing with bad stuff at a societal level requires energy. Turning that energy into good stuff and anti-bad stuff is mediated by resources and societal complexity; we need complex systems and resources to both create the energy and deploy it. As we increase the amount of energy that our society can deploy, we also need to increase the complexity of our society. Increasing complexity, however, creates more "friction" in the system. Similarly, for any given source of energy, acquiring more of it is increasingly expensive. However, if you can change the amount of energy you get for a given unit of complexity, you can continue to get benefits from increasing complexity.

There are a bunch of things that the book leaves frustratingly fuzzy (I'll list some of them but I think that ultimately they don't undermine the core thesis nor really affect my big conclusions):

- What does "benefit" actually mean? As Tainter points out, many people actually live better lives after the collapse of a complex society than before. There some hand wavy gesture towards "civilizational accomplishment and average well-being" but it's frustratingly vague and someone with more a more populist might use the fact that societal benefit does not directly translate to individual benefit to attach the whole theory. I'm inclined to accept the assumption that more benefit on the benefit-complexity curve is Good.
- What is the relationship between energy and other resources? Tainter points to the Roman acquisition of conquered foreign wealth as the same as a new source of energy. This makes sense because for most of human history, most energy came from human or animal sources, so energy was directly downstream of land and money a society controlled. (I think he may have addressed this and a breezed past it.)

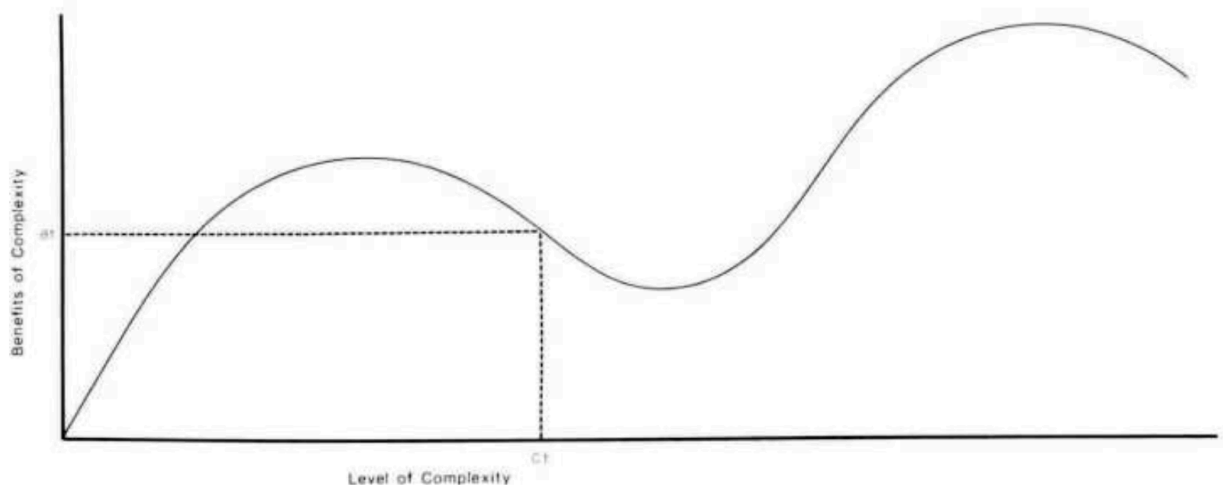
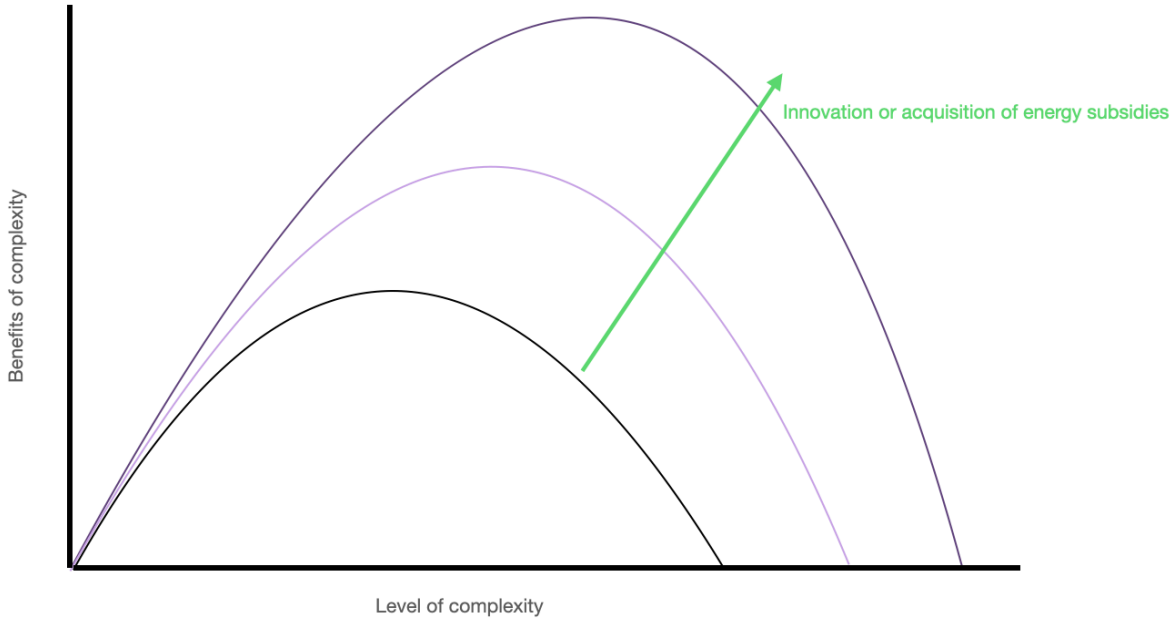


Fig. 20. The marginal product of increasing complexity, with technological innovation or acquisition of an energy subsidy.

- Is the graph above correct, or does creating an innovation or acquisition of an energy subsidy actually change the shape of the curve? (like the graph below) Eg. This graph implies that a new technology actually inverts decreasing returns on complexity, whereas my understanding is that you still have decreasing marginal returns on complexity but energy subsidies keep the curve from inverting longer.



- What counts as a new energy paradigm?

If we accept the thesis, which I do find compelling, there are three important actionable possibilities:

1. Find a new energy paradigms that can enable us to shift the benefit-complexity curve.
2. Figure out ways of either increasing benefit without increasing complexity or decreasing complexity without decreasing benefit.
3. Prepare for an inevitable collapse because of our complexity and what will come after it.

1. Find new energy paradigms and subsidies

I'm already incredibly biased towards efforts to make energy orders of magnitude cheaper, but this thesis makes it an existential imperative.

A corollary is that not all R&D is created equal. If indeed new energy sources are the only thing that can shift the curve, most R&D actually just goes towards figuring out new ways of moving up the curve. Only R&D that contributes to new energy paradigms can actually shift the curve.
There are some related questions here: is energy actually the only technology that can shift the benefit-complexity curve? Or has it just been energy historically? Eg. Would the invention of general-purpose robots be able to change the tradeoff between societal complexity and benefits in a

similar way? Yes, robots need energy, but they might be able to break correlations between benefits and other things the way the discovery of fossil fuels broke the connection between land and energy. Even more pragmatically, organizations like ARPA-E shouldn't be dicking around with marginal gains, it should be going full bore on anything that even has a shot of making energy cheaper by an order of magnitude. Similarly, politicians should be desperately removing any barriers to cheaper energy.

2. Cheat the curve

The book left me wondering: **Why is it impossible to reduce complexity without reducing benefit?** At a sub-societal level you see several instances of reform that reduces complexity while actually making institutions in eg. various militaries. It seems like there should be other interventions which can (locally) mold the shape of the benefit-complexity curve.

It's absolutely my bias, but a corollary is that reducing complexity/avoiding increasing it where we can do it without reducing benefits is an existential imperative. Concretely, that means both fighting tooth and nail against unnecessary bureaucracy and process at a societal level and building more "robust" technologies that don't rely on complex supply chains.

There's also the question, **are there other ways of generating "benefit" besides increasing complexity?** I find the argument that the answer here is "no" a bit more compelling because of the preponderance of decreasing marginal returns across the board.

3. Prepare for collapse

As Tainter alludes to — perhaps the preppers are right. However, beyond a few contingency plans, I'm not going to spend a lot of my attention on this one. Both because other people have given it far more thought and because I'm an optimist and am not yet ready to give up.