Limits to Growth

Why the Only Solution is“Less”

Sheet 8

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The Laws of Thermodynamics cannot be changed – if we don't have the energy we need we are unable to carry out the work we want to. Consequently, as we face a peak in global energy supply, there is only one realistic option: We have to use “less” energy, and consume “less” resources.

The origins of economic growth

We might think that economic growth, purely for its own sake, was a trend that developed with the modern market system. This is not the case. “Gross Domestic Product” (or GDP) growth was first used as a measure by the US economist Simon Kuznets in 1929. In the UK, the pursuit of GDP growth as a matter of policy was enacted by the Conservative Chancellor Rab Butler's budget of 1954.

Along with growth, the 1950s and 1960s also saw the rise of debt as an important part of both national and personal finance. The development of *fractional reserve banking*, where banks lend more money than the”real” money that they hold, became an important part of this process. This is significant because it marks the departure between the “tangible” growth of economies based on the production and the use of goods, and the introduction of “intangible” economic instruments to drive growth and raise profits.

The Conflict with Thermodynamics

Ultimately growth must hit some sort of ceiling – it cannot continue indefinitely. This is because the *Law on the Conservation of Matter and Energy* makes it clear that the amount of energy and/or matter (since, in terms of relativity, they are much the same thing) is constant – you can't make something out of nothing (unlike fractional reserve banking). The *First Law of Thermodynamics* means that, in an isolated system such as the Earth (“isolated” because there's no prospect of obtaining additional energy and resources from elsewhere in the universe), the ultimate ceiling will be when the human species can no longer grow its energy supply. Clearly, Peak Energy is this point in time since, once oil and gas production peak, there are no more dense sources of energy for us to use.

Of course, as politicians make clear, the solution to thermodynamic, or resource, limits is to become more efficient. But the evidence from the recent past suggests that this does not happen in practice because the rate of efficiency seldom equals the overall rate of growth. Where significant advances do generate large efficiency gains the evidence from studies over the last two centuries suggest that these efficiency savings just increase the rate of growth, and energy consumption. For example, Britain has become more efficient in its use of energy and resources since the 1950s, but in that time actual consumption has grown by a factor of two (or, if we take account of the change in efficiency, it's nearly a factor of four).

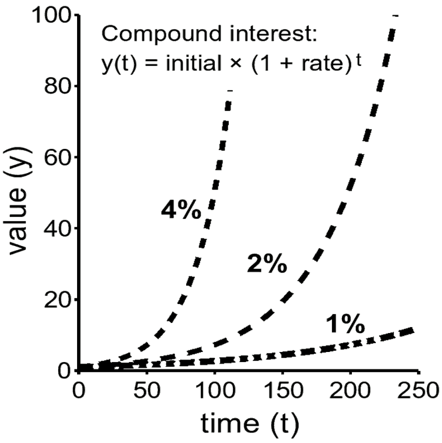
There have been three major developments in the study of the conflict between growth and efficiency. They show that efficiency, against a background of economic growth, does not reduce consumption:

- *Jeavon's Paradox* (1830s) – Jeavon discovered that more efficient stream engines led to more coal being used in more/larger engines;
- *Rebound Effect* (1960s) – the discovery by various economists that the financial benefits of efficiency savings are re-spent buying more “stuff”, so re-consuming any savings of energy or resources made by the efficiency measures;
- *Khazzom-Brookes Postulate* (1980s) – the greater efficiency, e.g. information and communications technology, results in cheaper services and the greater use/consumption of those services.

For these reasons efficiency will never deliver a saving of energy or resources. In any case, the *Second Law of Thermodynamics* limits what efficiency measures can achieve, and how they operate over time:

- *Efficiency measures can only take place once* – when the market has become saturated with an efficiency measure, e.g. an efficient fridge, there will be no further

Fig. 1. Change & Growth



In mathematics, growth is the change in the value of a quantity based upon its initial value. An example of a growth function is compound interest where the amount of money will grow faster year-on-year.

Where growth takes place at a fixed (or average) rate the value will double over a the same period of time (the “doubling time”). For example, at a growth rate of 1% the value will double every 70 years; at 2% the value will double every 35 years; a 4% 17.5 years; etc.

The problem is that large changes in consumption can occur even at low growth rates. As politicians strive for GDP growth in the region of 2% to 3%, economic activity doubles every 20 to 30 years, and energy consumption grows at a half to two-thirds this rate.

savings delivered (growth takes over again); and

- *Each successive efficiency gain generally produces less of a saving than previous ones* – this is because it becomes harder to save the same amount of energy with each improvement as the decline in the difference between the work done and the energy consumed creates a thermodynamic barrier to further reductions in consumption.

If the measures that economists use to reconcile economic growth and Thermodynamics do not work, the only logical conclusion is that at some point economic growth must hit a ceiling, at which point it must cease – then the system will be forced to change.

Overshoot – *When Growth Fails*

Ultimately the activity in our economic system is powered by energy, which is produced from a small number of very energetic fuel sources such as – oil, natural gas, coal and uranium. We are now approaching a point in time when, most likely in the next one to two decades, just over half of our current global energy supply (the oil and gas) reaches a peak in production and then declines.

However, what if we switched to other energy sources, such as renewable energy? Could that allow economic growth to continue? To answer this point let's conduct a "thought experiment" (see figure 2). We'll take the level of energy consumed by the world, the USA, and the UK, and assume that their energy needs continue to grow for the next 1,000 years as they have done for the last three decades.

As growth multiplies the energy consumed the level grows quickly: The world would exceed the theoretical production of renewable energy within 200 years; within 350 years the USA would require the global production of renewable energy just for itself; in 700 years the US would need an amount of energy equivalent to the entire solar energy radiated onto the planet each year; in 1,000 years, the world would require the entire solar energy output of the Sun.

Clearly, this isn't going to happen – apart from the fact that harnessing the levels of energy depicted is impossible, we'd run out of another critical resource long before. The Earth does not have an inexhaustible supply of many other critical commodities – fuels/energy are just one of these limited resources.

At the moment we are using energy to solve resource problems – by pumping water long distances, or ferrying wood and food around the globe. What Peak Energy means is that we just won't have the cheap, plentiful energy to do this any more. Eventually, one critical limit or another will be breached and we will be unable to compensate for this loss. The problem today is that energy depletion and climate change are accelerating this process by drawing the critical limits – such as water, farmland or fish – ever tighter. At this point a collapse will be unavoidable. This, in population ecology, is termed *overshoot*, and the effects are always catastrophic on the species concerned. The only way to avoid an enforced contraction following overshoot is to begin, voluntarily, a planned "descent" ahead of the depletion trend.

Accepting Thermodynamic Reality

The modern, growth-oriented market system is strong because, like the Internet, it is a distributed, anarchic system. There is no one weak point within this system, no control room, no ruling council. This means that it is able to withstand large amounts of damage without necessary failure (e.g., North Sea oil production falls... "let's just import it!").

Due to the complexity of this anarchic system we cannot predict precisely when we will reach overshoot: The Club of Rome's report, *Limits to Growth: The 30 Year Update*, makes it clear that overshoot and collapse will happen around the latter half of this century unless we actively work to avoid it through a global programme of contraction.

The fact is that because economists, and the politicians who laud them, cannot reconcile their philosophy within the Laws of Thermodynamics at some point a collapse is inevitable. What we have to do is understand this, accept it, and then act to end the "growth delusion".

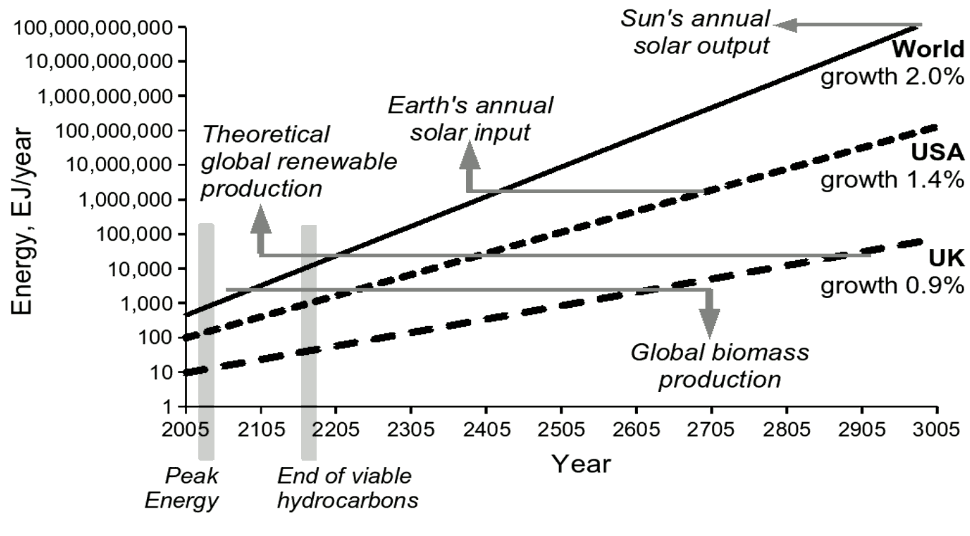


Fig.2.The "Illogical" Conclusion of Growth

In order to illustrate the growth in energy consumption for the next 1,000 years we have to use a graph with a logarithmic scale – in order to turn the exponential curve into a straight line.

This allows us to see that, in terms of scale, the idea of constant growth is nonsensical – there will simply be insufficient energy to power growth beyond this century.