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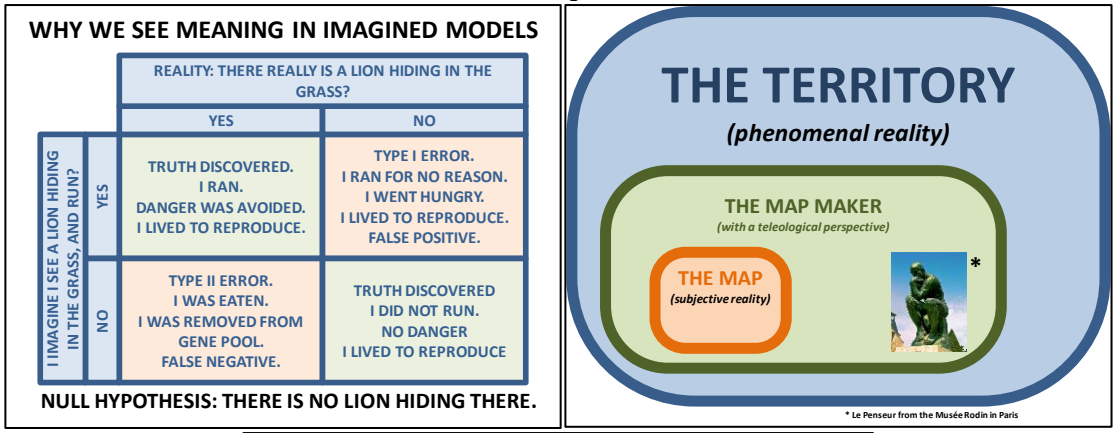
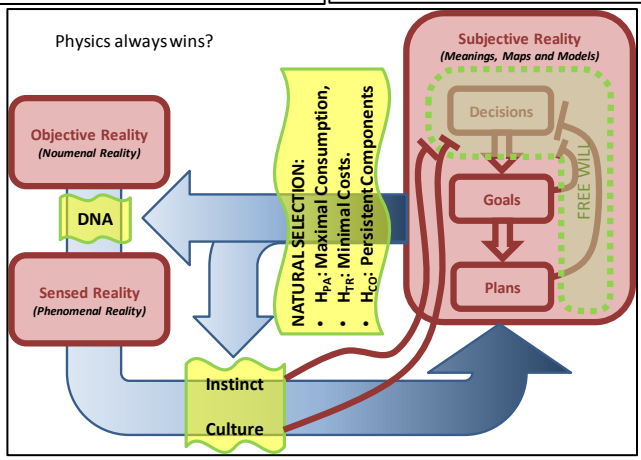
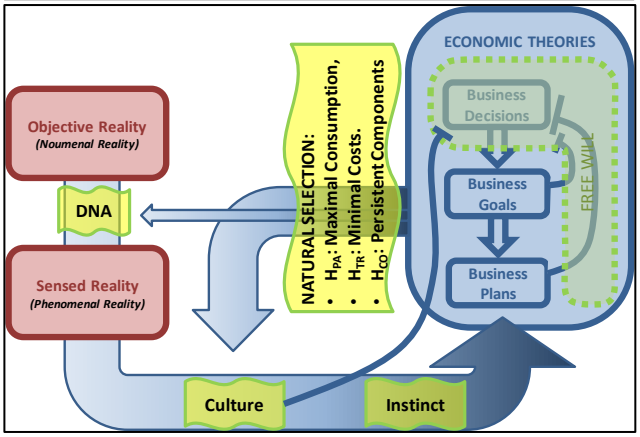
On Reconciling Economic Theory and Science

Frontispiece







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2 - Purpose and Approach

The purpose of this diary note is to explore my thoughts around the philosophical foundations of economic theory, its apparent resistance to inroads from scientific inquiry, and scientific methods and tools that might be appropriate to the study of economic theory.

My approach is, unfortunately, slightly circuitous, though I see no easy way to simplify it:

- I start in section 3 by briefly describing how I have dissected and re-assembled Odum's Maximum Power Principle (MPP) with specific roles and specific names for each part, as per my Ref A unfinished paper. This is necessary preamble to what follows.
- Then in section 4 I describe briefly the problem with modern economic theory, as I see it, and as written about by others, and I raise three questions. These questions are all closely inter-related, and one cannot be answered without easy reference to the other, so I take a spiral approach, addressing each question twice:
  - In section 5 I address each question once briefly, and
  - In sections 6 through 8 I address each a second time in more detail with reference to previously written notes and other sources.

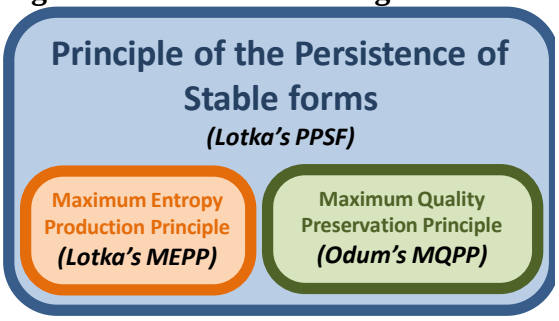
3 - Re-Imagining Odum's Maximum Power Principle (MPP)

Ref A is an as-yet unfinished paper in which I dissect Odum's MPP, identify the roles of each part, give each part a new name for discussion purposes, and re-assemble it. More extensive discussion of Odum's MPP is in my diary notes listed in the Ref B document. Refs C and D are especially pertinent to this note. I hope that, in this note, I can make the MPP more accessible to mathematical models. Here is a brief summary of the re-assembled MPP, as described in detail in Ref A.

I see Odum's re-imagined MPP as having three interlocking dynamic mechanisms:

- **Maximum Entropy Production Principle (MEPP)** – Alfred Lotka (1880-1949) proposed his version of the MPP in 1922b (see Ref E) calling it the "principle of maximum flux". In that paper, he argued that all system-wide energy pathways (whether physical, ecological, social or economic) evolve to capture and degrade matter and energy at ever faster rates, until all appropriate sources of matter and energy are depleted. In my Ref A paper I designate this as Lotka's MEPP.

Figure 01 – Odum's re-imagined MPP



- **Maximum Quality Preservation Principle (MQPP)** – The second piece of the re-imagined MPP comes from a paper by Howard T. Odum (1924-2002) and Richard C. Pinkerton in which they focused on energy transfer events, such as organism-to-organism energy transfers (see Ref F). In that paper they argued that such energy transfers evolve to conserve free energy and transfer that still-useful energy at a maximum rate. That is, energy transfers evolve to preserve the quality of the energy and maximize the power of the high-quality energy as it passes from step to step along an energy pathway. At Ref A I

have designated this piece Odum's MQPP. In my NTFs at Ref C and D I have proven (to my own satisfaction, at least) that the MQPP applies to all flows of benefits, whether in the form of energy, of cash, of land or of any other sufficiently-well conserved quantities, and that it therefore plays a significant in the dynamics of all economies.

- **Principle of the Persistence of Stable Forms (PPSF)** – In a second paper, published concurrently (Ref H) Lotka proposed that Darwin's ideas about natural selection be separated from his theory on the origin of species and be elevated as a general principle which could be applied, not just to organisms and species (as Darwin had done), or to energy pathways (as Lotka had proposed in his first paper), but to all varieties of persistent forms (Lotka 1922b). He called this expanded umbrella version of natural selection the "principle of the persistence of stable forms" which I designated as Lotka's PPSF. In Figure 01 it is shown as enclosing Lotka's MEPP and Odum's MQPP, because natural selection works differently for each, but is an essential over-arching stochastic mechanism that causes these two anti-thetic dynamics to work together, creating and/or removing complexity from systems as probability demands.

The MEPP and MQPP operate to provide a fitness criterion for persistent forms at different hierarchic levels, as does Darwin's theory on the origin of species (TOS). Darwin's TOS is, of course, the theory in which natural selection was first described, but Lotka saw natural selection as separable, and more widely applicable. There are three hierarchic levels of persistent forms, and all three can be found in reference to any energy pathway, from the biochemical energy pathways in single-celled organisms to the biosphere-wide energy pathways in global systems. I have developed a shorthand for reference to the three hierarchic levels:

- Darwin's TOS operates at the level of components (CO) of the pathway, e.g. organisms in a trophic web – designated H_{CO};
- Odum's MQPP operates at the level of energy transfers (TR) between components, e.g. between organisms in a trophic web – designated H_{TR}; and
- Lotka's MEPP operates at the level of the complete energy pathways (PA), e.g. the pathways through a trophic web – designated H_{PA}.

Within the biosphere there are many hierarchies of sub-systems, and these three types of hierarchical level occur over and over again at many scales, all acting and interacting under the ministrations of Lotka's PPSF.

H.T. Odum wrote extensively about the MPP over the course of his long and productive career. Out of deference to his long-standing conviction that these ideas all worked together and were exceedingly important, I have re-designated the entire complex of sub-principles Odum's (re-imagined) MPP. However, Odum did not apparently distinguish between the actions of these different pieces, and that caused me great confusion for some time. I suspect that it may also cause confusion with others since they may not be aware that I have recast it as three sub-principles. But for the purposes of the Ref A paper and this note, it works for me.

Darwin's TOS does not come into the remaining discussion in this note. From here on, I leave out the word "reimagined" when mentioning Odum's (reimagined) MPP, as I intend it as the default meaning of Odum's MPP.

With a focus on energy flows, setting aside the effects on organisms themselves, we get this

antithetic behaviour:

- H_{TR} – At the level of the transfers of energy along an energy pathway, Odum's MQPP dominates – a maximum amount of still useful energy is passed through each transfer event, and the production of entropy is minimized.
- H_{PA} – But at the level of the pathway itself, Lotka's MEPP dominates, a maximum amount of energy is captured at the head of the chain, and consumed as thoroughly as possible throughout the length of the chain, and the overall production of entropy by the system is maximized.

It is the conflicting action of these two energy flow dynamics that provides the varieties of forms of energy transfers and energy pathways upon which Lotka's PPSF can work. Lotka's PPSF determines which of those many forms of energy transfers and energy pathways will be stable, and persist.

Both Lotka and Odum proposed that this complex of dynamic interactions was applicable to all physical systems through which energy flows. I would extend that and propose that it also applies to logical systems that have certain qualifying characteristics. For example I can see these dynamics in action in my agent-based models – models which exist only as stochastic logical constructs in computer memory. I would posit that Odum's (re-imagined) MPP is active in any system in which (a) a group of agents (b) have shared access to (c) a conservative resource (d) of limited supply. I argue in my Ref D NTF that a conservative resource need not be absolutely conserved, but merely sufficiently-well conserved. The universal applicability (as argued in Ref C) of Lotka's MEPP and Odum's MQPP means the MPP incorporates the universal fitness criteria for all dynamic systems that exhibit persistent self-replicating behaviour when provided with a stream of potential benefits. This would include economic and financial systems.

Throughout the rest of this diary note I talk about being aligned with the effects of Odum's MPP. I define those effects here: The autonomous and ubiquitous effects of Odum's MPP are:

- To preferentially select for **enhanced** effect and **persistence**, at each level of the hierarchy, system components that **promote** increasing transfer-level parsimony and system-level profligacy, and by this means structure and complexity are **added** to the system;
- To preferentially select for **reduced** effect and **removal**, at each level of the hierarchy, system components that **prevent** increasing transfer-level parsimony and system-level profligacy, and by this means structure and complexity are **removed** from the system.

Example: When we look back on history, the effects of the MPP can be seen in the rise and fall of industries. There was a time when the fabrication of wagons and carriages was raised to a high art, when oat-burning horse-drawn vehicles were the most efficient means to move goods about. With the invention of the Newcomen engine (circa 1712) , wood-burning and coal-burning steam engines replaced the horse-drawn carts. With the invention of the internal combustion engine (circa 1859), and the distillation of oil into gasoline, modern automobiles replaced steam engines. The economy aligned itself with the effects of the MPP: first to increase the power and usage of steam-powered devices, and then, to decrease their usage again. At each step, the total throughput of the economic system, in terms of energy and matter, was increased.

4 - Considering Science and Economics – Three Questions

When considering modern global economic problems, one must ultimately conclude with Hall and Klitgaard that modern orthodox economic theory is not based on science, nor is it aligned with modern science (see Ref H). As part of the great 15th century European intellectual awakening now called the Renaissance, as the study of philosophy, art and architecture blossomed, so did the study of politics, commerce, and natural philosophy. It was in Italy that Galileo Galilei laid the first planks in the platform that we now call the scientific method (Ref F). Over time, each incipient branch of natural philosophy that distinguished itself and emerged sought to incorporate the scientific perspective into their studies and apparently adapted the techniques of science to its own peculiar circumstance. One can now distinguish different variations of the scientific method for almost every major academic discipline. There are those scientific methods that can be used directly in the laboratory, such as was used by the initial researchers in physics and chemistry. But, there are adaptations for those academic disciplines for which experiments are not repeatable in the lab. These would include cosmology, history, meteorology, evolutionary theory, paleontology, taxonomy, health sciences and even the social sciences, of which the study of economics should be a part. While most of the then incipient branches of the Renaissance-era study of natural philosophy have since embraced science, it would appear that the study of economics has wandered off like an orphaned child estranged from its cultural roots. It is difficult to find evidence of an accepted scientific method that has been used by mainstream orthodox economists to undergird the multiplicity of economic laws that have been proposed, accepted, and used in support of the modern practice of economics and politics.

On the other hand, it is not difficult to find small groups of heterodox economists who strive to establish some science-based inroads. A few forms of such science-based heterodox economic theories that come to mind are environmental economics, ecological economics, behavioural economics, econophysics, and, finally, the theories with which I associate myself most closely, biophysical economics. But, unfortunately, the goals and opinions of such heterodox economists are often ignored, underfunded, and marginalized at best, or even ridiculed, attacked and purged from the halls of research and teaching institutions. The needed scientific research is not undertaken. This is particularly troubling when one considers that our contemporary politicians and world leaders who are in control of global affairs take their advice from the coterie of orthodox economists who would seem to regard science as little more than a tool to make profits.

This raises three questions for me:

- Why is economic theory and practice so resistant, or impervious, to all attempts to bring it back into the fold of modern science-based investigation;
- What would be the characteristics of an effective scientific method for economic systems;
- What would be a phenomenon-based framework for the application of the very potent and sophisticated modern “systems science” to this dynamic system that we call the global economy.

Over the past six years I have developed personal opinions on all three of these questions. I am starting to come to the conclusion that they cannot be answered one-at-a-time. The answer to

each question has implications for the others, and the solution of each needs to be envisaged as part of a single answer to a complexity of problems that have made economic theory impervious to science.

In retrospect, I can say that virtually all of my diary notes written during this study of economics (see Ref B) are trying to address these three questions in some fashion. It would be impossible to effectively summarize those hundreds of pages of diary entries in this one note, but I need a summary to proceed, so I must do it ineffectively.

4.1 - What About a Scientific Method for Economics?

While the three questions as outlined above are in the order in which they logically arise, and build one upon the other, I find I must address the second question before I can comment on the first.

On consideration of the purpose and value of a scientific method for the study of the dynamics of an economy one must consider why the scientific method first arose as a method of seeking out the truth, what it replaced, and what it defended against. The major part of this diary note tries to examine these issues, but I summarize it here, briefly, just to get the ideas on the table. The scientific method first arose because, in the 14th century, due to the work of many European investigators, it became clear that the revered work of many ancient authorities was, at worst, wrong, and at best, badly misunderstood. The continued unquestioning acceptance of their revered opinions stood in the road of discovering the truth about the nature of the world. One of these ancient scholars, Aristotle (384–322 BC) wrote a treatise about motion (see Ref E). But the interpretation of Aristotle's theory of motion, which had been received wisdom for roughly 1,800 years, was shown by Newton and his immediate antecedents to be absolutely wrong – stating the exact opposite of the truth (see Refs F and G). So, rather than careful reading of the ancient texts, scholars of the day decided to read of the book of nature directly, and resorted to experiments, careful measurements, published verbal, mathematical and physical models, and open public debate.

Aristotle is regarded by many to be the first secular philosopher to use teleological explanations of causes. What, precisely, is a teleological explanation, and why is it a problem? In the case of Aristotle, his theory of motion could be interpreted as follows. Objects prefer to be stationary. It is in the nature of moving objects to slow down and come to a stop. A teleological explanation answers the question "Why?" with the answer "Someone, or something, wants it to be that way". The root concepts of teleological explanations include desires, plans, goals, uses, needs and purposes. The implication is that a person-like being acts or intervenes and causes the effect, at its choice. It becomes necessary to project personages, and ascribe motives to those personages, and that is always a guessing game. The ancient Greeks just loved to project personalities onto all inscrutable phenomena. Time was the god Cronos. Space was the gods Gaia (earth) and Uranus (sky). Love was the goddess Venus. The gods' desires were volatile, their plans inscrutable, their decisions arbitrary, and their wills always in conflict. The will of the gods, or some subset of them, was the ultimate explanation for all unanswered "why" questions about reality. Every observed effect can be questioned with "Why?", and every "Why?" answered with a cause. I view this as climbing a ladder of causes and effects until you come across the ultimate inscrutable cause, and the climb ends. The problem with such teleological explanations

is this: they bring an abrupt end to all lines of enquiry, and the ladder can too easily contract to a single rung. "The will of the gods" trumps all answers, and enquiry becomes futile and non-instructive.

In contrast to that, the question "How?" leads to the building of models and maps, the conjecture of ways and means, and avoids the need to ascribe personages and motives to anybody or anything. Mother nature can be viewed not as a woman who tends us, but as a relentless process to be understood.

The non-teleological explanations of nature that were developed in this way in the Renaissance era were often in disagreement with one ancient text in particular – the Bible. That, and the apparent effort of scientists to avoid using God's will as a simple teleological answer, caused many political and religious leaders of the day to consider this dependence on experiment to be godless and evil. In other words, as part of their goal to abandon dependence on the untested opinions of ancient authorities, they sought to replace the teleological arguments of both ancient secular scholars and contemporary biblical scholars with the non-teleological arguments of science. This explicitly intended aversion to teleological explanations was an important root cause of the emergence of the scientific method, and a troubling ongoing aspect of modern science.

This opposition of religious authorities in the 15th to 17th centuries has set up a continuing false opposition of scientific explanation versus vs teleological explanation, as if (a) science can have only a limited role in social studies involving people able to have motives or purposes and to express free will (giving rise to teleological explanations), and (b) teleological perspectives can have no role in science. However, if we look at commercial language we see that teleological arguments are at the core of modern economic theory. It uses the language of utility functions, consumer demands, business plans and national and global economic goals. These are all coming from a teleological perspective.

The purpose, then, of a scientific method tailored to deal with economic theory would be:

- To enable and encompass a study of the dynamics of systems that are substantively teleological in their presentation; and
- To discover a phenomenological (empirical) foundation upon which economic theory can be based, and to then reframe our economic knowledge, winnowing the grains of truth from the basket of economic laws currently seeking recognition.

The second bullet would let me segue into the third question, but I need to return to the first question before I go there.

4.2 - Why is Economic Theory Impervious to Science?

On consideration of the question of the apparently successful resistance of economic theory to inroads by practitioners of natural philosophy and science, I have come up with a theory that I am calling "Teleological Pruning".

This is, in itself, based on my opinions about how Odum's MPP works, which I explained above. As I said there, both Lotka and Odum proposed that this complex of dynamic interactions was

applicable to all physical systems, and I extend that to commercial and financial systems.

So, my answer to the second question goes like this. Those economic theories, practices, purposes, plans and decisions that do not align with the long-term effects of Odum's MPP are not selected for continuance and so decline in use, lose adherents, wane in power and effect, and eventually drop away and cease to exist. Those that do align with the long-term effects of Odum's MPP are selected for continuance and so rise in use, gain adherents, wax in power and effect, and eventually rise to dominance. Capitalism, augmented by globalization, is currently the dominant form of commercial activity largely because it is perfectly aligned with the effects of Odum's MPP and has been selected naturally by the operation of Lotka's PPSF. Those economic theories that augment the power of Capitalism get funding, gain adherents, and dominate in the university curricula. Those that would in any way tend to harness or impede the consumptive power of the global economy are not aligned with the effects of Odum's MPP and fail to attract support. They are not selected for continuance by Lotka's PPSF.

I call this effect "Teleological Pruning" (or TP, for short), for lack of a better name at the moment. The plans and purposes of our global political and commercial leaders are continuously and relentlessly pruned to align with the effects of Odum's MPP. The theories and models of our best economic thinkers are continuously and relentlessly pruned as well. I know of at least one instance in which corporate leaders explicitly and successfully called for a culling of economic theories and theorists from American universities. In the 1970s, in response to the "Powell Memorandum", the economic faculties of the universities were purged of heterodox economists who did not support the expanding role of big business (see Ref L). And just so, modern economic theory (which incorporates globalization theory) is (a) very much in line with the effects of the MPP; and (b) very much divorced from any science-based understanding of why things are the way they are, and how to control and fix the global problems.

Where, one might ask, does TP fit into the picture shown in Figure 01. I talked about Lotka's PPSF being applied to organisms (for Darwin's TOS) to energy transfer mechanism (for Odum's MQPP), and to energy pathways (for Lotka's MEPP). I am now applying Lotka's PPSF to ideas, cultural practices, and shared beliefs and belief systems. Our collective intellectual perspective is pruned relentlessly to conform to and align with the effects of Odum's MPP.

Darwin's TOS endows us with false positive patterns and interpretations, as long as those are not an impediment to the effects of the MPP. The appearance and rise to dominance of science worked to remove a collection of false beliefs that had become an impediment. Now, science has itself become a partial impediment, and the MPP, in the form of TP, is doing battle with science, keeping it subdued and a servant of commerce. I will refer to these culture-shaping effects of the MPP the MPP/TP.

4.3 - A Phenomenon-Based Framework for Economics?

It would be unreasonable to imagine that there is some aspect of the dynamics of economies functioning around the world that has not been carefully and thoroughly examined. Consider these two facts:

- There are an estimated 23,000 degree-granting universities around the world, most having economics departments, all collectively churning out hundreds of thousands of PhD degrees

per year. Among those hundreds of thousands of theses there must be hundreds of degree-worthy theses written on various aspects of economic theory.
- I understand that a typical annual economics conference in the US has 10,000 attendees and hundreds, if not thousands, of papers presented.

So, why would I imagine that there are important aspects of our economies being overlooked. I would argue that it is all a matter of perspective. Without having a real understanding of how fundamentally teleological systems work, and how TP would affect their development, we cannot know for sure whether there are giant blind spots that the practitioners themselves are unable to see. Perhaps a different perspective will provide deeper insights not available so far.

With those thoughts in mind, I start with the work done by heterodox economists so far and try to find a parallel in those fields in which science has proven its worth – such as physics, chemistry, biology, and ecology. I have worked out some of these ideas in more detail in other notes (see my SOAK at Ref B). I admit that I did not always realize that I was working on this larger alternate framework at the time the notes were written, but it seems that is what I was doing.

The short description of the process for developing such a framework is like this:
- Find a well-developed branch of science that is associated with similar dynamic systems; and
- Develop an understanding of how economic systems are the same as those classic systems for which the sciences were originally developed, and make adjustments to the science to get deeper insight into economics.

That is a deceptively simple concept, but not easy to do. Because it appears so simple, reductionists are likely to shrug it away, as I would have done years ago. But, there is a tenuous thread of hope that I have held onto, and I really do think there is reason to continue to hope. There seem to be two well-developed branches of science that offer such hope:
- One source of hope is the now-classical science of thermodynamics, and the other is the recently emerging (1930s to present) field of study called "systems science" which includes conceptual threads that have gone by several names in recent decades (ergodics, catastrophe theory, chaos theory, network theory, and complexity theory).
- The other is the somewhat schizoid branch of science having two faces: classic thermodynamics, and statistical thermodynamics.

These two branches of science overlap significantly. An economy is very clearly a thermodynamic engine in the classic sense, and is clearly a stochastic system, so I have no doubt whatsoever that thermodynamics, in both classic and statistical versions, is applicable. At the same time, it is clear to me that an economy is a perfect example of a complex adaptive system (CAS), of which the biosphere is the other perfect example. So, we have a CAS operating within another CAS, closely interlinked and doomed to share the same ultimate future. This is ripe territory for inroads using systems science.

My modeling of sustainable societies has led me to look at thermodynamics. Over the past 200 years, or so, the science of thermodynamics has been developed in two versions. Classical thermodynamics tends to work with macroscopic variables, and is particularly practical in civil

and mechanical engineering and in other large-scale applications. Statistical thermodynamics is more esoteric, more statistical, and tends to be more useful in studies of material science, condensed matter physics, cosmology and similar branches of science. However, as noted previously, Lotka and Odum both believed that economies are simply large-scale thermodynamic engines that consume fuel and do work. So, 200 years of scientific discovery can be applied to this economic engine to better understand how it functions. That was the inspiration that has led me to writing the Ref D NTF.

I would see a new branch of science developing that we might call "econodynamics" (if the name has not already been used) which takes some inspiration directly from thermodynamics. There would be a classical version dealing with macro-level variables, and a statistical version dealing with the micro-level economic behaviour of people. Much of the modern economic theory would need to be re-framed in terms of conservations laws, entropy production, and the aligning effects of Odum's MPP. This would go into macro-econodynamics. But some economic theory would be discarded. Much of the research that has gone into social behaviour, marketing, social traps, and effective illusions would go into the micro-econodynamics, or statistical econodynamics.

The absolute laws of conservation of mass and energy would find a parallel form in macro-econodynamics as the law of sufficient conservation of capital (mass, energy, cash, land). The 2nd law of thermodynamics would find a parallel form in the law of economic entropy production (affecting disproportionate distributions of wealth, access to energy, and social power) or something like that. The complex of principles discussed above in section three in reference to Odum's MPP and TP would provide the insight into how and why economies grow, and how and why they collapse.

There is no aspect of economic theory that I can think of that would not fit into this framework. But, there are lots of topics for research that this framework provides that are not, to my knowledge, currently being researched. That would be the main benefit of such a reframing, but it would also put economic theory within reach of scientific research.

5 - Why is Economic Theory Impervious to Science?

So, now I return to question number one. Why is economic theory impervious to inroads from science? In section 4.2 I gave my answer which can be summarized. Science eschews teleological explanations, and economic theory is fundamentally expressed in teleological language – i.e. language that is used in teleological explanations.

As always, that answer to a "Why?" leads to another question "But why, then, is economic theory necessarily expressed in such teleological language?" It is the answer to THAT question that I intend to address in this section.

5.1 - Science Without Teleological Explanations

I want to see if I can find a way to bring scientific explanation and teleological explanation (back) into sync (again?). I understand why the early practitioners of science had aversions to teleological explanations. Such explanations were, at best, confusing and obstructive, and at worst, backed up with threats of torture and death from their proponents. Purposive causes have

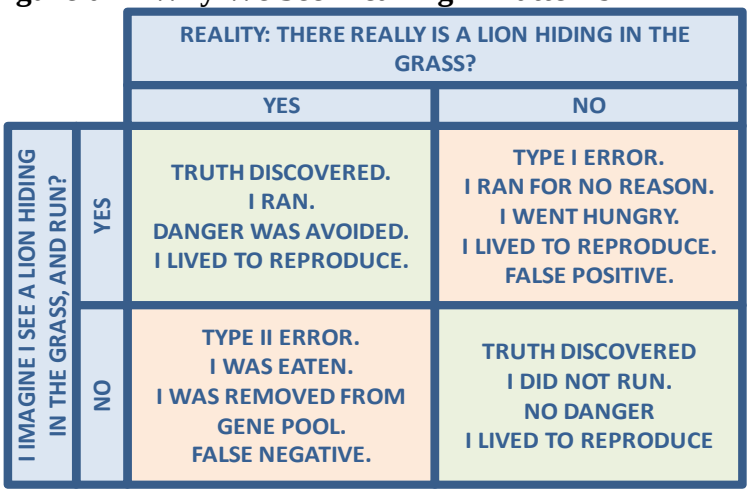
been written out of physics and chemistry, and most students understand that physical and chemical changes happen autonomously without plan or purpose, and without intervention of some personage. They just happen. The question "why" is largely ignored, except by philosophers and statisticians. But, when we are talking about biological beings, such as turtles, it gets difficult. We might say "sea turtles go ashore annually ***to lay their eggs***" (implying plan and purpose, see Ref I, Dave's NTF). It has been suggested that such statements should properly be re-written to say "sea turtles go ashore annually ***and lay their eggs***", making the declaration non-teleological. However, critics rightly argue that this hides the real cause-effect nature of the activity, and the necessity of going ashore. The fact that turtle eggs must be laid in warm sand, out of the water, is understated in the first teleological explanation, but totally missing in the second non-teleological statement. Rather than improving the description, it waters it down. The everyday experience of an animal is a sequence of situations, free-will decisions, and actions, that have a definite teleological flavour. You can argue that the turtle does these things by instinct, but that is not all that different from me putting on a kettle ***to make some tea***. I have free will to put it on or not; to drink it or not. My world is a teleological world, as is the world of a turtle.

Some have argued that a new word, "teleonomic" should be used to describe such statements. Such language recognizes the problem, and sounds like a good idea, but it does insufficient to enlighten. How do we integrate the observations that the subjective lives of people and animals of all sizes are fundamentally purposive and teleological, while the noumenal and phenomenal reality of which we are a part, and from which we arose, is fundamentally non-purposive and non-teleological (see Figure 02.) The old argument was that soul-bearing humans are distinct from soulless animals, and so animals can conceive of no subjective purposes. This does not withstand observation. My pet dog has trained my family well, and we serve her purposes more often than we would like to think.

Many changes that have directionality (e.g. water flows downhill) can be viewed, figuratively or otherwise, as purposive. From a religious perspective, water nymphs, mother nature, or some god ordains it to be so. Or, from Aristotle's secular perspective, it is because it is in the nature of water to flow downhill. Because our subjective existence is fundamentally teleological, I suppose we simply project purposiveness onto phenomena that are not, in fact, purposive, as did the Greek philosophers of old.

However true such "projection" of purposiveness may or may not be, that argument seems

Figure 02 – Why We See Meaning in Patterns



to be more of a dismissive rationalization leading us to discard a distasteful truth, rather than an integration of two conflicting but equally valid perspectives into a larger model of reality.

5.2 - Of Meanings, and False Beliefs

We, people, are very good at seeing patterns in nature, and giving them meaning. A million years ago when our ancestors lived on the savannahs of Africa, and lions hid in the grass, we watched for the lions and saw dangerous patterns. There are four possible interpretations of the patterns we see, of which two align with reality (green), and two of which are in error (pink, see Figure 02). You might think that, as our abilities to perceive and interpret these patterns, there should be no particular bias, and we would make both types of error equally often, but this is not so. Evolution and Lotka's PPSF (i.e. natural selection) can be heavily biased against one type of error over the other. For example, if the null hypothesis is that there is no lion, the most common case, the bias is extreme. We can make a Type I error (false positive) over and over again, and survive to reproduce. Of course, there is a small cost to Type I error. We expend energy running when there is no danger. We bypass opportunities for food. There must be some selective evolutionary pressure against making such errors repeatedly. However, a single Type II error (false negative), and our genes are removed from the gene pool.

Those who saw dangerous patterns in the grass were wary and timid, and lived, whether false pattern or not. Those who did not see the patterns, or who were bold and ignored them, were eaten without offspring. We are the offspring of an unbroken chain of 500 million years of complex organisms who all survived to reproduce themselves. We are the offspring of the imaginative but timid dwellers of the savannahs of Africa who lived one million years ago and saw danger in false-positive patterns. We have been trained to see patterns in nature, to assign them meaning, and to act accordingly, even though the assigned meaning is most often in error.

5.3 - Cultural Feedback

But, we do not live as singular independent organisms like bears. Our species depends on co-operative social behaviour to survive. As a community we learned to identify dangerous predators, dangerous foods, dangerous places, dangerous practices, and dangerous ideas. Our culture is based on sets of collective beliefs and morals that act as fences around dangerous places in our map of reality. I would argue that it is this pattern-seeking map-making ability and our inclination to believe false-positive interpretations of perceived patterns that leads to the problem of teleological thinking. We can find patterns everywhere. We can individually or collectively assign them meaning and be convinced of their truth. Those deeply held convictions can be wrong.

Lotka's PPSF (natural selection when applied to ideas and cultural norms of behaviour) is quick and brutal in weeding out false negatives, but it is relatively slow to weed out false positives. Both true and false beliefs based on type I errors become woven into the fabric of our cultural heritage as morals. In times of environmental stability, such morals – such cultural fences – protect us from old dangers while posing no real danger themselves. But, the PPSF is not necessarily our friend today. In times of rapidly changing circumstances like we see today, practices that used to be safe or even beneficial for humanity may no longer be safe. In particular, those practices designed to find and extract natural resources and to manufacture goods may have worked to the benefit of some portion of humanity in the past, but may have

become unsafe and may lead to future collapse. As long as new energy resources can be found and exploited, the MPP will continue to ramp up the human population of the world, and ramp up the consumptive power of the global economy. You don't need to be a rocket scientist to see that this cannot go on forever.

Lotka's PPSF has no foresight and no compassion or empathy. It cannot weed out ideas that may be dangerous in the future. Nor does it preserve ideas that are no longer aligned with its own relentless actions. All those ideas and practices that are misaligned with today's reality, and only those, are effectively suppressed and removed.

When people are experiencing a collective false-positive belief, we need some way to determine the truth. Unlike the savannah dwellers, we have the luxury of making experiments and discussing the outcomes at our leisure, without the risk of being eaten. This was the impetus, I believe, for the development of the scientific method. After the culture of Europe had been burned to the ground in the dark ages, a new society arose. It turned to the ancient texts for wisdom, and found them to insufficient. The actions of Odum's MPP and TP demoted those false ancient ideas that prevented greater exploitation of the Earth's resources, and fostered the growth of more potent true ideas, patterns and models. The non-teleological explanations of reality emerged, and the scientific method for discovery of truth was born. It's goal was to distinguish between false positives and true positives.

But, 300 years later, when science was in full bloom in the late 1880s, a new technology-enabled energy-driven economy arose, and science was demoted, by the MPP/TP, and capitalism was promoted to replace it. Science became the servant of commerce.

So, I would argue that modern science MUST come to understand why and how the MPP/TP (a) caused the science-based perspective to arise, and then (b) caused science to be replaced by a type of energy-driven globalized consumerism. The real out-of-control monster is unmasked. It is NOT, as we all like to believe, the global corporate consumerism that modern economic theory espouses. The real monster is the MPP/TP that has promoted consumerism to be the dominant culture, and protects it from incursions by science. Science must learn how to control this monster, the MPP/TP, if we, the human race, are to continue to exist when the Earth's resources have been consumed.

5.4 - In Search of Truth

I am very aware of the irony built into what I am about to say. From an objective perspective of natural history, the scientific method arose inevitably as a persistent cultural form under the ministrations of the MPP/TP which enhanced those cultural practices that increased the capture and consumption of natural resources. But, from the subjective perspective of the human race, as embodied in the early community of natural philosophers in Europe, the reason why early scientists developed the scientific method was to break out of the box that teleological reasoning (Aristotelian reasoning) had placed them in. The scientific method was developed as a credible way to test the truth of received wisdom.

At Ref I Dave completed a wide-ranging survey of the various theories of truth. I asked him to do this so that I would be able to connect my developing ideas about the MPP/TP to the vast

body of philosophical writings on the nature of truth, and related topics. So, I'll start by attempting to summarize his findings.

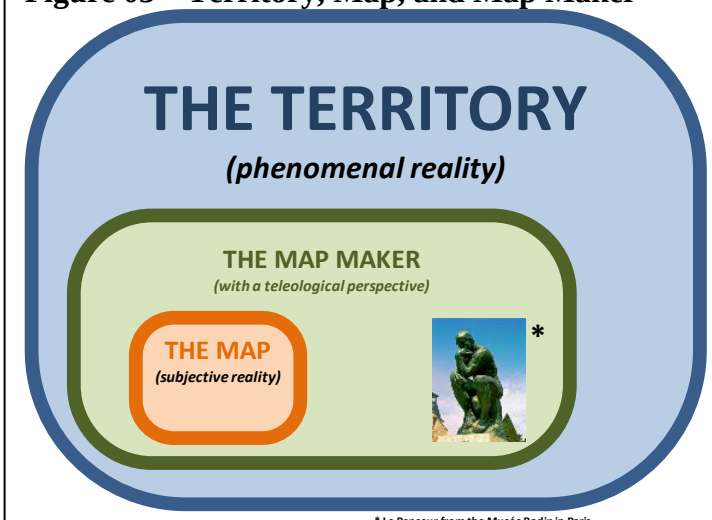
While reading through Dave's summary, I had the impression, for each theory, that there was some "truth" to each of them, even though they were in apparent disagreement with each other. It seemed that, for each different perspective, I could think of examples that were consistent with their arguments, but others that were not. I wonder if this isn't a bit like the old tale of the seven blind men and the elephant.

I would observe, however, that all of those theories of truth seem to consider truth to be an eternal static concept, like love or gravity. I prefer to attempt an understanding of truth with a dynamic perspective, and cherry-picking from the great thinkers as I need.

5.4.1 - Of Territory, Maps and Map Makers

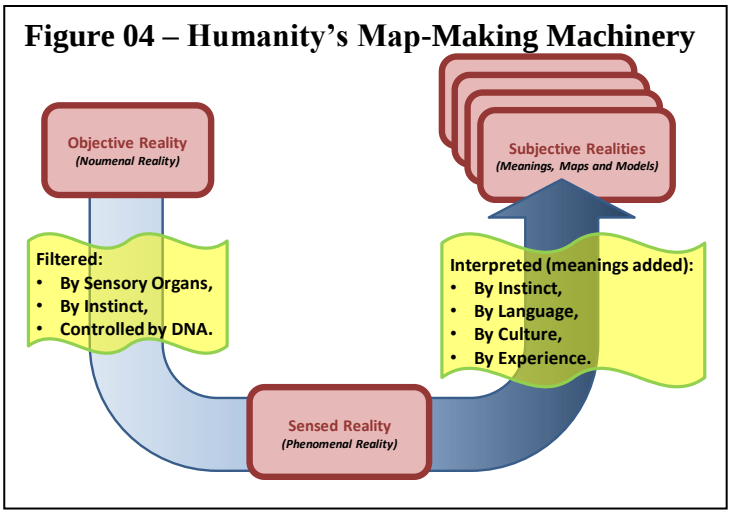
I start, as Dave did, with Alfred Korzybski (1879-1950) whose pithy contribution is the statement "The map is not the territory" (see Ref N). This leads me to Bonini's paradox (see Ref O) that says "No system can contain a perfect model of itself", or to the now famous saying by G.E.P. Box "all models are wrong, but some models are, nevertheless, useful" (see Ref P). Taking his cue from Korzybski, Dave's approach is to try to examine the implicitly proposed relationships between the Territory, the Map, and the Map maker – an insightful approach which I have incorporated here. However, beyond just providing the basis of a framework for examining theories of truth, Korzybski proposes a reason why all models are wrong. He posits that any models we construct in our minds are necessarily the product of many layers of interpretation between reality and model.

Figure 03 – Territory, Map, and Map Maker

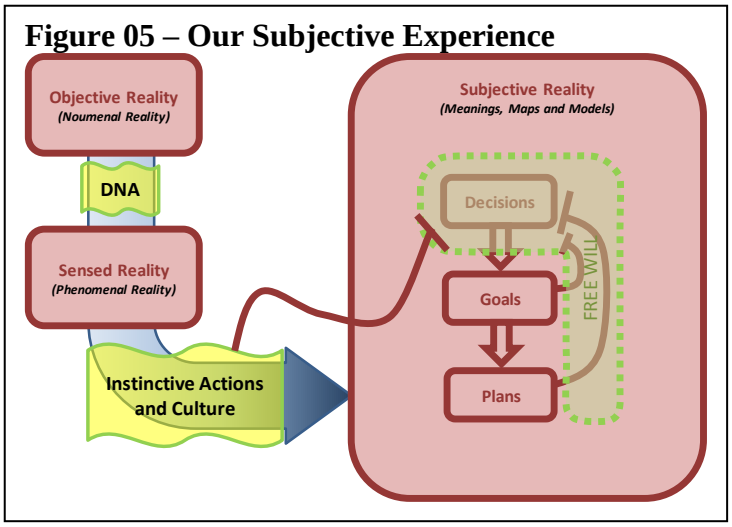


This is a good place, I think, to insert a word about terminology. I have used words such as pattern, model, and now map, to refer to our ideas about nature. I intend these words to be synonymous, and more broadly inclusive. For example, a map, in Korzybski's lexicon, can include words, sentences, paragraphs, and stories. It also includes cultural norms and practices, mathematical models, computer models, spoken and written themes, common concepts, and uniquely personal opinions, or just momentary ways of thinking.

Let me augment Korzybski's insight with that of Kant, who distinguished between noumenal and phenomenal reality (see Ref Q). Noumenal reality is that which exists, but may never be known. Phenomenal reality is that which we can perceive with our senses, or with the instruments we devise to extend our senses.



These thoughts lead to Figure 04. Objective reality exists as a dynamic system we call the universe, and it obeys unknown and perhaps unknowable laws of behaviour. That is a fundamental assumption of the philosophy of science and the scientific method. Our senses have evolved to detect sources of benefits, and dangers. Those detection devices that have led to persistence of the species have been enhanced. This narrow purpose-like focus on survival has sharpened some features at the expense of others, all under the control of DNA and instinctual behaviours. Dogs have an exquisite sense of smell and a poor sense of sight. Humans have a poor sense of smell, and an exquisite sense of sight, and of thought. Part of that sense of thought, is a sophisticated ability to make maps of sensed reality. So "sensed reality" is as small subset of noumenal reality. Modern humanity has extended its senses with microscopes, telescopes, mathematics and models, and this serves to expand the scope of sensed reality. But the input from the senses is then fed through a series of filters that apply meaning to the sensory input. In order of increasing discretion, these might be instinct, language, culture and personal experience. We have no discretion over instinctual interpretations (e.g. our minds find edges in the visual field and add perspective). We have substantial discretion in applying lessons learned from our previous experiences.



So, I have this Kant/Korzybski dynamic model of how we make models (self-reference noted) in our search for truth.

5.4.2 - The Dynamics of Subjective Reality

Marketers, behavioural economists, psychologists, psychiatrists and neurological researchers have made incredible strides in the past 100 years in coming to understand just how weird the human brain is, and how often it gets things right or wrong. How we perceive and interpret reality has been a difficult mystery, and the mists are slowly clearing. We can never get to the very bottom of that riddle, because no system can hold a complete model of itself, so no person can ever fully understand how their own psyche works (Bonini's paradox, see Ref O). But my goal in this note is to reconcile the concepts of scientific explanation and teleological explanation. And for that, I think I only need to scratch the surface of this deep riddle.

As a relatively standard example of the human species, my daily experience is a continuous stream of stimulation → (ponder) → (decision) → (action). The items in parentheses are optional. Stimulation is non-optional, and perceives a subset of noumenal reality. I may ponder, but instinctual reactions do not get pondered. I may make a decision, but instinctual reactions may be decided by default. Actions may be taken, or the stimulus may be ignored for many reasons, both instinctual and pondered.

When I awoke this morning, consciousness slowly arose out of the mists of sleep, but at some moment I realized I was awakening, and decided to fully awaken and get up. When faced with decisions about breakfast, I made decisions, made my breakfast, and ate it. My memory of my experience throughout the day is about decisive actions. Each of these decisions was made of my own free will. But, those discretionary decisions were strongly influenced by my personal goals (e.g. to return quickly to adding new ideas to this diary entry) and plans (e.g. to lose weight).

My daily experience is one of free will decisions corralled by fences that come from instinctual responses, cultural influences, and personal tactical goals and strategic plans (see Figure 05.) I am using the diagrammatic tools of a football coach to show that some decisions are proscribed by instinct, by culture, or by my personal goals and plans. Past failures make some decisions, goals and plans untenable. Past successes make some decisions, goals and plans more attractive, more dependable, and more often used. This is the action of teleological pruning as it shapes the teleological components of my world view.

5.4.3 - The Dynamics of Personal Feedback

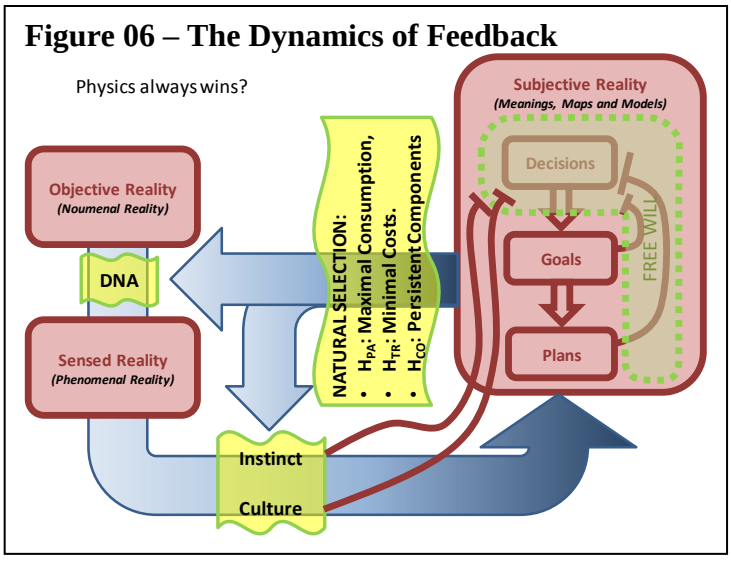


Figure 06 – The Dynamics of Feedback

As modern humans evolved from their earlier ancestors inhabiting the savannahs of Africa, all of these internal mechanisms were selected by Lotka's PPSF, based on the universal fitness criterion as described by the MPP/TP. Or so I argue (see Figure 06). We are among the dominant species of the planet at the moment due to the way these internal mechanisms have been finely tuned to minimize the thermodynamic costs of personal existence, and to maximize the thermodynamic throughput of the biosphere. Now senses and instincts that are rooted in DNA evolve very slowly. But culture can evolve quickly, and that is a tool that the MPP/TP has seized upon. (If I am going to project personages somewhere, this seems like the place to do it. The monster has seized upon a new potent control.)

I would imagine that the feedback on our DNA over the past million years has caused substantial

change. For example, our ability to speak languages developed as parts of our brain were converted from visual processing to language processing. This did not happen in a dozen generations. This took a long time – estimates seem to vary from 30,000 years to 100,000 years.

The feedback on cultural norms has caused much more rapid evolution. The rise of agriculture, the rise and fall of city states, the rise and fall of empires, the rise (and fall?) of science-based societies and nation-states, the rise of corporate capitalism as a dominant force in global society – all of these things have happened in relatively recent times. This entire panorama has unfolded in 12,000 years, with the most massive developments happening in the past 250.

For example, the last 250 years have seen dramatic changes in the energetic throughput of the biosphere due to the rise of our global society, enabled by the exploitation of fossilized energy sources. And our culture has evolved rapidly to embrace and enhance that throughput, though our genes have not. While instinctual behaviours are still operating as if we are living in small communities on the savannahs of Africa, our discretionary decisions are under the control of our free will, as influenced by language, culture and experience.

Let me consider the role of experience and the effects of free will. I have made decisions in the past that did not work out well. Either I squandered my resources and got nothing to show for it, say, by buying a car when all I needed was a bus pass to get to work. Or, I invested in green technology for moral reasons when I could have invested in a hot new oil play. In both cases, my decisions were not aligned with the effects of the MPP. How so? Those people who are efficient (low power) and do not waste a lot of their personal resources on metabolic maintenance (e.g. transportation to work) will prosper over those that are wasteful of personal resources. Those people that invest in maximizing the rate of consumption of matter and energy by society will prosper as they participate in the benefits from that rising stream. So, experience teaches me that it is wisest to conform to common practice, and reckless to be a contrarian. In this way, my free will decisions are, for the most part, steered to be aligned with the overall effects of the MPP, even as I am cognitively aware that the Earth's sources are being depleted and its sinks for matter and energy are being overwhelmed.

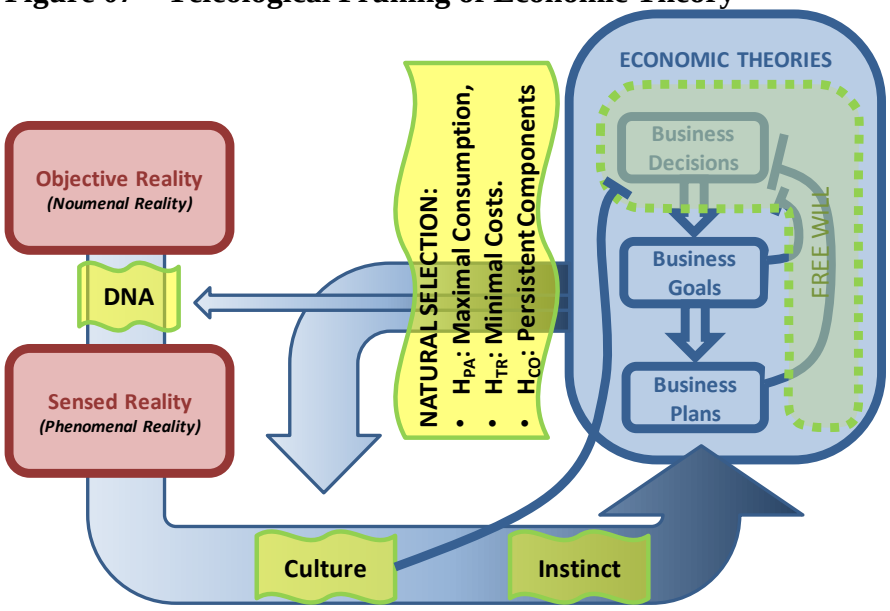
One could drop out of society, I suppose, as many have done. But that, it seems to me, is just switching chairs with someone else in the bus of life. Even a dropped-out person is still a part of the biosphere, and someone else steps forward to take on the vacated job, and buy the for-sale house and car. We are all collectively trapped on the same bus, driven by the MPP/TP. We need to learn how to drive this damn bus.

5.4.4 - The Rise of Corporate Capitalism

Modern economic theory has stubbornly resisted the adoption of any formalized scientific method, and neutralized the incursions of any scientific theories that would divert the evolution of society away from a path that aligns with the effects of the MPP/TP. Why? Because the MPP/TP provides the universal fitness criterion by which Lotka's PPSF prunes away dead wood and enhances the growth of new wood. It selects those energy transfers that are supremely efficient at conserving energy and passing it along. But it also selects those system-wide processes that maximize the exploitation of matter and energy, and maximizes its degradation. In this process it enhances the survival of economic theories that align with these effects, and

reduces the probability of survival of those that are not aligned with those effects.

Figure 07 – Teleological Pruning of Economic Theory



I note that the fundamental concepts of modern economic theory are all expressed in terms of personal subjective reality (compare Figures 06 and 07). Economic concepts are all in terms of goals, plans, decisions, purposes, demands, and uses. This is the teleological language of theological discussions. It is NOT the language of science. But, in this diagram I have a composite of teleological language, where the economic theories exist, and scientific concepts, where natural selection provides the feedback on genes and culture.

In Figure 07, I show the impact of the fast-evolving economic theories on our DNA as relatively small, due to the great difference in relaxation times for perturbed genetic systems versus perturbed economic systems. I also show the effects of culture and instinct separated for the same reason. Instinct is still a significant filter on the channel of information going into the system, but it does not play the same role. In personal subjective reality, instinct is a filter that alters our perception of reality. In an economic theory, human instincts are merely tools to be used by marketers. But culture continues to play a significant role in determining how economic theory develops. All of the university faculties around the world, all of the global organizations such as the IMF, the World Bank, the United Nations, and other such organizations, as well as the global web of trade and monetary treaties – all of these work to determine which economic decisions get made, and which goals and plans have any reasonable chance of survival. Now, that's a cyclone of cultural feedback on a global scale!

6 - What About A Scientific Method for Economics?

We can now look at the second question in a little more detail. What might be the needed characteristics of a scientific method for studying economic systems? I am unhappy with my answer here, but I can take it as far as possible. First I want to discuss the static theories of truth that are discussed in the literature, try to fit those into the concept of a scientific method as a means to seek truth, and then derive from that a means to address fundamental differences between teleological truths, and objective phenomenological truths.

6.1 - Theories of Truth

In Dave's Ref M survey of theories of truth he identifies three main theories upon which I want

to build an argument: (a) the correspondence theory; (b) the coherence theory; and (c) the pragmatist theory. These are all very cool, and all very static, but life is not static – it is dynamic. All of the varieties, all of the finely grained differences noted, all of the varieties of names – these all can be sorted into these three grand bins. Briefly, they are as follows:

- ***Correspondence theory of truth*** – a proposition (or map) is true if the map corresponds to the territory. There are differences of opinion about how closely the proposition must correspond (exact match vs approximation); about which is the true original and which is the true copy (e.g. Platonic circles vs worldly circles); or about which reality is being mimicked (e.g. noumenal, phenomenal or subjective). I would say that empirically determined simple facts would tend to fall into this category of truth. When measurements are carefully made, and carefully analysed and interpreted using universally accepted methods, then the results are considered true facts. E.g. the average height of students in a certain class falls between x and y. This statement is easily verified, and can be considered an empirical fact.
- ***Coherence theory of truth*** – a proposition (or map) is true if it is coherent with other known truths, that we might call axioms. The axioms must be self-evident truths that all can accept without debate, putting them, I would say, in the category of empirical facts of the correspondence theory. But, once the axioms (or empirically determined truths) are accepted, then the seven accepted tools of Greek logic can be used to derive other propositions. The restriction to these approved tools of logic ensures that all derived propositions are also true, and the truth is preserved throughout the manipulations of the propositions. These are the bread-and-butter tools of mathematicians. If the axioms are true, then the derived propositions MUST be true, as long as the rules of derivation are known to preserve the truth. It is possible to build very complex sets of theorems using the coherence theory of truth, and it is possible that a single wrong axiom would make significant parts of the logical structure non-conformant to any reality. The assumptions that undergird a theory are critical to its applicability.
- ***Pragmatic theory of truth*** – a proposition is true if action based on that proposition leads to an expected result. Engineers and investment bankers are the professionals who look for this sort of truth. If the proposition works, it's a good proposition. The proof is in the pudding. Economists tend to live in this arena. They would not care if an assumption might be classified as a false positive (with reference to Figure 02 classifications) as long as it turns a profit reliably.

Compared to my dynamic description of where economic theory comes from, these seem to be very static definitions of truth.

Pragmatic theory of truth examined – I would argue that the pragmatic theory of truth is the default theory in our daily lives, and the theory by which our society is organized, and has been organized since the beginning of time. The pragmatic theory is, by definition, purposive and teleological in nature. Propositions are true because they conform to a purpose, and purposes are validated because they are commonly known to derive from accepted goals and plans, and usually lead to success. All pragmatic propositions have some characteristics of correspondence and coherence, but these are not essential. Politicians, judges and lawyers are concerned with pragmatic truths. All of the Sophist's rhetorical tools are available to them to persuade and to make or interpret laws. Engineers, bankers, economists and business owners are all concerned with pragmatic truths. Religious leaders and their adherents all follow each their own lights. In

all cases, the successful practitioners persist, and the others fall away, under the ministrations of the MPP/TP. A pragmatic truth is one that is aligned with the universal fitness criterion – the MPP.

Pragmatic truths can exist in three out of four quadrants in Figure 02. The Type I errors are of special interest to me, as they are a part of the fabric of our culture which does not correspond to reality – to true phenomenal reality. That is, we see the pattern, but we do not interpret it correctly. These are outside of the boundaries of scientific study, but this is where we live, and this is where economic theory persists. Natural selection ensures that theories found in this quadrant of Figure 02 are not lethal, at the moment. But, if they also lead to short-term success of some sort, their lack of correspondence with reality is not an immediate drawback to the pragmatist. Adherents of pragmatic truths are not troubled by deep concerns with correspondence or coherence.

Pragmatic truth dominates our decisions in our daily lives. Experience tells us that certain foods are good and safe, at least in the short term. Certain actions and behaviours are safe, at least in the short term. Certain purchases and investments are safe, at least in the short term. But, since natural selection does not have foresight, such pragmatic truths do not have foresight either. And that is the great problem with pragmatic truth, and the problem with modern economic theory.

Coherent theory of truth examined – But, what about coherent truth? Euclid's GREAT achievement (see Ref R) was to codify coherent truths for plane geometry. Gödel's GREAT achievement (see Ref S) was to show that for every such truthful structure, there remain true propositions that cannot be proven. The tools of logic are insufficient to discover all of the truth that is associated with a set of axioms. So, the coherence theory of truth is astoundingly potent, but not absolutely potent, for discovering truthful statements. My point is, no matter how many empirically-determined axioms science may discover about phenomenal reality, even if all of the axioms correspond well to phenomenal reality, there will yet remain true propositions about phenomenal reality that cannot be proven to be true using coherence theory.

Correspondence theory of truth examined – This leaves us with the correspondence theory as the primary means by which truths can be examined for veracity. It is not a surprise, then, to think that much of the writings on the philosophy of science are focussed on techniques to improve the correspondence between the map and the territory. Neither is it a surprise to realise that economic theory puts substantially less emphasis on such issues.

6.2 - Comparing Methodologies?

6.2.1 - Scientific Methodologies – A General Description

As I said before, I believe that there are many variations on the scientific method, as each major discipline has had to make accommodations for the circumstances of their discipline. These methodologies all seem to bear the marks of all three significant theories of truth. But, I think I can nevertheless make some general statements that would apply to them all:

- For historical reasons, scientific methodologies avoid teleological explanations of causes and effects, and prefer explanations that invoke impersonal processes that have no ability to hold a purpose or a express a goal;
- They seem to bear the marks of all three theories of truth:

  - Correspondence theory of truth: They are all founded on the assumption that objective reality exists (whether noumenal or phenomenal);
  - Coherence theory of truth: They start with empirically established facts, and known and trusted prior theories, and then use accepted logical arguments (excluding most Sophist tools of rhetoric) to build verbal arguments;
  - Pragmatic theory of truth: They are all goal oriented towards one of two kinds of goal: (a) to build a model of reality that corresponds ever more closely with known reality, or (b) to successfully control reality (e.g. health care);
- Results are published as falsifiable theories in open peer-reviewed journals, and rebuttals are encouraged in a dialectic intended to improve the theories and models;
- Research is focussed on the falsification of current theories, and their improvement thereby;
- There is usually broad agreement among scientists on the major body of theoretical knowledge that has withstood all attempts to disprove it – disagreement being confined to the smaller details of the theories.

6.2.2 - Economic Theories – A General Description

By way of contrast, the study of economics is less disciplined in some ways, and more focused. Again, I think I can make a few general statements about economic theories, from the perspective of the above discussion:

- For historical reasons, economic theories embrace teleological explanations of causes and effects, and prefer explanations that are founded on decisions guided by experience, purposes, plans and goals;
- The ultimate goal of economic theory is to enable its adherents to more successfully align their activities with contemporary market forces, enabling them to enlarge their share of the flow of wealth;
- Economic theories seem to bear the marks of all three theories of truth, but faintly:
  - Correspondence theory of truth: They seek to match the predictions of contemporary economic theory with contemporary economic performance, with the goal of gaining advantage over competitors;
  - Coherence theory of truth: They start with empirically established facts about the market, and known and trusted prior theories, and then use accepted logical arguments (excluding most Sophist tools of rhetoric) to build verbal arguments and mathematical models;
  - Pragmatic theory of truth: They are goal oriented towards successfully controlling economic reality to the advantage of adherents;
- Results are often published as theories and models in open peer-reviewed journals, and rebuttals are encouraged in a dialectic intended to improve the theories and models. Falsification is not a required quality for a good published theory. Verification of its worth is measured in its successful application.
- However, at other times results are often kept proprietary, corporate espionage is often undertaken to discover the secrets of competitors.
- There is often very broad disagreement between economists on significant issues having to do with national economies, and theorists associate with brands. Adoption of a brand of orthodox economic theory seems to occur as waves of world-wide fads that are potent for a while, until they are not, and are replaced by another fadish theory.

I have intentionally written the last two sub-sections in parallel form, to make them easily

comparable.

6.3 - How Can Scientists and Heterodox Economists Help?

My personal opinion is that the modern global economic system is a monster out of control that will devour and disperse the Earth's resources leaving mankind with a woefully depleted planet, unless we find a way to understand it and control it. But that is just a façade. The real out-of-control monster is the MPP/TP. The narrow focus of all orthodox economic research is on (a) how to make the contemporary economy to continue to grow; and (b) how to profit from that growth more effectively that the competitors. That focus has to change. Orthodox economists are NOT in a position to change, as their discipline does not enable them to get an objective perspective, nor do they perceive an incentive to change. They are, in fact, incented to fight change.

The following are some possible avenues of research:

- Philosophers of science can examine the role of the MPP/TP as a cause of the rise and fall of reverence for science in our culture.
- Systems scientists can study the nature of the MPP/TP and its role in making economic theory impervious to inroads by scientific study.
- Behavioural economists can investigate the connections between personal beliefs and the effects of the MPP/TP, and the phenomenon of teleological pruning of beliefs, goals, plans and purposes.
- Biophysical economists can investigate the dynamics of hybrid biophysical-commercial-financial systems.
- Econophysicists, physicists and chemists can research the applicability of concepts developed in thermodynamics to the understanding of the dynamics of economies, studying the effect of non-absolute conservation laws, extended non-physical entropy effects, and the self-organizing role of the MPP.
- Philosophers, social scientists, and teachers of morals can discover means by which people can resist the siren call of wealth, and participate in a revamping of common morals by which this engine of destruction can be stopped.

Out of all of these types of activities, there would arise a new "Scientific Method" appropriate for the study of economic systems.

7 - A Phenomenon-based Framework for Economics?

My views on this topic are best expressed in the NTF at Ref D.

8 - Afterthoughts About Age-Old Arguments

The following thoughts really deserve an NTF for themselves. I am stretching to fit it in here. But it completes this note, so I will try to put it here.

8.1 - Science Versus the Humanities

Since the dawn of "science", with roots going back to the ancient Greek philosophers, and the reaction of the "natural philosophers" of the Italian Renaissance, there has been a division

between the study of science, and the study of the humanities. I have intentionally avoided reading too deeply into that spaghetti bowl of theories and counter-theories until I could work out some of my own opinions on the matters around my emerging ideas on Teleological Pruning. But, if the contents of these diary entries ever see the light of day, say in publication, there may be throngs of academics who have well-worn opinions, backed by weighty and pithy quotes from eminent philosophers, who would be able to dissect and classify each idea as to its ontological and epistemological character. I clearly was taught science (1968-1972) by logical positivists, and have swung over, in some fashion, to Popperian anti-positivism. Some might even claim that I have not really turned to anti-positivism, but, rather, am an example of someone who suffers from "scientism" with a pretense of being Popperian – i.e. those who participate in a cult-like belief that science is supreme.

I also, clearly, have a deep belief that the theory of evolution provides insight into who we are and how we function, and so I try to reframe the question "What is truth?" into the question "How do beliefs (in the truth) arise?", converting truth from a static object of ontological discussion to a dynamic epistemological process of discovery, and the products discovered thereby. That positions me somewhere in the morass of ontological and epistemological opinions on the nature of truth and knowledge. I like that because it justifies the position taken, but it also serves to explain the rise of science as a method of enquiry, and it explains the rise of modern economic theory and its displacement and subjugation of scientism, replacing that with capitalism.

Otherwise, I don't know how to address that tangle of ideas without becoming deeply enmeshed in tricky nuanced interpretations of fuzzy concepts that are difficult to invalidate. The argument that the humanities are distinctly different from the sciences has a history that reaches back to the emergence of sociology as a study in its own right (see Refs V, W, X and Y). My observation that economic theory is fundamentally and irrevocably teleological in its perspective would be readily agreed upon by students of the humanities. That is in some sense merely repeating the century-old objections of students of the humanities. My observation that economic theory is able to actively resist all attempts to validate/refute it using the techniques of science is, I think, a less commonly commented upon observation, if ever.

I do think that, for the sake of preservation of the future of mankind, economic theory MUST be rationalized using science. However, I have tried to avoid discussion of the normative issue whether or not economics "should" be addressed using science, or brought into the fold of scientific enquiry. That argument is a separate one which I have jumped over in this note. The normative argument as to "why" the disjunction must be repaired is a teleological argument.

In this NTF I am addressing "how" it has managed to resist being brought into the fold, despite the many attempts to do so over the past century. I am also addressing (somewhat weakly) how the disjunction of science and the humanities can be closed, and, in particular, how the disjunction between science and economics can be closed.

8.2 - Ultimate Cause(s) Found?

I also have this observation as an afterthought that I have gone full circle. In struggling to break free of the errors of the ancients, such as Aristotle, I find I am coming back to Aristotle's

viewpoint. As I argue above, Aristotle had a teleological perspective. He and other ancient and modern philosophers have sought the "ultimate cause" – the "ultimate why?" In trying to avoid the truncated chains of logic of teleological explanations, scientists have adopted an intentional aversion to "Why?" questions, and sought an answer to "How?" questions in their stead, seeking impersonal mechanistic answers to life's riddles. ("Techne" in place of "telos".) But, there is a deeper difference between "Why?" and "How?" than the relative strength of the implied invitation to respond with a teleological explanation. "Why" invites a static answer, but "How" invites a dynamic answer. The answer to "Why?" usually (or often) implies motive (a teleological concept). The answer to "How?" usually implies motion, in the way that Aristotle understood motion. Aristotle viewed motion, not just as an object sliding or rolling across a table, but as including all changes that are happening or could happen (see Ref E). Seasonal changes, thought processes, economic processes – all of these would fall somewhere within the circle of what he considered to be motion. So, for Aristotle, when he pondered "Why do things move?" (1) he was actually asking something far broader like "Why do processes process?"; and (2) the very framing of the question creates a subtle bias towards a teleological answer; and (3) the framing of the question also creates a subtle bias towards a static answer rather than a dynamic answer. The fact that I see a tinge of teleological colour in his rather static answer is a product of the care he took to answer the question as posed, I should think.

In my search for an answer to how an economy functions, I am forced to face the fact that my answer, as it seems to be coming clear to me, is also an answer to Aristotle's question "What is motion?" And I am coming to the conclusion that there is one ultimate kind or form of constraint, and two ultimate causes.

8.2.1 - The ultimate form of constraint:

That moniker is possibly too grandiose for the idea, but maybe not. It's application in economics has been developed in some detail in the Ref D note. The ultimate form of constraint is a conservation law. Physicists have discovered many – conservation of matter; conservation of energy; conservation of linear or angular momentum; conservation of electric charge; and many more. Conservation laws tell you what cannot happen. They create barriers in phase space, slicing it up into infinitely thin manifolds between which motion is not possible, but within which motion can happen. Newton argued that for every force there must be an equal and opposite force. In some fashion, we could say that those reactionary forces must be pushing against a constraint, against a conservation law. If there were not an equal and opposite reaction force, some conservation law would be broken. The changes that are allowed within a system conform to the conservation laws. Motion within the phase space of the system must be within the allowed sub-spaces – the allowed manifolds.

In economics, there are a number of conservation laws that play a role. In the Ref D note I soften the definition of conservation law. In physics, most laws are absolute. The measured property of the system must be absolutely conserved. So, the law of conservation of matter is not actually recognized as a law in physics, due to the potential transformation implied by the equation $E = mc^2$. If matter is considered a form of energy, then energy is absolutely conserved, and matter is merely conserved most of the time. In the language of my Ref D note, matter is "sufficiently-well conserved" that the conservation of matter takes on a very significant role in our daily lives, and is a basic assumption in most scientific theories and engineering practices.

Just so, in a modern economy, land and money are sufficiently-well conserved to play a significant role as a constraint.

Just how do these constraints exhibit their significance? There is an insufficient amount of the conserved property to meet demand, access is limited, and re-allocation of the limited property must be observed. This is a fundamental characteristic of all economies. All economic inputs are available in quantities that are limited, either in quantity, or in accessibility rates.

8.2.2 - The two ultimate causes:

All change is, at its very roots, stochastic. The current state of any system having a number of distinct properties can be described as a point in a Cartesian space for which the properties form the dimensions. A change in any property would appear as motion in the phase space. Conservation laws would restrict motion to certain subsets of the phase space. Of all of those allowed directions of motion, motion in some directions may be more probable that motion in others. Relativistic mechanics (with its arguments about non-simultaneity) and quantum mechanics (with its own indeterminacy principle) have shown that the universe is, generally, non-deterministic, and that motion from state-to-state must be characterized by some measure of stochastic indeterminacy. We can say that the most probable direction of motion of the system within its state space is usually the change that is realized, but not always. Sometimes, a very improbable change may nevertheless be realized.

The nature of "natural selection" (i.e. Lotka's PPSF) is just that. The most probable outcome is the usual outcome, without excluding the occasional realization of an improbable outcome. This ultimate cause expresses itself in two ways.

8.2.3 - **Ultimate cause #1:** Rising overall entropy.

The 2nd law of thermodynamics is a particular example of a widespread phenomenon. It is particular, because it addresses the redistribution of a single conserved property – energy. But there are many conserved properties, in many kinds of systems, and each may be in a circumstance in which the mechanics of re-allocation of the property within the system leads to rising entropy. This happens whether or not the conserved quantities are in over supply, or undersupply, but dominates, and is most visible, when conserved quantities are in undersupply. This is often called the Maximum Entropy Principle (or MEP) and is to be distinguished from Lotka's Maximum Entropy Production Principle (MEP). This process leads to the disintegration and disappearance of complexity, structure and inhomogeneity.

8.2.4 - **Ultimate cause #2:** Falling local entropy.

The MPP/TP is the source of all complexity, structure and inhomogeneity, except for that due to occasional temporary perturbation due to the realization of improbable outcomes. When conserved quantities are in oversupply, such as energy in an ecosystem through which high-quality energy flows, then re-allocation occurs in a turbulent fashion, and the effects of the MPP/TP dominate. In that case, the structure and non-homogeneity results in forms of low-entropy, in apparent defiance of the MEP.

So, in seeking an understanding of economic theory, I come to an opinion about the philosopher's holy grail – the ultimate cause. COOL!!