ADVISOR PERSPECTIVES

Energy and the Wealth of Nations

By Richard Vodra, JD, CFP
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When our society relies on an understanding of economics that did not predict, prevent, or mitigate the current economic crisis, and that, more importantly, does not effectively address climate change or resource depletion, it is time for a new and different approach to understanding the economy. That premise is the foundation of *Energy and the Wealth of Nations*, an important book by ecologist Charles Hall and economist Kent Klitgaard, who together are pioneering the new discipline of biophysical economics.

Two major themes interweave through this book. One is about the nature of the economy; the other, about the nature of economics (by which I mean contemporary, academic economic thought).

Hall and Klitgaard's work has important implications for financial planners, but first let's look at their view of the historical role of energy in civilization and why they contend that contemporary economics lacks the tools to enable policy makers to make optimal decisions.

A history of energy

The book is based on the premise that the capture of excess energy supports all the functions of life. Every plant or animal must not only get energy from food, sunlight, or other sources, but must ingest more energy than the energy it expends to obtain its sustenance – this excess enables an organism to move about, reproduce and raise its young, and do whatever else is on its agenda. Social animals, like humans, can share energy within their tribe, pack, or hive.

Human civilization began when agriculture led to enough excess storable food (derived from solar energy, via plant life) to support non-producing groups of priests, soldiers, royalty, artists and others. Technology gradually allowed the capture of wind and water power (other forms of solar energy) for trading, simple manufacture and other purposes. The economy was based on the capture and transformation of energy and other resources for the benefit of people, and when those resources were used up (as with deforestation or overfishing), disappeared (as with chronic drought, or loss of territory), or employed more effectively by others (as by an invading nation), civilizations declined or disappeared. Human interaction with the "real world" was the ultimate determinant of economic activity. We lived in a close balance – economic growth averaged less than 0.1% per year for the two thousand years before 1700.

Something remarkable happened late in the 18th century – people discovered how to obtain and use vast new forms of stored solar energy, such that they were no longer dependent on the energy received in a single season or a few years. Those new energy sources – fossil fuels – came from vast new supplies of concentrated and portable energy – first coal, then oil, then natural gas. The challenge was on, both to find and extract more of these energy stores and to find new ways to use them. Coal led to vast quantities of iron and steel, which allowed for trains, faster and bigger ships, factories, taller buildings, and more. Oil became the main fuel for gasoline, diesel, and jet engines, allowing for cars, trucks, ships, and planes. Natural gas not only led to better forms of heat, but also to artificial fertilizer.

Those energy sources, and the technologies they spawned, allowed for the more effective extraction of copper and other minerals, the generation of electricity, vast increases in agricultural production, the efficient concentration of resources into factories for mass production, and cheap transportation, which created mass markets. The effect on military power was similarly profound, as muskets, sailing ships, and horse-based transport were replaced, and replaced again, and again, and again.

Conventional economics and history texts rarely notice the essential role of cheap and plentiful resources on the massive changes of the past two centuries, preferring to focus on inventions, political changes, and new economic forms. While these were all important, it all started with energy.

Hall and Klitgaard show that the correlation between energy use and economic activity (and population levels) has been very high throughout this period. Most academic economics considers production to be a function of capital and labor alone, but including energy makes the analysis work much better. Cheap energy, more than anything else, has facilitated new technologies and fostered the creation of a true global economy.

Where we are today

This would be merely an interesting observation were it not for a nagging problem – energy (starting with oil, soon to be followed by coal and natural gas) has started becoming more expensive, harder to find, and absolutely scarce in many parts of the world. The authors say that the amount of net energy (the amount left after the energy cost of production) available has stopped growing, or is about to. Since economic growth depends on growing amounts of net energy (especially at the global level), flat energy supplies will lead to the end of economic growth, and that will come sooner, not later.

This is something for which no one is prepared.

The key analytic concept, which Hall developed over the last 40 years, is EROI – the energy return on energy invested – the best measure of net energy. The early oil wells in East Texas were so productive that they produced 100 barrels of oil for each barrel of oil (or the equivalent amount of energy) it took to drill the wells. Building a massive offshore platform today to drill a well in a mile of water and two more miles of rock a hundred miles from land is vastly more expensive, both in financial and energy terms, so the EROI of deepwater oil is in the range of 8-15 barrels produced per barrel invested, not 100, and drilling hundreds of low-yield shale wells that require fracking leads to EROI numbers in the single digits.

Stated differently, it used to take 1% of the ultimate output to extract our energy supplies, but now it can take 6% to 20%. EROI is independent of the monetary cost or price of energy – due to subsidies, something can make investment sense but not energy sense. Most EROI estimates for corn-based ethanol, for instance, are between 0.9 and 1.9, so energetically this supposedly renewable fuel barely breaks even. Since the economy is ultimately grounded in energy, not finance, Hall and Klitgaard argue, the energy return is more important than the financial return on an energy project and energy system.

EROI is usually measured at the point of production, but Hall estimates that an equal amount of energy is often used to transform raw energy into a useful form (moving it by pipeline to a refinery, then to the ultimate user, for instance) and another equal amount is needed to create and sustain the infrastructure to make use of the energy (building and maintaining roads and vehicles, for example, plus dealing with environmental impacts). Thus, an EROI of three is generally needed just to put energy to use, and an EROI of 5 to 10 is the minimum required to yield the net energy to run the rest of society. Few alternative energy sources (solar, wind, algae, etc.) have net returns that high.

The biophysical world limits our available resources. In addition to energy and mineral stores, we are also constrained by soil, water and the capacity of the atmosphere to absorb CO_2 and maintain an acceptable climate. We have used more oil than we have discovered each year since 1979. No amount of "quantitative easing" or debt financing can ultimately get around these limits. As the saying goes, "Mother Nature bats last."

That's a brief overview of the book's first theme: We have not paid adequate attention to the real drivers of economic activity and change, or to their future availability. The second theme explains why – the bankruptcy of economics.

The bankruptcy of economics

Economics should be the study of the economy, but Hall and Klitgaard contend that academic economics merely pretends to be a science. The book contains lengthy discussions on what it takes to be a science, which they consider to be a study of reality, with testable hypotheses and useful predictions. Economics is based on a number of assumptions that are clearly false: that people are rational; that they seek always to maximize their overall well-being by increasing their (monetarily-defined) economic condition; that they operate in a competitive free-market world where information and power are equally shared in the exchange process; that all inputs have easy substitutes; that input supplies are unlimited at some price; that the economic system tends toward equilibrium; that the sum of outputs equals the sum of inputs; that everything can (and should) have a monetary value; that economic growth is the default state of affairs… the list goes on.

These are handy assumptions for creating mathematical models, but not for creating something that reflects reality. Financial advisors have known for decades that people have many non-financial motives and make irrational decisions. From the earliest days of guilds and the formation of the Standard Oil Trust, businesses have attempted to control or eliminate competition to enhance their power. Hundreds of years of commodity price and economic output data show no tendency toward reaching a steady state. Even Mastercard knows that some things are "priceless" – and those are the most important things. Resource depletion has bedeviled many civilizations, and now it's our turn.

Two of the assumptions are even more fundamentally in error. Inputs do not equal outputs, because all activity generates waste or decay, according to the Second Law of Thermodynamics. Thus, there has to be new net energy entering the system to keep it running – energy that may not always be adequate in the real world. More importantly, as anyone with a calculator can confirm, endless growth eventually becomes unsupportable. In the famous words of economist Kenneth Boulding, "anyone who believes that exponential growth can continue forever in a finite system is either a madman or an economist." This is not a reality that economics has a way to address.

Rewiring economics

We are not surprised when answers in biology, geology, and physics turn out to be very complicated. But we expect economics, which combines the biophysical aspects of all three with the equally complicated issues of human behavior and intention to be easily explained by a few straightforward equations and understood by politicians when presented between market updates on CNBC. Hall and Klitgaard argue that, far from this forced simplicity, what economics needs is to be consistent with the real world, both in physical and behavioral terms. The book includes chapters on the science and mathematics needed to proceed with this work.

One recurring complaint in the book is that serious energy analysis (supplies, uses, technologies, EROI, capital requirements, and so on for all the energy sources) is foundational to economic analysis, but there is no source of funding for any of that analysis now. Instead, we get advocacy research designed to promote particular business or political interests. ("Clean Coal," anyone?)

There will always be important policy decisions to be made, but they should be based on good data, and they should include the tradeoffs of economic benefits and costs, effects on communities, environmental impacts, and other values. It's not just about the quarterly numbers.

A better energy policy

Do we have good policy options, or is the situation beyond redemption? The concluding chapter, "Living the Good Life in a Lower EROI Future," points out that people's perceived happiness in the 1950s was about the same as today – proof that we can be happy with less "stuff." Further, societies can respond effectively to energy crises, as Cuba has done in the face of the US embargo and the cutoff of cheap Russian oil supplies.

But broad-based ignorance about and even denial of these challenges, coupled with a political process that avoids difficult issues (not just in the US, but globally), leads the authors to be "not entirely optimistic." We should at least start with actions to localize food production, while providing reasonable levels of support to technological optimists (like Jeremy Rifkin) and efficiency efforts.

Charles Hall has been working on these issues for over 40 years, and this book represents a summary of his and his co-author's views and life work. It is in the form of a textbook, to be used for a course in Biophysical Economics. While the book is expensive ($99 – what is it about textbooks?), several of the important chapters are based on papers that Hall has written recently that are available through his website (www.esf.edu/efb/hall). If you are interested in more detail, I recommend checking out the papers (and related research and discussion on the website The Oil Drum).

The authors are so hard on the profession of economics that it is hard to imagine its use in a regular economics department. (One particularly biting critique: "Most of the time economists do not 'do science.' Rather they tell stories dressed up in mathematics.") But this book should be adopted by financial planners instead.

Financial planning, to be successful, must be based in reality. Recommendations are based on what is possible (including aspirations), in a world that includes risk and hardship, and takes into account multiple motivations. Most planners scorn the concept of "whoever dies with the most toys, wins," as do our clients, but that is the basis of most economics.

Further, with our focus on saving for the future (education and retirement), risk management, career development, and other topics, we appreciate the long-term impacts of decisions made today. The more planners understand about how the world works, what constraints may be looming, and how to evaluate various scenarios, the better will be the advice we give our clients. Just as planners have embraced behavioral economics for the insights it provides, learning about biophysical economics will add considerably to our skills and our wisdom.

Richard Vodra, J.D., CFP®, is the President of Worldview Two Planning of McLean, VA. He recently retired from a 27-year career as a personal financial planner. He is a member of the Board of the Association for the Study of Peak Oil (ASPO-USA). He can be reached at rvodra@worldviewtwo.com.